



The **2022** Africa Asia Pacific Accord, WFEO-CECB  
Capacity Building in Engineering Education International Forum,  
and the **Zimbabwe Institution of Engineers'**  
Biennial Conference

In Partnership with **UNESCO**

15 - 19 August 2022

Victoria Falls, Zimbabwe

**Elephant Hills Resort Conference Centre**




## DEDICATION

The Conference is dedicated to all the Engineering Professionals who were promoted to glory during the turbulent COVID-19 pandemic era. We promise to run well the race they aborted. May their dear souls rest in eternal peace.

## ABOUT THE VENUE

The Victoria Falls is one of the seven natural wonders of the world and a UNESCO Heritage Site. The Elephant Hills Hotel is the conference venue, and is situated 4kms from the Victoria Falls central business district, on a small hill. The hotel provides panoramic views of the Zambezi River and spray from the Victoria Falls.

This luxury hotel is decorated with an ethnic essence of Zimbabwe and even boasts an impressive miniature replica of The Victoria Falls in the middle. The Elephant Hills Hotel certainly does not lack entertainment with two swimming pools, tennis courts, squash courts and much more. The building with its thatched roof is an unmistakable landmark in the area and it blends well into the surroundings.



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**Theme - Engineering the Future through  
Quality Engineering Education, Partnerships,  
Capacity Building and Innovation**

# FOREWORD



**Dr Eng. Tammy Stevenson**

A philosopher, Sadhguru said, “What I know, I know and what I don’t know, I don’t know. Only then, are we open to possibilities.”

I am constantly challenged by my blind spots. We live in a fast-paced world filled with information overload; thus, an information diet is imperative. It helps to reflect and contemplate on important issues, which will lead to wise thought-out decision making.

When we acknowledge our capacity and limitations, we encompass the physical, emotional, and intellectual spheres, and strive to find ways to fill the gap. Using different lenses, we consider different scenarios faced with the realities of life and business. Our personal, individual attitudes toward engineering and toward society have positive or negative impact on our country's future.

However small the impact may be, each one of us should desire to have cherishable legacy. Engineering is indeed a noble profession, and the legacy of good engineers is a better physical world for those who follow them. Hence, we should never fear that our profession will become routine or dull. If it becomes, be rest assured that we would not be practicing it properly.

Engineering plays a key role in ensuring the growth and development of a country's economy as well as in improving the quality of life for citizens within the country.

I write this foreword to the proceedings of the ZIE Biennial Conference, in collaboration with Africa Asia Pacific Accord & WFEO-CECB International

Capacity Building in Engineering Education Forum.

The fulfilment of our aim is guided by the theme: Engineering the future through Quality Education, Capacity building, Partnerships, and Development of Innovative Infrastructure.

To explore the related thematic areas we bring together researchers, academics, and professionals from all over the nation and globally, to share strategies on finding engineering solutions to societal challenges or inadequacies through trainings, plenary sessions, paper presentations and round table discussions.

My sincere hope is that all attendees glean valuable engineering solutions that will enhance their careers resulting in more productive, innovative and policy changing professional engineers and technocrats.

In conclusion, I would like to extend my sincere appreciation to both the local and international Conference Planning Committees, for your unrelenting commitment and dedication resulted in the successful hosting of the conference. To our revered Sponsors and Partners, you have made this conference possible. We are eternally grateful for this opportunity to share our vision with you.

Be blessed for always as the conference delegates. Your active participation is highly cherished.

**Inserted by the ZIE Vice President and CPC Chairman: Dr Eng. Tammy Stevenson**

# GREETINGS

## GOODWILL MESSAGE FROM THE PRESIDENT OF THE FEDERATION OF AFRICAN ENGINEERING ORGANISATIONS



**ING. MRS CARLIEN BOU-CHEDID**

I bring you greetings from the community of African engineers on the occasion of the 2022 Africa-Asia Pacific Accord, WFEO-CECB International Capacity Building in Engineering Education Forum and Zimbabwe Institution of Engineers Biennial Conference. The Federation of African Engineering Organisations (FAEO) has as one of its key goals, the development of a sufficient, diverse, inclusive and competent engineering workforce that engages in safe, ethical and sustainable practice. The theme of this conference, “Engineering the future through quality engineering education, partnerships, capacity building and innovative infrastructure”, thus addresses a topic that is important to FAEO.

Preparing engineers for the future workplace has become very challenging because of the fast-changing landscape. Some very basic competencies on which we used to rely, have become less relevant with the passage of time and we find that engineers need to know more and more about an ever-increasing variety of issues to be able to survive in a work environment which may not be entirely local but global.

As a way of addressing these issues, FAEO and The Federation of Engineering Institutions of Asia and the Pacific (FEIAP) signed an MoU on July 2, 2020, to develop a comprehensive framework for accreditation of education qualifications and

competency of engineering personnel. This later resulted in the historic signing of the Africa Asia Pacific AAP Accord on April 16, 2021 which creates the framework for the establishment of an international standard of engineering education. This conference is one of the fruits of the AAP Accord.

We are also pleased with the FAEO’s collaboration with the South African Department of Science and Innovation (DSI), which made possible the pre-conference training workshop on Water and Sanitation Infrastructure Assets Maintenance to Local Authorities’ Management and Engineering Practitioners in the SADC region.

Finally, we welcome the collaboration with other important international organisations, including the World Federation of Engineering Organisations (WFEO), UNESCO, and the World Council of Civil Engineers (WCCE). We have no doubt that their participation in this conference will enrich its content and contribute to its success.

**We wish all participants fruitful deliberations.**

## CONFERENCE PARTNERS



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# MESSAGES

## GOODWILL MESSAGES



### 1.1 Message from the WFEO-CECB

**Eng. Martin Manuhwa – WFEO Vice President and CECB Chair**

“Dear Colleague Engineering Practitioners, Excellences, Ladies and Gentlemen”

On behalf of the World Federation of Engineering Organisations Committee on Engineering Capacity Building (WFEO-CECB), I am very delighted to welcome you to the 2022 Africa-Asia Pacific Accord, WFEO-CECB Capacity Building in Engineering Education International Forum and Zimbabwe Institution of Engineers Biennial Conference held from the 16th to the 20th of August 2022 in Victoria Falls, Zimbabwe.

The WFEO CECB is proudly hosted by the Engineering Council of Zimbabwe (ECZ). WFEO-CECB is together with partners promoting two critical preconference events namely, “capacity building training on water and sanitation infrastructure assets maintenance to local authorities management and engineering practitioners in SADC” and “Robotics and Artificial intelligence Worksop and Bootcamp for school children”, both supported by SADC, UNESCO and the South African Department of Science and Innovation (DSI). We believe, engineering capacity building is a lever for economic, social, and sustainable development, and is recognized as a priority in the success of every country.

This august international forum and conference is intended to provide a befitting opportunity for the interactions among the professionals, experts, policy makers and the public from around the world with the aim of advancing engineering capacity building, innovative infrastructure, quality and relevant engineering education and professional practice that delivers the quality of life we want. The conference will have speakers who will share innovative ideas regarding engineering the future to accelerate the achievement of the Sustainable Development

Goals (SDGs), the Africa Union Agenda 2063 (The Africa We Want!), National Development Strategies and Policies, Vision 2030, and other developmental aspirations – None of which will be achieved without Engineering.

Engineering professionals are the custodians of infrastructure who facilitates and enhance not only their own knowledge, but also assist decision makers from all levels of society to ensure a sustainable world for all. Engineers are needed in increased numbers and right quality for the growth and development of essential infrastructure such as airports, roads, railways bridges, dams and for improved outcomes on water, energy, climate change adaptation and mitigation, smart and sustainable cities, natural disaster resilience and the quality of life in general. To achieve this we need robust engineering standards, ethics and professionalism.

I hope that you will find this conference and your stay in Victoria Falls both valuable and enjoyable. I sincerely thank you for taking part in this valuable conference as speakers or as participants. This message from the WFEO CECB is in solidarity with all our international partners, who include the Federation of African Engineering Organisations (FAEO), the Federation of Engineering Institutions in Asia and Pacific (FEIAP) and UNESCO, for in Africa we say, “If you want to go fast, go alone, but if you want to go far, let’s go together.” Together lets go with an “Engineering the Future through Quality Engineering Education, Partnerships, Capacity Building and Innovative Infrastructure” mindset!

Siyabonga, Tatenda, Asante Sana, I thank you.

# MESSAGES

## GOODWILL MESSAGES



### 1.2 Message from the ECZ Chairman

**Eng. Israel Rwodzi**

Dear Engineers and Distinguished Colleagues,  
WELCOME.

On behalf of The Engineering Council of Zimbabwe (ECZ), I would like to extend our invitation and warm welcome to participate in the 2022 Africa Asia Pacific International, WFEO-CECB Capacity Building in Engineering Education Forum, and the Zimbabwe Institution of Engineers' Biennial Conference which is a crucial physical interaction.

It is with joy that this form of conference comes back to our lives after more than 30 months of dormancy due to the health havoc which was caused by the COVID 19 epidemic in our region and the world over.

This event which will be taking place in the resort town of Victoria Falls over a full active period of four days will bring back the good and friendly practice of information sharing and active discussions in the appropriate engineering advances of the world, in particular the areas that affect the development of the African region. The participation by our international counterparts is critical to benchmark the set targets of the region against our international peers.

The selection of Victoria Falls as the venue of the meeting is not just because of its reputation as a

tourist destination, but more than that, it has a proven record of hosting various kinds of international events. It is also an opportunity to see boundless variety of unique sceneries in particular the falls, which is a UNESCO World Heritage Centre, as well as countless traditional and other cultural heritages within the vicinity.

To complement these, the distinct culturally rich province offers an extensive range of classic hotels, fascinating sceneries, a genuinely friendly and charming people practicing an authentic ancient heritage culture and almost unlimited recreational and cultural options.

We trust that the time you spend with us in Victoria Falls will be most rewarding, which leads to many experiences and friendships. We are looking forward to welcoming you to the conference and hope that your participation will be productive as well as memorable.



# MESSAGES

## GOODWILL MESSAGES



### 1.3 Message from the ZIE President

**Eng. T. Mpala**

On behalf of the Zimbabwe Institution of Engineers, the Board, Secretariat and members of ZIE, it gives me great pleasure and gratitude to warmly welcome you to the 2022 Africa-Asia Pacific International, WFEO-CECB Capacity Building in Engineering Education Forum and Zimbabwe Institution of Engineers Biennial Conference.

This year's theme of the conference is "Engineering the future through quality engineering education, partnerships, capacity building and innovative infrastructure". This conference could not have come at a better time, where global challenges call for coordinated engineering solutions and where capacity building and partnerships demand our focused attention to meet and solve ever-changing demands and technological challenges.

The setting of this international conference in Victoria Falls is a major milestone in the global engineering calendar as it brings together renowned engineers, scientists, professors, industrialists, educators and governments in one place to discuss and set pathways for sustainable, quality engineering education, implementation and innovative infrastructure.

Therefore, this beautiful location; Victoria Falls; a UNESCO world heritage site, is befitting for such

an esteemed gathering.

Our conference will be graced and opened by His Excellency, the President of the Republic of Zimbabwe, Cde. E.D. Mnangagwa, which in itself is testament of government's acknowledgement and appreciation that engineering is the future and bedrock to our country's thrust to attain an upper middle-income society by 2030.

To our colleagues, friends and visitors who have committed significant resources and time just to be here physically with us, I say a hearty welcome to you all. We welcome you with open arms and a friendly smile as true Zimbabweans do, and say feel free to embrace and enjoy our spirit and culture.

Happy engineering deliberations to you all. Thank you!

# WHO IS WHO

## SOME OF OUR CONFERENCE ATTENDEES

### **Eng. Thami Mpala – President Zimbabwe Institution of Engineers (2021-2023)**

**Eng. Thami Mpala** is the current President of the Zimbabwe Institution of Engineers, a term that began on the 1st of August 2021 and will run up to the end of August 2023. Eng. Thami Mpala, is the Managing Partner at Hydro-Utilities Consulting Engineers (Pvt) Ltd, a position, he has held for 12 years.

Eng. Mpala is a registered, professional civil engineer with 23 years' post graduate experience in the infrastructural engineering field. His specialization within the civil engineering discipline is focused strongly on water supply systems, water and wastewater treatment, hydraulics and water resources management.

His work experience includes 6 years (between 2006 – 2012) working as an Infrastructure Design Engineer with Sweco Group Consulting Engineers (formerly Grontmij) in Scotland, United Kingdom before returning to Zimbabwe. His experience is largely within the consulting sector, although he has previously enjoyed a three-and-a-half-year stint as a Research Engineer with the Scientific Industrial Research and Development Centre from 2003 – 2005.

Engineer Mpala joined the Zimbabwe Institution of Engineers (ZIE) in 1998 as a Graduate Engineer soon after his BSc graduation. Eng Mpala is currently a holder of an MBA degree with Steinbeis University (Germany) having completed in 2019. He holds a Master's degree in Water Resources Engineering & Management from the University of Zimbabwe (2002), and a Bachelor of Science degree in Civil Engineering with the

University of Hertfordshire, UK (1998). Eng.

Mpala is a Fellow of the Zimbabwe Institution of Engineers and sits on the ZIE Executive Board. He is a Member of the Institute of Directors Zimbabwe, a Visiting Lecturer at the University of Zimbabwe and a curriculum reviewer at the Zimbabwe Council for Higher Education.

Eng. Mpala has held the post of Managing Partner of Hydro-Utilities Consulting Engineers (Pvt) Ltd since 2012. Hydro-Utilities is a registered civil and structural engineering design firm with its headquarters in Harare, that provides engineering design and project management services. He has taken Hydro-Utilities to great strides since joining in 2012 and has been able to double the company's gross annual turnover in the space of just under 10 years.

He has spearheaded a number of large infrastructure projects in the country and these involve multi-story buildings, bulk water supply, housing developments and wastewater treatment plants.

Hydro-Utilities have a team of dynamic and competent professional engineers and technicians, whom are all registered and deliver swiftly on projects, and this is a team that Eng. Mpala has built from scratch. Eng. Mpala has tremendous passion for the engineering industry and his mandate is to see the uplifting of the profession and contribution to the infrastructural development in the country.

# WHO IS WHO

## SOME OF OUR CONFERENCE ATTENDEES



### Engr. Unyime Enobong Okure

**Engr. Unyime Enobong Okure** is a Plant Design expert and Head of Department Health Safety and Environment in krisQuest Energy Portharcourt-Nigeria and Senior Resource Lecturer in Petroleum and Maritime Training Institute, Nigeria. Previously she worked in Kuokeno integrated services as field Support Engineer on Solar Generator Installations/ Maintenance.

She obtained her Bachelor of Engineering degree in Chemical Engineering from the Prestigious University of Port Harcourt and Masters of Technology in Chemical/Petrochemical Engineering from Rivers State University, Nigeria.

Currently she is a PhD researcher in Chemical Engineering, Niger Delta University, Nigeria. Unyime has performed research in a wide range of academic fields which include; Bio-based Transformer oil, Biofuels, Bioremediation, Plant Design, environment and Sustainability, energy and fuels. Engr. Unyime is an active Member - Scientific and Innovation Committee -African Scientific Research and Innovation Council (ASRIC).

In addition, she is a Corporate Member of The Association of Professional Women Engineers of Nigeria (APWEN) where she advocates the inclusion of females in the engineering sector and female representation in STEM courses and projects in the engineering field.

More so, she is a member Council for the Regulation of Engineering in Nigeria [COREN], Corporate Member, Nigerian Society of Chemical Engineers, Corporate Member, Nigerian Society of Engineers and Member, International Project Management Professionals.

Finally, Unyime is a leader. When she is not working, she spends her time in humanitarian service as the CEO/Founder of an NGO called "Save the Boy-Child initiative" aimed at reducing, rehabilitation and mentoring of abused street boys. Ms Okure's hobbies are photography, cooking, mentoring, coaching, spending time in nature, swimming and travelling.



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### Michelle Rutendo Sibongile Maphosa

**Michelle Rutendo Sibongile Maphosa** is the author of Sibo the Engineer series, a Zimbabwean children's educational program on STEM. She is a passionate advocate for the increased quality of STEM education in Zimbabwe, as well as the uptake and retention of women in STEM. She is a civil engineer, graduating from the National University of Science and Technology in Bulawayo in 2017.

Michelle is a certified project management professional with experience in planning and construction of transportation and housing infrastructure in the developmental sector. She is the cofounder of Tea in 60, a virtual mentorship and networking platform for Zimbabwean girls and women in STEM, and its offshoot STEMExplorers, which focuses on the early introduction of STEM to children under 12 years.

# WHO IS WHO

## SOME OF OUR CONFERENCE ATTENDEES



### Dr. Eng. Tamara Mary Stevenson

**Dr. Eng. Tamara Mary Stevenson** is a holder of a PhD in Project Management (UP2016) 'Thesis title: Sustainability of quality improvement programmes in a Heavy engineering manufacturing environment - a system Dynamics approach', Certificate in Marketing (IMM-SA 2011), Masters in Mechanical Engineering MSOM (UZ-2010), Galileo Systems Certificate (GZ-2008), Leadership Development (2008- Celebration International College), Technical Support Certificate (ArcGIS-UZ-2007), Diploma in Mining Engineering (ZSoM-1997), Investment in Excellence (2006- The Pacific Institute (TPI) and BSc degree in Mechanical Engineering (UZ-1994).

She worked at Ashanti Mine from 1996-1998 as an Underground Section Engineer and ventured into entrepreneurship as a Technical Sales Manager (1998-2005), Management Consultant (2005, Holistic Information Systems), Operations Manager (2007, Racewin Trading) and GIS Marketing Director (2008-2010, GIBS).

Currently she is a Manufacturing and Production Factory Manager at Mitek Zimbabwe specializing in sheet metal forming. Tammy was awarded the Young Businesswoman of the year, (1999), BID Business Award (2000), WECA/ZNCC Nominee (2014). Board Chairman of the year 2021- Gold winner on the women's category (MEGAFEST Business Award).

Under JCI she was awarded the Best Local CRC Programme National Award, Active Citizenship Award, Best Local Project Award, Outstanding Member, Most Travelled Member and Most Outstanding Individual Member National.

She has attended the IDC Group maintenance workshop (Price Waterhouse), Situational Leadership seminar (Ashanti) and Performance Management Bentley Breakfast Seminar (Zimbabwe Institution of Engineers), Women in STEM seminar (Silicon Valley Tech women).

Tammy participated in the adjudication of NESAC competitions (2016). She presented a paper on Hybrid Maintenance Management System - Case study Mitek Zimbabwe at IConIA Conference (2017).

Tammy is part of the following committees: UZ Student Paperette Committee Member representing ZIE Mashonaland area- a preliminary of the NESAC competition; ZIE Environmental Division committee member; ZIE Conference Planning Committee Member- Corporate Affairs, Media and Public Relations Sub-committee Vice Chair.

Tammy is The Board Chairman of CMED, a JCI Zimbabwe Alumni, Member of the Institute of Mechanical Engineers, Engineering Council of Zimbabwe, Vice President of the Zimbabwe Institution of Engineers and its Conference Planning Chair, and sits on the advisory board of NUST IME Department. She is the Past Chair of the (Malaysia - Zimbabwe Business) MYZIMBIZ network.

# WHO IS WHO

## SOME OF OUR CONFERENCE ATTENDEES



### **Ivy Mwangi Getanda**

**Paper Title:** Optimization of Career Bootcamps as a capacity Building Effort for Engineering Students and Graduate Engineers.

**Ivy Mwangi Getanda** is a Fifth Year, Civil Engineering Student at Jomo Kenyatta University of Agriculture and Technology, Kenya. She is also an Attaché at the State Department for Housing and Urban Development, Kenya. She has actively been involved in various site activities and worked collaboratively with Graduate and Professional Engineers during the Attachment.

She has participated in Mentorship workshops through the State Department for Housing and Urban Development and The Institution of Engineers of Kenya. In addition, through The Society of the Engineering Students, (JKUAT) she passionately mentors students in High Schools

and Primary Schools to appreciate Science, Technology, Engineering and Mathematics. Furthermore, she has presented a paper at the Institution of Engineers of Kenya International Conference, 2021 entitled: The Future of Engineering Graduates and their Role in Economic Recovery in Kenya. Her engagements in mentorship drove her to research on the benefits of Career Boot Camps and how they impact the overall career growth of students and Graduate Engineers in particular.

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### **Hagreaves Kumba**

**Topic:** “Review on how to bridge the gap between Engineering Education and Industrialisation for Sustainable Development in Zimbabwe.”

Hagreaves Kumba is a young graduate engineer with passion in research and development. He earned his undergraduate degree at Chinhoyi University of Technology, and he was studying Bachelor of Engineering Honours Degree in Production Engineering. He is currently pursuing post-graduate studies in South Africa, a final year student in the department of Industrial Engineering at Durban University of Technology studying Master of Engineering in Industrial Engineering. Area of research or expertise: Energy, Engineering Education, Optimisation and Sustainable Development

Cliford Gobo is the Acting Managing Director of Traffic Safety Council of Zimbabwe and a Visiting Lecturer at Chinhoyi University of Technology. Cliford holds Bachelor’s degrees in Economics and Accounting from the University of Zimbabwe



and Great Zimbabwe University, respectively.

He is also a holder of three Master’s degrees in Finance & Investment; Strategic Management, and Professional Accounting & Corporate Governance from the National University of Science and Technology, Chinhoyi University of Technology and Great Zimbabwe University, respectively.

He is currently a Ph.D. finalist at Binary University in Malaysia. His areas of research are: transport safety & emerging technologies; connected and autonomous transport; speed management; driver simulation; the causes and consequences of road traffic collisions and other unintentional injuries, as well as economic benefits of road safety measures.

# WHO IS WHO

## SOME OF OUR CONFERENCE ATTENDEES



### Zvikomborero Hweju

**Zvikomborero Hweju** is currently a lecturer in the department of mechatronics engineering at Chinhoyi University of Technology. He is a PhD candidate in Mechatronics Engineering with Nelson Mandela University. Zvikomborero has an M.Eng in Mechatronics Engineering from Nelson Mandela University and a B.Eng in Mechatronics Engineering from Chinhoyi University of Technology.

His research interests are in ultra-high precision machining, advanced manufacturing, design and analysis of Unmanned Aerial Vehicles (UAV) and autonomous robots. Zvikomborero is currently the local National Engineering Students Awards Competition (NESAC) Chairperson at Chinhoyi University of Technology. Zvikomborero has written several papers on computational intelligence-based modelling of engineering systems.



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### Marjorie Munyonga

**Marjorie Munyonga** is an astute marketer and business leader with over 18 yrs experience in marketing, advertising, corporate communications, public relations, customer experience management as well as strategic management.

Currently Marjorie is the Head of Corporate Communications and Marketing at the Zimbabwe National Water Authority where she has successfully spearheaded the organisation's brand management efforts resulting in ZINWA being the 2012 Super Brand in the parastatals category.

Marjorie holds a Bachelor of Commerce Degree in Marketing, a Master of Science Degree in Strategic Management, a Chartered Institute of Marketing, CIM (UK) Professional Diploma in Marketing and a Post Graduate Diploma in Marketing with CIM (UK). She is currently studying for a Doctorate of Business Administration with

Binary University in Malaysia and Chinhoyi University of Technology.

She is also full Chartered Institute of Marketers (CIM) member and a ZimChartered Marketer from the Marketers Association of Zimbabwe (MAZ), where she is a member. Marjorie is a Non-Executive Director of Tobacco Industry and Marketing Board (TIMB) and chairperson of the Production and Marketing Committee. She is also the Contact Centre Association of Zimbabwe Service Excellency Ambassador.

Marjorie also sits on the Advisory Board of the School of Wildlife, Ecology and Conservation at Chinhoyi University of Technology. She is also the Megafest 2017 Female Manager of the year, and the Corporate Communications Personality of 2021. Marjorie has also served on the Zimbabwe Institute of Public Relations (ZIPR) Council. During her spare time Marjorie will be teeing off on the golf course.

# WHO IS WHO

## SOME OF OUR CONFERENCE ATTENDEES



### Eng. Martin Manuhwa

**Eng. Martin Manuhwa** is a Professional Engineer who is the current Chairman of the Capacity Building Committee of the World Federation of Engineering Organisations (WFEO). He sits in the Africa's Major Groups and Other Stakeholders as alternative Chair of the Scientific and Technological Community which is hosted by UNECA. He is the current Chairperson of the Chinhoyi University of Technology (CUT) Council in Zimbabwe. Martin is also the Chairman of the Ziscosteel resuscitation board. He is a past Chairman of the Engineering Council of Zimbabwe (ECZ) and a Past President Fellow of the Zimbabwe Institution of Engineers (ZIE). He is also a Past president of the Southern African Federation of Engineering Organisations (SAFEO). He is the Immediate Past President of the Federation of African Engineering Organisations (FAEO). He is a member the Zimbabwe Higher Education Council (ZIMCHE), where he chairs the ICT Committee.

Martin is an electrical engineer, energy expert and consultant engineer. His engineering practice is in energy, construction projects worksite project implementation and management. Martin is the Managing Consultant of the Zimbabwe Africa Infrastructure Development Group (ZAIDG), a company that specializes in engineering procurement and construction project management (EPCM) and consulting engineering. ZAIDG works with Hatch Africa (Pty) Ltd in Zimbabwe to deliver infrastructure solutions in the power industry, mining and public arena. His company, ZAIDG is together with Hatch, the technical advisor on the Kariba Extension (now successfully commissioned) and the Hwange Power Station Expansion Projects currently under construction.

Martin is a Distinguished Fellow of the FAEO, fellow of the African Scientific Institute (ASI),

fellow of the Academy of Engineering and Technology of the Developing World (AETDEW), Foreign Fellow of the ASEAN Academy of Engineering and Technology (AAET), a Past and Foreign Fellow of the Ghana Institution of Engineering. He has received numerous awards, including the ZIE SKF service to engineering. He was also awarded for service to the World Federation of Engineering Organisations in 2019. He has delivered various infrastructure papers at occasions like the UNESCO Africa Engineering Week in various African Countries, World Energy Forum in China, OECD in Paris, World Engineering Conferences in Australia, Japan and Switzerland, the Africa Union and the Global Engineering Conference and at the Royal Academy of Engineering, UK. He has been felicitated by many Engineering Institutions in the World most notably in Ghana and India. At the 2021 Engineering Excellence Awards, he was conferred with the prestigious FAEO distinguished fellowship and the FAEO President's Special Award for services to Engineering in Africa by the New FAEO Executive Board.

Martin has set in various boards in Zimbabwe and abroad including Kariba Hydro Power Station Company, Zimbabwe Broadcasting Corporation (ZBC), Global Infrastructure Anti-corruption Centre, and the Zimbabwe School of Mines. Martin was the chair of the Electrical and Mechanical Industry Sector Committee for National Manpower Advisory Board (NAMACO) which he represented in the NAMACO Council. Martin also teaches part time Big Data Analytic and Software Project Management at the Zimbabwe National Defence University, he has taught at the University of Zimbabwe and Bindura University of Sciences.

# WHO IS WHO

## SOME OF OUR CONFERENCE ATTENDEES



### Dr. Chuah Hean Teik

**Dr. Chuah Hean Teik** graduated with a BEng (First Class Honours), MEngSc and PhD in electrical engineering, all from University of Malaya, Malaysia. He was President of Universiti Tunku Abdul Rahman (UTAR) in Malaysia from 2008-2019, where he is now an Emeritus Professor. He is currently a Consultant Professor to Northwestern Polytechnical University, Xian, China; and University Advisor to University Sanya, Hainan, China. His research interests include microwave remote sensing and applied electromagnetics.

He has authored/co-authored more than 280 papers in international journals and conferences. Dr. Chuah has received many awards locally and internationally.

Among them include the inaugural Young Engineer Award by the Institution of Engineers, Malaysia IEM in 1991; 1990 Young Scientist Award at the 23rd General Assembly of the International Union of Radio Science (URSI) at Prague, Czechoslovakia; 1993 Young Scientist Award at the 24th General Assembly of URSI at Kyoto, Japan; 1995 Young Scientist Award (Industrial Sector) by the Malaysian Ministry of Science, Technology and the Environment; 1999 Malaysian Toray Science Foundation Science and Technology Award; 2017 Outstanding Engineering Achievement Award by the ASEAN Federation of Engineering Organisations; the IEM Engineering Hall of Fame in 2019 for his outstanding professional achievements, 2019 FEIAP Engineer of the Year, and 2019 WFEO Medal of Excellence in Engineering Education.

In 2021, Dr Chuah received the Chinese Government's Friendship Award, which is the People's Republic of China's highest award for foreign experts who have made outstanding contributions to China's economic and social

development, as well as effort in facilitating friendly international exchanges in culture, education, science and technology.

Dr. Chuah is an eminent technical leader. He is current Chairman of FEIAP Standing Committee on Engineering Education, and Chairman of the Africa, Asia and the Pacific (AAP) Accord Engineering Education Council. He is the Immediate Past President of ASEAN Academy of Engineering and Technology (AAET), Past President of the Federation of Engineering Institutions of Asia and the Pacific (FEIAP) 2011-2015, and Past President of IEM (2009-2011).

He is a Senior Fellow of the Academy of Sciences, Malaysia (ASM); Distinguished Honorary Fellow of IEM; a Founding Fellow of the AAET and The Academy of Engineering and Technology of the Developing World; Fellow of the Institution of Engineering and Technology, UK; the Institute of Electrical and Electronics Engineers, USA; and the Electromagnetics Academy, USA.

He is currently a member of the Disciplinary Committee Panel under the Advocates and Solicitors' Disciplinary Board, Malaysia, the Malaysian Engineering Accreditation Council (EAC), the Malaysian Engineering and Technology Accreditation Council (ETAC) and the Civil Aviation Authority of Malaysia.

In recognition of his valuable services and contributions, he was conferred an Order of Chivalry, Darjah Setia Pangkuan Negeri, which carries the title "Dato", by the Governor of Penang in July 2005, and conferred the Panglima Setia Mahkota Award, which carries the title "Tan Sri" by the Yang DiPertuan Agung, The King of Malaysia, in September 2019.



# WHO IS WHO

## SOME OF OUR CONFERENCE ATTENDEES



### Eng. Joy Makumbe

**Eng. Joy Makumbe** is a qualified Civil, Water, and Sanitation Engineer, with more than 18 years of experience in the field. She has led teams of project personnel for the successful completion of various water and sanitation projects in Tanzania, Uganda, and Zimbabwe.

Joy was part of the 5 Zimbabwean women representatives in the 2015 TechWomen program held in San Francisco. Her vision to see more women in Africa take up positions of impact and influence in the Engineering and Science fields led her to start the Joy Makumbe trust in 2016.

A trust dedicated to empowering women with entrepreneurial skills and career guidance. Young girls in our communities lack role models in STEM careers. Joy started documenting her journey in tech through a YouTube channel titled The Tech Girl and she has written a book, “Tech Girl Diaries”, which is available on Amazon.

She hopes to motivate, inspire, and build girls’ interest in STEM careers as careers of choice. She also founded the Tech Girl Mentorship Program to pay it forward in her community and beyond.



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### Muchaneta Munamati

**Muchaneta Munamati** is the Science Project Coordinator at UNESCO Regional Office of Southern Africa – Harare, Zimbabwe.

She coordinates projects such as Governance of Groundwater Resources in Transboundary Aquifers’ (GGRETA) in Southern Africa, A Community-focused Flood Early Warning System for the BuPuSa Transboundary River Basins and Science Technology and Innovation programmes. Muchaneta was also instrumental in the development of a groundwater project funded by Adaptation Fund.

The USD5million project whose title is Strengthening local communities’ adaptive capacities and resilience to climate change

through sustainable groundwater utilisation in Zimbabwe’ is aimed at increasing local communities’ adaptive capacity and resilience to climate change through sustainable groundwater utilisation for food security and other productive uses in rural areas of Zimbabwe.

Muchaneta has over 10 years experience in water research and coordinating water-related projects. She is a holder of a Masters degree in Integrated Water Resources Management and a PhD in Water and Sanitation both from the University of Zimbabwe. She has published a number of articles in peer-reviewed journals as well as book chapters.

# ABSTRACTS

## List of Accepted Conference Abstracts

n	RESOURCE PERSON	EMAIL ADDRESS	PAPER TITLE
1	Eng. Joy Pedzisayi Makumbe	pedzie@yahoo.com;	A Review of the Role Played by Sustainable Infrastructure in Zimbabwean Cities: A Focus on the Contributions to the Economic Growth of the Country
2	Prof. Wang Xue Tsinghua University P.R. China	wangxue@mail.tsinghua.edu.cn;	Achievement oriented engineering education - professional certification
3	Engr. Unyime Enobong O. (Niger)	okureunyime@gmail.com;	Achieving Sustainability in Robotics through Eliminating the Skill Gap in Academia and Industry
4	Ir. Academician Emeritus Professor Tan Sri Dr. Chuah Hean Teik	tanyechin@gmail.com; chuahht@gmail.com;	Benchmarking of Engineering Education for Regional and International Mobility: A FEIAP Experience
5	Ben Edenseting	edenseting77@gmail.com;	Bioethanol Production through simultaneous Saccharification and Fermentation Process: Energy Option for Nigeria
6	Michelle Rutendo Sibongile Maphosa	michellemaphosa@gmail.com;	Catching them Young: Sibo the Engineer Project
7	Dr. Eng. T. Stevenson1, Eng. N. Gwangwadze2	stevensont@mittek.co.zw,	Complex Challenges Faced in Engineering Education: Case Study Zimbabwe
8	Engr. Nnadikwe Johnson (Nigeria)	johnsonnnadikwe@gmail.com	Design Method of Engineering Education Standard Assurance in African Educational Field
9	Mary Nyaradzayi Chikuruwo, Tatenda Mpisa, Mupfumira Portia, Milton Manyangadze, Harmony Musiyarira	nyarihugh@gmail.com; mchikuruwo@hit.ac.zw;	Development of a Computerised Maintenance Management System (CMMS) Learning Tool: Case Study for Harare Institute of Technology
10	Engineer Mainford Mutandavari and Engineer Charity Chigwada	mmutanda.vari@gmail.com cherry3chig@gmail.com;	Digital infrastructure as a key enabler in engineering education and capacity building in Zimbabwe
11	Eng. Martin Manuhwa	mmanuhwa1@yahoo.com;	Digital Transformation Through Engineering Capacity Building and Quality Education for New National Development Models: A Disruptive New World Order in Africa's Favour
12	Ir. Prof Dr Norlida Bunyamin, IEM President	nbuniamin@gmail.com;	Education of Professional Engineers and Engineering Educators
13	Engr. Nnadikwe Johnson (Nigeria)	johnsonnnadikwe@gmail.com;	Engineering Capacity Building in Developing Nations
14	Zvikomborero Hweju	hwejuzvikomborero@gmail.com;	Engineering Education for the Accomplishment of Sustainable Development Goals
15	1Engr.Unyime Enobong Okure and Engr. Ovens Ehimatie Festus	Ovnslid@yahoo.com;	Engineering Institution-Industry Partnership a Panacea for Quality Engineering Education, Innovative and Sustainable Growth

# ABSTRACTS

## List of Accepted Conference Abstracts

n	RESOURCE PERSON	EMAIL ADDRESS	PAPER TITLE
16	Marjorie Munyonga	mmunyonga@zinwa.co.zw;	Engineering the alternative way: Locating the place of soft skills in the success of the engineering profession
17	Engr. Ibe Raymond Obinna (Nigeria)	drobinnaibe2017@gmail.co;	Implications of Engineering Education and Capacity Building in Africa
18	Cliford Gobo - Acting Managing Director: Traffic Safety Council of Zimbabwe	nyoni@trafficsafety.co.zw;	Internet of Things (IoTs) and Road Safety: Challenges and Opportunities for Africa
19	Engr. Unyime Enobong O. (Niger)	okureunyime@gmail.com;	Novel Algorithm for Enhancing Power Transformer Protection Sensitivity
20	Ivy Getanda (Kenya)	getandaivy@gmail.com;	Optimization of Career Bootcamps as A Capacity Building Effort for Engineering Students and Graduate Engineers
21	Mary Chikuruwo, Samson Mhlanga,	nyarihugh@gmail.com; samson.mhlanga@nust.ac.zw; tngwarati@gmail.com;	Redesign and weight optimization of chassis and suspension system for a mini tractor
22	Hagreaves Kumba (SA)	hagreaves3@gmail.com	Review on how to bridge the gap between Engineering Education and Industrialisation for Sustainable Development in Zimbabwe
23	Zvikomborero Hweju	hwejuzvikomborero@gmail.co;	Role of Smart Engineering Infrastructure in Creating Safe Learning Environments
24	Ir. Dr. Tan Yean Chin	tanyeanchin@gmail.com;	Setting up of Federation of Engineering Institutions of Asia and the Pacific (FEIAP) Graduate Engineering Personnel Registry
25	Stanley Kudzai Mwalamba	stankudzi@zndu.ac.zw;	Spatiotemporal Analysis of Bottling Biogas: A Case of Harare Sewage Treatment Plant
26	Eng. Ronald Robertson -Tarugarira	robertsonr263@gmail.com;	Strategies for Engineering the future through Quality Engineering Education, Capacity Building and the Development of Innovative Infrastructure: The Case of Global South Countries
27	Muchaneta Munamati	m.munamati@unesco.org;	Towards the implementation of the recommendations of the SADC Engineering Needs and Numbers Study
28	Allen Ditima, Mary N.H Chikuruwo, Harmony Musiyarira, Milton Manyangadze	nyarihugh@gmail.com; mchikuruwo@hit.ac.zw;	Underground Mine Safety Monitoring and Alerting System
29	Eng. Avitol Nkweendenda	avitol.nkweendenda@ZAMBEZIRA.ORG;	TBA

# ABSTRACTS

## NARRATION of Accepted Conference Abstracts

### 4.0 Introduction

It is the purpose of this instalment to outline the diverse abstracts that have been accepted for the named conference. Delegates are advised to refer to the related conference programme in preparation of the requisite active participation, both on plenary and breakaway sessions.

#### **4.1 Achieving Sustainability in Robotics through Eliminating the Skill Gap in Academia and Industry**

##### **Unyime Enobong Okure**

Department: Chemical Engineering  
Niger Delta University, Wilberforce Island, Bayelsa  
Okureunyime@Gmail.Com

##### **Uduak Godwin Etokakpan**

Department: Electrical Electronic  
Akwa Ibom State Polytechnic, Ikot Osurua, Akwa  
Ibom State  
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Global and national need for highly skilled scientific and technical personnel (engineers and researchers) in robotics is the topic of this article. Text-mining of open-access openings and in-depth interviews with experts are used to get information about global trends and national trends, respectively.

Interdisciplinary and hard and soft skills are examined in the research. The need for soft skills is growing, while the demand for hard skills (particularly digital) isn't easing.

Programming and understanding of specialist software packages are essential, but must be supplemented by practical abilities (assembly, welding, soldering). Robotic systems have a wide variety of applications, which necessitates the development of new, cross-disciplinary talents (knowledge of artificial intelligence, new materials, and biology).

Because of the rapid advancement of technology, soft skills like communication, self-motivation, and openness to new ideas are becoming more important. Different nations have similar lists of sought-after abilities. The findings may be used to build strategies targeted at reducing the skill gap in future technical fields.

Keywords: engineers, research and development management, robotics, demand for skills, skill set

#### **4.2 A Review of the Role Played by Sustainable Infrastructure in Zimbabwean Cities of Zimbabwe: A Focus on the Contributions to the Economic Growth of the Country**

##### **Engineer Joy Pedzisayi Makumbe**

pedzie@yahoo.com;

As developing countries urbanise at unprecedented rates, cities play a more important role than ever in the attainment of the Agenda 2030, which envisages a world grounded in universal respect for human rights and human dignity, the rule of law, justice, equality and non-discrimination. This is achieved through meeting the SDGs targets and ensuring a proper response to climate change and preventing the loss of biodiversity.

As cities continue to grow and sprawl outwards, intermediary towns are born. It is estimated that by 2050, cities will account for the majority of the global population. But these will not necessarily be, nor need to be, very big cities. In fact, by 2030, cities with less than 1 million inhabitants could account for 32% of total urban population growth in Latin America, 38% in Asia and 47% in sub-Saharan Africa.

Among these cities, intermediary ones hold a particularly important and transformative potential. A study of infrastructure in various cities in the different Provinces of Zimbabwe was done through literature review, document review

and observed data to record their economic activities and establish the relationship between sustainable infrastructure provision and their contributions to the GDP of the country. The presentation describes the sustainable infrastructure in these cities and establishes the existing capacity and the potential the economic development, job creation and the consumption of local products, goods and services from the study areas.

Keywords: urbanise; climate change; intermediary; sustainable; development

#### **4.3 Setting up of FEIAP Graduate Engineering Personnel Registry**

##### **Ir. Dr. Tan Yean Chin**

tanyeanchin@gmail.com;

Secretary General, the Federation of Engineering Institutions of Asia and the Pacific (FEIAP) & Past President, the Institution of Engineers, Malaysia (IEM)

The Federation of Engineering Institutions of Asia and the Pacific (FEIAP) will set up a FEIAP Graduate Engineering Personnel Registry (FGEPR) which will allow FEIAP Members to register its individual graduate engineering personnel who fulfilled the criteria set in this document.

This FEIAP Engineering Personnel Register (FGEPR) as it shall be called will be under the auspices of FEIAP comprising of graduate engineers, graduate engineering technologists and graduate engineering technicians of FEIAP member economies (called “FEIAP Graduate Engineering Personnel”).

Similarly, for Africa, Asia and the Pacific Accord (AAP Accord), there will be AAP Graduate Engineering Personnel Registry (AAPEPR) to also be set up when AAP Accord engineering education guidelines have been implemented and fulfilled by members of the AAP Accord.

The FGEPR will pave the way to enhance their mobility and networking at international stage and prepare them to face future challenges to be successful engineering personnel. FEIAP empowers each member economy within FEIAP which has fulfilled the FEIAP criteria for

international recognition to establish a section of the Register for graduate engineers, graduate engineering technologists and graduate engineering technicians.

This will also allow mobility of engineering graduates (i.e. engineers, engineering technologists and engineering technicians) holding suitable qualifications which are considered by the respective FEIAP Engineering Education and Accreditation Guidelines for Engineer, Engineering Technologist and Engineering Technician (generally called “FEIAP Education Guidelines”) to be of substantial equivalence.

Member economies though voluntary must be committed to promote good practices in engineering education and graduates training. The activities of the FGEPR would include developing exemplars of the graduates’ profiles for the relevant types of engineering qualifications to facilitate mobility internationally and within the FEIAP economies. These FEIAP graduate engineers, engineering technologists and engineering technicians shall hereon be generally referred to as “FEIAP Graduate Engineering Personnel.”

The Objectives of the FEIAP Engineering Personnel Register (FEPR) are:

1. To provide a comprehensive data of the engineering graduates within FEIAP (Asia Pacific region) who fulfilled the “FEIAP Education Guidelines”, with ultimate purpose of facilitating their mobility within the Asia Pacific area and to establish a framework of mutual recognition of qualifications in order to allow these “FEIAP Graduate Engineering Personnel” who wish to work outside their home economy.
2. To provide sufficient database of “FEIAP Graduate Engineering Personnel” for the benefit of prospective employers in employing these graduates and for mobility.
3. To encourage a continuous improvement of the quality of “FEIAP Graduate Engineering Personnel” by providing training through NPU-FEIAP “Belt and Road” Engineering Education Training Center (NFTC) and also respective FEIAP Member Economies for these graduates.

4. To promote cultural and professional links among Asia and the Pacific for “FEIAP Graduate Engineering Personnel” via FEIAP and its members.
5. To enhance wealth creation process of Asia and the Pacific countries through improvement of employment and mobility of “FEIAP Graduate Engineering Personnel”.
6. To have a unified & inclusive engineering education accord that promotes substantial equivalence of engineering education for engineers, engineering technologists and engineering technicians in Asia and the Pacific including economies in the Belt and Road Initiative region and Africa through Africa, Asia and the Pacific Accord (AAP Accord).
7. To facilitate the rationalization of the standards of these graduates for cross-economy employment, subject to immigration and legal requirements of each member economy
8. To enable mobility of engineering workforce in Asia and the Pacific including Africa for promoting the mobility of engineering workforce and the exchange of scientific innovations.
9. Build the “community with a shared value for future of mankind”
10. To promote understanding of civilization in these regions via cultivation of cultural intelligence in engineering education

#### **4.4 Benchmarking of Engineering Education for Regional and International Mobility: A FEIAP Experience**

##### **Ir. Academician Emeritus Professor Tan Sri Dr. Chuah Hean Teik**

Standing Committee of Engineering Education, the Federation of Engineering Institutions of Asia and the Pacific (FEIAP)  
Chairman, Africa, Asia and the Pacific AAP Accord Engineering Education Council

Engineering Education is of utmost importance for sustainable development of a nation. Our Engineering Education has to be able to train competent future engineering team consisting of engineers, engineering technologists and technicians who are able to be at par with their counterparts in other countries. In addition, in the

Digital Era where we live in, there is no boundary for engineering practice.

Under the General Agreement on Trade in Services (GATS), there are four modes of supply in international trade in services. The fourth mode: the movement of natural persons will mean that a "natural person" or a human being from a country, as distinct from legal persons such as companies or organisations, would be able to give his or her services in other countries.

In engineering services, it means a professional engineer recognised in one country will be able to practice in another country (if it is liberalised by the countries concerned). This will mean mobility of professional services, and it will bring more opportunities for professional engineers to participate in regional and international projects.

However, with the opportunities, it comes with challenges and competitions. Thus there is a need to ensure professional engineers who are trained and recognised in one country are of substantial standard in terms of education and experience with professional engineers in another country.

This naturally means that there is a need for international bench-marking of the engineering education to ensure substantial equivalence between the countries. Similarly the professional engineering competence must also be bench-marked regionally and internationally. This makes accreditation of engineering programmes necessary within the country, and between different countries.

In this talk, the speaker will share on the stages of professional development for engineers. The various regional and international agreements for mobility of engineers are discussed. The speaker will also speak on the competency required for a professional engineer and how outcome-based engineering education prepares an engineering graduate to attain the professional competency profile needed.

The speaker also illustrates how the professional competency profile is necessary for designing engineering solutions. The speaker will also share the experiences from the Federation of Engineering Institutions of Asia and the Pacific (FEIAP) in development an engineering education

framework which aims to allow economies in Asia and the Pacific to have a common yardstick in engineering education.

Attainment of substantial equivalence in compliance with the FEIAP Engineering Guidelines means the engineering education has fulfilled the basic academic requirement for mutual recognition under the APEC Engineers Register Agreement.

With the signing of AAP Accord in 2021, the speaker will also explain the initiative by the Federation of African Engineering Organisations FAEO and FEIAP to cooperate in establishing substantially equivalent engineering accreditation systems in both regions for common good of the regions.

#### **4.5 Digital Transformation through Engineering Capacity Building and Quality Education for New National Development Models: A Disruptive New World Order in Africa's Favour**

##### **Martin Manuhwa**

- Immediate President - Federation of African Engineering Organisations (FAEO),
- Chairman, World Federation of Engineering Organisations (WFEO) Capacity Building Committee
- Past chair of the Engineering Council of Zimbabwe, and Past President of the SAFEEO and the Zimbabwe Institution of Engineers respectively.

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The Fourth Industrial Revolution (IR4.0) or Industry 4.0 is an opportunity for the world, especially Africa to achieve most of the Sustainable Development Goals (SDGs) targets.

Digital technologies and ICTs developments as represented by broadband internet in artificial intelligence (AI), big data, internet of Everything, internet of things (IoT) (medical, energy, transport etc), robotics, artificial intelligence, cloud computing, facial recognition and augmented reality, machine learning (ML) and deep learning (DL) should be quickly harnessed by all

engineering practitioners to accelerate development. The digital transformation crusade has also played a critical and successful role in the fight against the COVID-19 pandemic.

It is the IR4.0 that will ensure Africa leapfrogs the achieving the SDGs through development of new Capacity Building and Engineering Education Models. This paper will discuss a lot of challenges and opportunities for Engineering Professionals to deal with now and in the post COVID-19 future.

We are very fortunate to have the above-mentioned digital technologies at our disposal to accelerate the process of inquiry-based science education or evidence or data and AI-based science education and science literacy to achieve the Africa we want. While the allure of disruptive technologies like artificial intelligence or augmented reality cannot be denied, organizations need to carefully evaluate those technologies in their business context.

In the post COVID-19 pandemic era, the digitisation of our lives especially on-line education will be more and more important. However, some 3.8 billion people on earth are not connected or have no access to broadband internet and cannot avail themselves to the benefits of the digital transformation era.

The digital transformation of Africa will reduce inequalities, disrupt life as we know it and create more benefits and prosperous lifestyles for our citizens. This advent of technology especially advances in ICTs, artificial intelligence (AI) and robotics confluence through ML and IoT should make anti-corruption a lot easier as they bring new means of interconnectedness and unprecedented surveillance. In the Digital era, success is about leading with experience, being agile and blending within the ecosystem. Digital transformation is a journey – “It is a means to an end, not an end in itself”.

Keywords: Fourth Industrial Revolution, Capacity Building, Engineering Education, block chain, internet of things, Sustainable Development Goals

#### **4.6 Bioethanol Production through Simultaneous Saccharification and Fermentation Process: Energy Option for Nigeria**

**Engr Benedict Okon Edenseting**

Department of Chemical and Petroleum Engineering, University of Uyo, Nigeria

**edenseting77@gmail.com;**

The consumption of fossil fuels derived from petroleum is one of the main sources of pollution of the environment, in addition to its expensive and decreasing production, whereas its demand is increasing. This is why countries around the world such as Nigeria have directed their policies toward the biofuels usage, which are sustainable, biodegradable, with high combustion efficiency, and their development generates manufacturing and investment jobs, promoting the agricultural sector development, as well reducing greenhouse gases.

The use of biofuels such as bioethanol is pursued to reduce dependence on fossil fuels and contribute to meet the future demands of energy in Nigeria and at the same time meeting the carbon dioxide emissions reduction goals. A proposed solution is the production of bioethanol through a simultaneous saccharification and fermentation process (SSF); however, it is necessary to apply temperatures above 40°C. This process is based on the use of an enzymatic complex to hydrolyze cellulose and obtain sugars. These sugars are later used by the microorganisms and are converted into value-added products such as bioethanol in Nigeria. Keywords: Bioethanol, Simultaneous Saccharification and Fermentation

#### **4.7 Complex Challenges Faced in Engineering Education: Case Study Zimbabwe**

**Dr. Eng. T. Stevenson<sup>1</sup>, Eng. N. Gwangwadze<sup>2</sup>**

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A substantial number of engineering graduates coming out of institutions of higher learning, in particular universities in Zimbabwe are found lacking requisite skills and problem-solving abilities. These graduates have theoretical knowledge and a structured thinking pattern.

Unfortunately, this alone cannot solve the complex engineering problems presented in the real world. This paper explores the role of engineering epistemology in curriculum development and graduate training programs in producing knowledgeable graduates who can integrate and develop scientific knowledge utilising emotional intelligence and transformational leadership skills in the problem-solving process.

Research is done focused on developing a holistic engineering graduate training program that addressing not only the theoretical knowledge, but also practical and emotional in assisting the graduates to adjust to the real world and start tackling complex challenges with the aim of producing a cutting edge, competitive and relevant Engineer, or Technocrat.

The use of the three important components in engineering education which are knowledge, skill and attitude are explored to develop a framework for future research in the field of Engineering epistemology that does not only focus on the traditional engineering curriculum.

#### **4.8 Design Method of Engineering Education Standard Assurance in African Educational Field**

**Engr. Nnadikwe Johnson**

**johnsonnnadikwe@gmail.com**

Department of Petroleum & Gas Engineering Imo State University, Owerri, Nigeria

The paper discusses the key ideas of engineer education and how to relate it to future engineering tasks, as well as the social, economic, and technological developments. The issues surrounding the standard of higher education programs are briefly discussed.



Among the criteria for future engineering activities are the humanization, fundamentalization, and professionalization of engineering education. As a result, educational and professional programs for training experts in the scientific and technological fields are highly expected in the worldwide educational services market, with content and structure matching approved international norms.

Modernizing engineering education requires focusing on current scientific and technological advances, in-depth study of fundamental disciplines, development of future engineers' creative and organizational skills, and ability to work in a competitive environment.

To better coordinate the operations of higher education institutions that teach engineers, public accreditation of engineering education programs, engineering credentials, and professional engineering activities should be expanded.

#### **4.9 Development of a Computerised Maintenance Management System (CMMS) Learning Tool: Case Study for Harare Institute of Technology**

**Mary Nyaradzayi Chikuruwo, Tatenda Mpisa, Mupfumira Portia, Milton Manyangadze, Harmony Musiyarira**

**nyarihugh@gmail.com;**

The essence of this research is on developing an interactive computerised maintenance management system (CMMS) which can double as a learning tool for students at higher institutions of learning.

The system will also provide a training platform for companies to enable their employees to learn its applications. Literature on CMMS revealed that existing CMMS require licensing which is very expensive and usually expire after a certain period of time which makes them inaccessible for use as a learning tool.

Besides being expensive, existing CMMS's lack versatility as they are machine specific. Of the systems reviewed SCADA system was found to be expensive and requires high expertise. Other

CMMS systems like eMant, Hippo CMMS, AiM and BIM require a monthly licence renewal and are not highly centralized. Other available systems cannot work offline and real time monitoring is difficult to achieve.

The developed CMMS has a decision making mechanism and can work offline. Visual studios with Java programming language, MYSQL were used in developing the system and a central processing unit was used to achieve the desired output.

The system enabled real time monitoring on the machine and a GSM communication module will give notifications to the maintenance personnel. The data collected will be processed and results will be shown in graphs representing the performance of the machine. The issue tracking system will provide a continuous update on the maintenance tasks being held or done. The system includes a circuit which was simulated using Proteus 8.

Keywords: Communication Module, Decision making, Learning tool, Maintenance Management, Real Time monitoring.

#### **4.10 Digital infrastructure as a key enabler in engineering education and capacity building in Zimbabwe**

**Eng. Mainford Mutandavari**

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Lecturer Software Engineering Department  
Harare Institute of Technology, Harare  
Eng. Charity Chigwada cherry3chig@gmail.com  
Tel-One Centre for Learning

Zimbabwe offers a plethora of economic potential in nearly every area, and the country's young population structure represents a huge opportunity in this digital age, necessitating the country's prioritization of technologically enabled socio-economic growth.

Digital transformation is a catalyst for growth that is inventive, inclusive, and long-term. Innovations and digitalization are spurring job creation and assisting in the attainment of Agenda 2063 and the Sustainable Development

Goals by lowering poverty, reducing inequality, and facilitating the supply of goods and services. Internet technology has the ability to change society.

Access to internet knowledge is a critical component of human development and learning. The internet has the potential to generate economic benefits via reducing costs, boosting efficiency, and enhancing labor productivity.

As a result, the internet might be a crucial tool in achieving the country's goals of guaranteeing stability, enhancing future viability, and embracing responsibility for constructing an interconnected world. The industrial sector, as well as many production and service sectors, have benefited from technological innovation and rapid evolution.

Education is one of the service areas that has benefitted the most. This paper emphasizes the crucial role of digital infrastructure that enables engineering education staff and students to effectively use digital technologies for teaching, learning, research and engagement.

Similarly, a five-layer paradigm of engineering education (i) The Four Pillars of Education (ii): The 5-E Model for Engineering Education (iii): The three strategies to reform engineering education (iv): A comprehensive set of quality assurance standards (v): Integrated Learning Activities and Resource Allocation is explored in order to help realize the potential of ICT-enabled engineering education, whereby stakeholders of these educational policies need a coherent conceptual roadmap.

Keywords: Engineering Education, Capacity building, Digital Infrastructure, Digital transformation

#### **4.11 Implications of Engineering Education and Capacity Building in Africa**

**Engr. Ibe Raymond Obinna, Imo state Polytechnic Nigeria**

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With the growth in world population, resource per capita has decreased and large numbers of people living in developing nations are left under

unnecessary destitution. Government budgets are overwhelmed by previous deficits, and current revenue generated swept by loan servicing, devaluation of currencies and skyrocketing inflation.

Existing Infrastructure are ageing and inefficient. Pollution is prevalent and consequent climatic effects. There has been so much dependence on foreign engineering work and technological development, while ignoring the technological discoveries of indigenous engineering strides.

Most developing countries and institutions that offer engineering education, lack quality capacity building for graduating engineers to step into the modern complex engineering developments. The future questions the past warns the present, and it is then up to Africa to take care of itself.

In the pursuit of a more secure, stable and sustainable Continent, African countries need to enhance their human, institutional and infrastructure capacity. To do so they need a solid base of technologically prepared people to effectively improve their economies and quality of life.

Such a base will facilitate the infusion of foreign capital through attraction of multinational companies to invest in the African country and provide a basis for business development by local entrepreneurs. It is pertinent at this period that efforts should be made to improve on the technical capacity building in Africa.

#### **4.12 Education of Professional Engineers and Engineering Educators**

**Ir. Prof Dr Norlida Buniyamin, IEM President**

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This paper presents the competencies and criteria required to become a competent and successful professional engineer and an engineering educator/lecturer. It provides a historical overview of how engineers were taught. It trace the evolution of how engineers used to work in the early days and then highlights that for the modern engineer, they must work in an environment and provide solution that requires integration of various engineering disciplines, the

use of tools produced by the rapid emergence of technologies, and the need to be competitive as well as professionally recognised due to global market, and the need for mobility.

Subsequently, a discussion is provided that resulted with the conclusion that the modern engineers must be trained to be multitasking, a good communicator, presenter and strong not only technically but also ethically to develop and provide solutions that enables our planet's limited resources to ensure sustainability.

Since engineers must be trained to have multiple attributes and diverse competencies in many areas, the educator in an engineering school must also learn new ways and approaches.

Circumstances such as the COVID pandemic that forced engineering education to be non-face to face required engineering educators to embrace and learn new methods of teaching which includes online teaching.

An engineering lecturer at an Institution of Higher Learning (IHL), must be taught and must self-develop his/her competence to be not only an effective educator delivering technical contents but must have the ability to ensure that students, for example develop soft skills and ethical values to fulfil the International Engineering Alliance (IEA) graduate attributes and competence requirement.

The lecturers must also be competent to execute other related duties and play multiple roles in an engineering faculty such as the development of new programs that will provide outcomes that will produce an engineering graduate with the required attributes.

The role of an engineering educator in universities is explored and the required competencies that a lecturer must have to become an ideal facilitator are discussed.

The paper ends with an examination of how professional engineers and engineering educators are now trained and a suggestion of how training of an engineering educator can be improved is proposed.

#### **4.13 Engineering Capacity Building in Economically Developing Nations**

**Engr. Nnadikwe Johnson**

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Department of Petroleum & Gas Engineering  
Imo State University, Owerri, Nigeria

Globally, developing nations are seeking to strengthen their human, institutional, and infrastructural capacities. They require a strong technology basis to boost their economy and standard of living. This base will help attract international money, help maximize foreign assistance monies, and help local entrepreneurs build their businesses. The World Federation of Engineering Organizations is investing heavily in developing nations' technical capability.

#### **4.14 Engineering Education for the Accomplishment of Sustainable Development Goals**

**Zvikomborero Hweju**

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Engineering education plays a crucial role in accomplishing Sustainable Development Goals (SDGs). This study seeks to elucidate on how the quality and relevance of engineering education aids in the realization of sustainable development goals. In this study, relevant engineering education is defined as education that considers the needs of society.

An assessment of the problems facing society together with challenges in implementing sustainability plans in engineering is made. Direct observation at the system of engineering education in some Southern African universities revealed that challenges in implementation of sustainable engineering solutions can be traced back to inappropriate engineering teaching and curriculum.

This challenge is ascribed to lack of consultation between community and engineering education institutions. This study suggested on the need to bridge the gap between the engineering education system and society's expectations.

The recommended strategies to bridge the gap are as follows: building student motivation, balanced curriculum, workplace exposure, capacity development and consistent knowledge transfer. Hindrances and solutions to collaborations between industry and academia have also been highlighted in the study. This study anticipates a significant and positive influence on realization of Sustainable Development Goals (SDGs).

#### **4.15 Engineering Institution-Industry Partnership a Panacea for Quality Engineering Education, Innovative and Sustainable Growth**

##### **1. Unyime Enobong Okure**

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The most important purpose of engineering education in the society is the production of professional engineers who will make significant contributions. But even so, many universities do not serve this purpose. The majority of students lack the necessary technical skills required by the industry to meet the industry's requirement for skilled and specialized labor.

Partnering Engineering universities and research organizations with industries has been a major concern of Engineering education planners and academics around the world in recent years. Engineering Universities can boost the value of products through knowledge; industry can boost the value of universities through funding.

The Partnership between engineering universities and industry is primarily determined by the technical experience available and its commitment, the infrastructural facilities, and the economic advantages amassed from such a

collaboration, this can be enhanced only through the cooperative effort of Industry-Institute Partnership Cell, which supervises the multi-faceted parameters of the engagement to ensure efficient partnership.

(1) For effective and timely decision making, clear guidelines and policies are required.

(2) An independent institution agency is required to oversee the sustained development of multidimensional parameters for effective partnership. This article will focus on the partnership between industry and engineering Universities.

Additionally, innovative means of enhancing and working to make the partnership more efficient for a sustainable future.

Key words: Partnership, University, Industry, Technical Skills, Research, Engineering, Education

#### **4.16 Novel Algorithm for Enhancing Power Transformer Protection Sensitivity**

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Power transmission systems rely heavily on transformers. For the first time, this study proposes a unique approach to the design and implementation of a system for monitoring a transformer's oil level and ambient temperature. We deployed a GSM-based solution to keep the transformer safe from the aforementioned dangers.

This technique helps transformers run smoothly and detect issues before they become difficult to

fix. At the transformer location, it's installed and the aforementioned metrics are tracked. Any time the Arduino controller detects an anomaly or an emergency, it will send an alert to the user's phone through a text message providing relevant information.

In order to help the user identify potential issues before a distribution transformer fails, this method has been designed.

Keywords: Transformer, Transmission, GSM, Sensor, Arduino, Flowchart

#### **4.17 Optimization of Career Bootcamps as a Capacity Building Effort for Engineering Students and Graduate Engineers**

**Ivy Getanda (Kenya)**

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Engineering skills are a key ingredient to the economic development of a country and young Engineers are a great resource to the growing talent pool in the Engineering sector.

Engineers use their creativity to design solutions to the world's problems through creative application of scientific principles that are put in practice to invent, design, build, maintain and improve structures, machines, devices, systems, materials and processes.

The scope of engineering is continually evolving because of the dynamic nature of engineering-related industries brought about by a constantly evolving world; there is need for more proactive innovations to address the industrial needs.

Therefore more grass root engagement and mentorship to young Engineers is necessary for them to grow a diverse set of skills that will provide engineering solutions and innovations in Africa.

This paper aims to accentuate career boot camps as one of the ways in which young Engineers in different Engineering fields can be greatly involved, trained and mentored to advance their skills. Career boot camps have been traditionally done as high intensity short-duration courses to offer technological practical knowledge to

students. This has played a big role in increasing access to technology jobs worldwide especially to those who take up coding boot camps.

Moreover boot camps have aided in filling the skills gaps and influencing economic growth of countries. Contrary to this previous approach of boot camps where the boot camps are done separately, this paper is anchored towards incorporating boot camps in education curriculums and in Engineering work places (both public and private sectors) and the impact it would have in the career growth of young Engineers.

The basis for this is that it would be an exquisite opportunity for Graduate Engineers and Students to be grounded in both comprehensive education and practical skills. In addition, incorporating boot camps in all fields of Engineering and not just Tech related courses would ensure that Engineers grow in all sectors from Agricultural Engineering, Civil Engineering, Chemical Engineering, Mechanical Engineering and Marine Engineering among others.

In this paper, we discuss the attributes of technology related programs offered in Africa both physically and online. We find more diversity among boot camp providers and programs than would be expected from public discourse. This primarily relates to the mode of delivery (online vs. in person), intensity (part time/full time), cost, and program types.

The methodology also involves primary data from Engineering Institutions through interviews and questionnaires. The questionnaires would be directed to Management officials like Deans of schools and Senior Engineers, Graduate Engineers and Students. The data collected would then be analyzed by qualitative techniques and discussed to support optimization of Career Boot camps as a capacity building effort for Graduate Engineers and Engineering students.

Proper planning and implementation of this would be a positive economic impact to the African Industry.

Key words: Career Bootcamps, Capacity Building, Engineering curriculum, Career growth, Skills, Economic development

#### **4.18 Review on how to bridge the gap between Engineering Education and Industrialisation for Sustainable Development in Zimbabwe**

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Engineering Education in Zimbabwe remains one of the major determinants of country's vision 2030 economic agenda. However, at the moment the education system offers the industry and society unsatisfactory knowledge and services due to mismatch between the supplied educational talents and the ever-changing world of engineering.

The shortage of appropriately skilled engineers impeded economic growth and retarded efforts to fight poverty, diseases and other challenges that affected the country. Studies have revealed the prevalence of passive and demotivating traditional teaching methods and outdated teaching materials in Zimbabwe affect the outcome of the engineering graduates to fill the industry.

Due to rapid changes in industrial development, technical education systems also need to be reviewed to keep pace with the changes and equip students with relevant skills.

To address the skills gap, the 2017 Ministry of Higher and tertiary education transitioned from the education 3.0 model focused on teaching, research, and community service to education 5.0 models that incorporates two additional elements of innovation and industrialization. In line with the objectives of education 5.0, this paper reviews engineering education in Zimbabwe

and recommends necessary adjustments to address the growing need for competent engineers in the industry for economic development.

An extensive literature review is presented which addresses current gap between engineering education and industry.

The paper will use questionnaires and semi-structure interviews to address the investigation. Finally, the write-up is expected to inspire education designers and curriculum developers in preparing programs that provide for the society and industry for sustainable development.

Keywords: Engineering Education, Sustainable Development, Industrialisation

#### **4.19 Spatiotemporal Analysis of Bottling Biogas: A Case of Harare Sewage Treatment Plant**

##### **Stanley Kudzai Mwalamba**

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Biogas production in Zimbabwe inadvertently takes a short route from production site directly to point of use without going through any storage mechanisms. This geospatial restriction makes its ubiquitous applications limited to places of production only as it lacks mobility like other renewables. Variances in biogas production may result in excess gas produced requiring bottling and storage.

There has been little evidence in the public domain of recent initiatives on bottling biogas and this inconclusiveness is hampering uptake and full implementation of the technology in Zimbabwe.

To fill in this gap, this study seeks to explore novel ways and methods of biogas bottling for future, wider and remote applications which is the major objective of this study. Studies conducted indicate that biogas potential in Zimbabwe is

much greater than is currently being exploited with a very low uptake and non-usage of the generated biogas by the municipalities.

As of 2016, a modest 711 biogas plants had been constructed, illustrating that Zimbabwe is still in its infancy in embracing biogas technology in comparison with other Sub-Saharan Africa countries.

In Harare, the two sewage plants Firlle and Crowborough have installed capacities of around 17 000m<sup>3</sup> and 8 500m<sup>3</sup> of biogas respectively and can cumulatively produce purified methane that can then be bottled. Filling of biogas may require cylinders with a thickness of about 3cm.

The study is expected to lead into creation of biogas bottling plants resulting in employment creation, generation of revenue and conservation of the environment. Bottling biogas will enable especially rural women to access cheap gas and reduce time spend looking for firewood for cooking and exposure to smoke which affects their health.

Biogas farms with multiple purpose of providing bottled biogas, bio fertilizers and meat may also be established in Zimbabwe and the region for sustainable development.

Keywords: Biogas, Bottling, Compression, Feedstock, Spatiotemporal

#### **4.20 Role of Smart Engineering Infrastructure in Creating Safe Learning Environments**

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Since a safe learning environment is a conducive physical space that promotes teaching, research, community service, and innovation, higher learning institutions must strive to provide such environments. The quality of engineering infrastructure in higher education institutions plays a critical role in creating such safe environments through reduction of the spread of pandemics such as COVID-19.

It is the role of engineers to proffer solutions that enhance quality of education through creation of

safe learning environments. Thanks to sensor and actuator-based technology (smart engineering infrastructure) for minimizing needless human contact with highly infected surfaces.

This study is a presentation on the capability of smart engineering infrastructure in creating safe learning environments through suppression of the spread of diseases. Smart engineering infrastructure suppresses the spread of diseases by reducing human exposure to potentially infected surfaces and objects.

Examples of possibly infected surfaces in higher education institutions include, but not limited to, water taps, door handles, bank notes and coins, human to human contact, light switches, and public telephones.

The study is structured as follows: the working principle of smart engineering infrastructure, the proportion of higher education institutions in Africa that are already utilizing smart engineering infrastructure, evidence for the justification of the effectiveness smart engineering infrastructure, factors against the adoption of smart engineering infrastructure and finally, ways to overcome the hurdles against the adoption of smart engineering infrastructure in higher education learning institutions.

Data used in the study has been collected using direct observation method and literature survey. Since the data collection method is unobtrusive and does not depend on opinions of other participants, the results are legitimate.

Study results have indicated that despite the smart engineering infrastructure having tremendous potential, most higher education institutions in Africa have not yet embraced it to mitigate the spread of pandemics. The low uptake of the smart engineering infrastructure has been due to the general lack of awareness to the vast benefits of the technology.

Evidence provided in literature has proved the effectiveness of smart engineering infrastructure in creating safe learning environments. This study expects a remarkable and positive influence on the path of epidemics derived from using smart engineering infrastructure in higher education institutions. The authors recommend the setting

up of a regional policy that stipulates the minimum smart engineering infrastructure expected for all higher education institutions in the region. Additionally, engineers have a role of educating society on the benefits of adopting smart engineering infrastructure.

Keywords: Safe Learning Environments, Smart Engineering Infrastructure, Global Pandemics.

#### **4.21 Strategies for Engineering the future through Quality Engineering Education, Capacity Building and the Development of Innovative Infrastructure: The Case of African Countries**

**Eng. Ronald Robertson-Tarugarira**

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Research Background and Motivation

Jones (2007) argues that in order to build vibrant and sustainable economies in the 4th Industrial revolution and beyond, countries must endeavour to craft human, Institutional and infrastructure capacity.

Allow me to state that this can only be achieved when Governments lead in formulating and implementing an array of strategies to: improve Quality of Engineering Education, Relook at Partnerships and Build resilient innovation infrastructure.

Engineering the Future through Capacity Building: In order to successfully engineer the future we need to develop capacity. The United Nations (2022) defines Capacity Building as a systematic process designed to build and enhance the skills; aptitude, capabilities, processes and resourcing required by organisations to sustainably survive as the world rapidly evolves.

The United Nations came up with Sustainable Development Goal 17 focusing on Capacity building, promoting role of technology and innovation etc and these are key in engineering the future as outlined in the 2022 Conference Theme. Beesley & Shebby (2010) concur with Connolly, P. & York, P. (2002) that Capacity Building is defined as a process for enhancing the management and governance of organizations to facilitate the achievement of organizational mandates.

Engineering The Future Through Engineering Education: According to Gakusi (2008), since the arrival of missionaries in Africa in the 19th century there has been a slow start to engineering education with a post independence surge in numbers.

This rise has been constrained by a spectrum of impediments which include: Poor Financing, Lack of equitable access to education, inadequate education capacity, unsuitable curriculum, lack of coherence between engineering education and work environment.

Mihyo (2005) states that in the African post independent era countries followed colonial education which in some cases was deliberately delinked to the African context.

As Gakusi (2008) notes, in the post-independence era concerted efforts were made solely by African Governments either s or through partnerships with global and regional organisations.

To this end this paper seeks to research and get insights into the strategies which African Governments can employ to engineer the future by building capacity in engineering education which is a key catalyst of the deployment of the impending 4th Industrial Revolution.

The thinking is that once universities and technical colleges equip students with appropriate knowledge it is easier for industry to effectively train them and impart practical skills to enable them to participate in the building of a sustainable industrial capacity muscle which will eventually spearhead sustainable economic development.

There is a need to look at the research on an end to end basis.

Engineering The Future Through Technological Innovations: The 4th Industrial revolution seeking to blur the boundaries between the Physical, Digital and Biological worlds brings a mirage of opportunities to build resilient Industrial Capacity and greater opportunities to improve education capacity. To this end the paper will also research into strategies to improve the role of ICT technology and Innovation/innovation



infrastructure at the engineering education and industrial level. Overall the research will focus on strategies both the African and Global level.

KEYWORDS: Capacity Building, Innovation, Fourth Industrial Revolution.

#### **4.22 Underground Mine Safety Monitoring and Alerting System**

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Underground mining operations have proven to be very risky for workers. The risk is mostly due to the late identification of harmful and toxic gases released during mineral extraction. The gases are currently undetectable without the use of proper tools. This research therefore focuses on real time monitoring of these toxic gases using wireless sensor network.

Existing systems are able to monitor the amount of gases and temperatures separately albeit in real time. An algorithm that identifies unacceptable temperature increases and concentration of explosive gases was developed. Temperature and humidity multiple sensors were used in this research together with methane and carbon dioxide sensor to monitor surrounding environmental conditions and multiple toxic and explosive gases.

The system provides early warning in cases of temperature or explosives gases rising above set threshold value. The alerting system is made up of sirens and buzzers which alert the workers to evacuate from the proximity of the gases within 2 seconds of the identifications of the toxic gases concentration exceeding the set threshold value.

The abnormal parameters that cause the buzzing on the system are displayed on a liquid crystal display (LCD) which helps real time monitoring of the surroundings.

A PIC microcontroller was used in this research because of its capability to communicate with a global system for mobile communication (GSM) module through its Universal asynchronous receiver/transmitter( UART) peripherals and also

because it has three timer modules that are required to measure external pulses from sensors.

Keywords: Liquid crystal display, Real time, Toxic, Threshold, Underground mine.

#### **4.23 Catching them Young: Sib0 the Engineer Project**

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Sibo the Engineer is a program focused on increasing the quality of engineering education for Zimbabwean children, to get them involved and interested in STEM from the youngest possible age. It comprises of children's books on Science, Technology, Engineering and Mathematics.

The books teach children what the different professions are all about in a fun and engaging way suitable for children. The names, locations and processes are localised to Zimbabwe in order to help the children identify with the STEM professions as early as possible. Currently, Sib0 the Civil Engineer and Sib0 the Chemical Engineer books are out, and in the pipeline are Sib0 the Electronic Engineer and Sib0 the Computer Scientist. The program will expand to include as many professions in the Science, Technology and Mathematics fields. The idea is to have the books distributed widely in primary schools nationwide.

Aside from the books, the program will include animation series based on the books to be shown in schools and on national television. There will also be practical visits to engineering sites for the children, as well as various other edutainment activities.

Additionally, the book intentionally has a female main character, as well as other female characters in the books to provide the much needed female role models to encourage the uptake and retention of girls and women in STEM. Sib0 the Engineer program was created by Michelle R.S. Maphosa, a Zimbabwean civil engineer, and Wadzanayi K. Bwanya, a Zimbabwean UX/UI designer.

#### **4.24 Redesign and weight optimization of chassis and suspension system for a mini tractor**

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Vibration is an ergonomic challenge to tractor drivers in Zimbabwe. A special mini tractor chassis suspension type for towing was designed and diagrams of simulations of chassis and suspension were included in this paper.

A design methodology was used which included tools such as Reverse Engineering, Computer Aided Engineering software's and Finite Element Analysis. Finite Element Analysis was used to determine forces that can be attained by the chassis.

Material selection was included and a selected material simulation performed which shows favourable results is also in this paper. The chassis is the major component where engine, gearbox and all other controls and mounted.

The results presented are of the structural characteristics of finite element analysis of a modern mini tractor chassis attached to suspension leaf springs.

Von misses using Invertor CAD software was to be performed to identify critical regions and based on the results obtained design modification has been done.

Key Words: Chassis, Modelling, Simulation, Strain, Stress and Von Misses

#### **4.25 Achievement oriented engineering education - professional certification**

##### **Wang Xue Tsinghua**

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The professional certification of engineering education follows three basic concepts: achievement oriented, student-centered and continuous improvement.

##### **Result oriented Education**

As an advanced educational concept, outcome based education (OBE for short, also known as ability oriented education, goal oriented education or demand-oriented Education) was put forward in 1981. OBE refers to that the goal of teaching design and teaching implementation is the learning outcomes that students finally achieve through the educational process.

OBE emphasizes the following four questions: what are the learning outcomes that we want students to achieve? Why should students achieve such learning outcomes? How to effectively help students achieve these learning outcomes? How to know that students have achieved these learning outcomes?

##### **Result oriented instructional design**

The focus of the result oriented instructional design is to determine four corresponding relationships:

( 1 ) The corresponding relationship between internal and external needs and training objectives. Internal and external needs are the basis for determining the training objectives, which should be compatible with internal and external needs. ( 2 ) The corresponding relationship between training objectives and graduation requirements. The training objective is the basis for determining the graduation

requirements, and the graduation requirements are the support for achieving the training objectives. ( 3 ) The corresponding relationship between graduation requirements and curriculum system. Graduation requirements are the basis for building the curriculum system, which is the support to meet the graduation requirements. ( 4 ) The corresponding relationship between graduation requirements and teaching content. Graduation requirements are the basis for determining the teaching content, and the teaching content is the support to meet the graduation requirements.

Achievement oriented teaching implementation Classroom is the main form of teaching implementation. Classroom teaching is the basis for students to meet graduation requirements and achieve training goals. However, the current classroom teaching has not yet got rid of the shackles of scientific education.

In order to meet the requirements of results oriented education, at least five changes should be realized: from indoctrination classroom to dialogue classroom, from closed classroom to open classroom, from knowledge classroom to ability classroom, from emphasizing learning and neglecting thinking to combining learning and thinking, and from emphasizing teaching and neglecting learning to teaching and learning.

#### **4.26 Towards the implementation of the recommendations of the SADC Engineering Needs and Numbers Study**

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##### **Concept Note**

In June 2019, the SADC Ministers responsible for Education and Training and Science, Technology and Innovation (ET-STI) endorsed the regional report on the engineering needs and numbers capacities study.

The overall objective of the study was to get a better understanding of the Engineering Technologist and Engineering Technician capacities in the SADC region to allow for better planning and implementation of infrastructure programmes to support the SADC

Industrialisation Strategy (2015-2063). The SADC Industrialisation Strategy identifies lack of adequate infrastructure and lack of adequate skills and capacities in science, technology, engineering and mathematics (STEM) among others as the constraints for industrial development.

The study considered the contribution of engineering to the GDP, the systems and processes which must be developed, the targets which must be achieved, and the type of engineering skills required to address these needs. Engineering disciplines and the roles they play were also outlined and the role of the engineer, technologist and technician explored.

Some of the key recommendations from the study include the need to address the ever-growing challenge of unemployed graduates, whereby a regional approach to developing graduates must be established and adopted.

The study reveals that without investment in infrastructure and maintenance, economic growth cannot take place. The study emphasises the need for localisation in that agreement with foreign partners should include not only the use of local labour, plant, equipment and developing local manufacturers but should strongly include training of engineering professionals. The huge infrastructure projects being implemented in the region should spend funds on local staff as well as locally sourced materials.

As part of the 2022 Africa, Asia Pacific Accord & WFE0-CECB International Capacity Building in Engineering Education Forum and the Zimbabwe Institution of Engineers Biennial Conference, UNESCO Regional Office for Southern Africa, the Department of Science and Innovation (DSI) in partnership with the Federation of African Engineering Organisations (FAEO) and the Zimbabwe Institution of Engineers and SADC Secretariat will be hosting a session to discuss the implementation of the recommendations from the SADC Engineering Needs and Numbers study.

In addition, UNESCO published the second Engineering Report; Engineering for Sustainable Development: Delivering on the Sustainable Development Goal in March

2021. The report highlights the crucial role of engineering in achieving each of the 17 SDGs. It shows how equal opportunities for all is key to ensuring an inclusive and gender balanced profession that can better respond to the shortage of engineers for implementing the SDGs.

The report provides a snapshot of the engineering innovations that are shaping the world, especially emerging technologies such as big data and Artificial Intelligence, which are crucial for addressing the pressing challenges facing humankind and the planet. It analyses the transformation of engineering education and capacity-building at the dawn of the Fourth Industrial Revolution that will enable engineers to tackle the challenges ahead.

It also highlights the global effort required to address the specific regional disparities, while summarizing the trends of engineering across the different regions of the world.

### **Objectives**

The main objective for this session will be to unpack the implementation of the recommendations from the SADC Engineering Needs and Numbers. The session will deliberate on the following:

- a) What are the key recommendations from the SADC Engineering Needs and Numbers study,
- b) Which national and regional engineering initiatives are being implemented that respond to the SADC Engineering study, and
- c) What are the key recommendations from the UNESCO Engineering report and their implications on the SDG's.

# AGENDA

## Conference Agenda

Monday, August 15, 2022	
1400-1800	ARRIVAL AND REGISTRATION
1800-2000	WELCOME COCKTAIL HOSTED IN HONOUR OF OUR LOCAL AND INTERNATIONAL DELEGATES
Tuesday, August 16, 2022	
0800-0830	REGISTRATION
<p><b>FACILITATOR</b> – Prof. D. J. Simbi – Conference Organising Committee Co-Chair and Vice Chancellor of Chinhoyi University of Technology.</p> <p><b>Rapporteur General:</b> Eng. Dr. W Goriwondo – Pro Vice Chancellor – National University of Science and Technology.</p>	
0830-0833	National Anthem
0830 – 1100	<p>AFRICA ASIA PACIFIC ACCORD, WFEO-CECB CAPACITY BUILDING IN ENGINEERING EDUCATION INTERNATIONAL FORUM AND ZIE BIENNIEL CONFERENCE</p> <p><b>CONFERENCE KICK-OFF SESSION</b></p> <p>SESSION CHAIRPERSON: Prof. D. J. Simbi</p> <p><i>High Level Dialogue on Capacity Building in Engineering and Quality Education</i></p>
Exhibits Open & Robotics	

0833- 0835	Opening Prayer: Dr. Eng. Ben Rafemoyo
0835- 0840	Welcome Remarks: His Worship S. Dhlamini, The Mayor of Victoria Falls Municipality
0840- 0845	Introductory Remarks -WFEO Vice President and CECB Chair: Eng. Martin Manuhwa
0845- 0850	Objectives of the Conference - Planning Committee Chair: Dr. Eng. Tammy Stevenson
0850- 0900	Opening Remarks from the ECZ Chairman: Eng. Israel Rwodzi
0900- 0910	Opening Remarks from the ZIE President: Eng. Thami Mpala
0910- 0920	Keynote Address from the FEIAP President: Prof Huang Wei (China)
0920- 0940	Keynote Address from the WFEO President: Prof. José Vieira (Portugal)
0940- 1000	Keynote Address from the AAP Chairperson: Ir. Academician Emeritus Prof Tan Sri Dato' Dr. Chuah Hean Teik. "Benchmarking of Engineering Education for Regional and International Mobility: A FEIAP Experience"
1000-1010	Address by Professor Martiale Zebaze-Kana, Senior Programme Specialist- Natural Science UNESCO Regional Office for Southern Africa.
High Level Panel Dialogue and Discussion on Capacity Building in Engineering and Quality Education	
1010-1100	Moderator - Prof. D. J. Simbi – Conference Organising Committee Co-Chair <u>Panelists</u> - Eng. Mustafa Shehu - WFEO President Elect - Eng. Dr. W. Ganda – Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development (Zimbabwe). - Prof P. K Dzvimbo – Zimbabwe Council for Higher Education (ZIMCHE CEO) - Dr. Kwame Boakye – Ghana Institution of Engineering (GHiE) Past President. - Eng. Nathaniel Matalanga – IEK Past President and WFEO Executive Council Member (Kenya). - Dr. Eng. Sanzan Diarra – ZIE Chief Executive Officer <b>Concluding remarks for the morning Plenary session and Vote of thanks: Eng. Papias Kazawadi – FAEO PRESIDENT ELECT</b>
1100 - 1130	GROUP PHOTO AND COFFEE BREAK


1130 - 1330	<p><b>CAPACITY BUILDING AND ENGINEERING EDUCATION PLENARY SESSION 1</b>  <b>Chair: UNESCO ROSA (TBA)</b></p> <p><i>Keynote Address: Transforming Engineering Education Capacity Building for Africa – From Strategy to Implementation.</i>  <b>Speaker 1: Eng. Yashin Brijmohan (South Africa)</b>  – FAEO CHAIR Standing Technical Committee in Engineering Education and AAP Co-Chair</p> <p><i>“Achievement oriented engineering education professional certification”</i>  <b>Speaker 2: Prof. Wang Xue – Tsinghua University P. R. China</b></p> <p><i>“Setting up of FEAIP Graduate Engineering Personnel Registry”</i>  <b>Speaker 3: Ir. Dr. Tan Yean Chin, Secretary – The Federation of Engineering Institutions of Asia and the Pacific (FEAIP) &amp; Past President, the Institution of Engineers, Malaysia.</b></p> <p><i>Keynote Address - “The Role of Education in Creating a Global Engineer”</i>  <b>Speaker 4: Mr. Damien Owen (Ireland) - Deputy Chair - International Engineering Alliance.</b></p> <p><i>Keynote Address – Education of Professional Engineers and Engineering Educators</i>  <b>Speaker 5: Ir. Dr. Prof. Norlida Buniyami, IEM President – MALAYSIA</b></p>
1330 - 1430	LUNCH
14:30 - 17:30	<p><b>PLENARY SESSION 2</b>  <b>Chair: Prof. D. Musademba (Dean CUT)</b>  <b>Rapporteur General: Dr. Eng. A. Mamuse (Dean MSU)</b></p> <p><i>Keynote Address - “The Future of Jobs for African Graduates in the Digital Age.”</i>  <b>Speaker 1: Academician Dato` Ir (Dr) Lee Yee Cheong – WFEO Past President</b></p> <p><i>Strategies for Engineering the future through Quality Engineering Education, Capacity Building, and the Development of Innovative Infrastructure: The Case of Global South Countries3</i>  <b>Speaker 2: - Eng. Ronald Robertson -Tarugarira</b></p> <p><b>Speaker 3: Catching them Young through Sibona the Engineer - Michelle Maphosa</b></p> <p>Engineering the alternative way: Locating the place of soft skills in the success of the engineering profession  <b>Speaker 4: Marjorie Munyonga</b></p> <p><i>Keynote Address “Roadmap for transforming Africa with focus on gender</i></p>

	<p><i>transformative STEM Higher Education and Innovation”</i></p> <p>Speaker 5: <i>Eng. F. Mavhiya</i>, Deputy President ZIE and Past Chairperson ECZ.</p>
<p>Wednesday, August 17, 2022</p>	
0830 - 1100	<p>AFRICA ASIA PACIFIC ACCORD, WFEO-CECB CAPACITY BUILDING IN ENGINEERING EDUCATION INTERNATIONAL FORUM AND ZIE BIENNIAL CONFERENCE</p> <p><b>SECOND DAY PLENARY SESSION</b></p> <p>CHAIR: Prof Mercy Manyuchi – Chief Director - Ministry of Mines and Mining Development</p> <p>Rapporteur General: Eng. Dr. W Goriwondo – Pro Vice Chancellor – National University of Science and Technology</p>
0833-0835	Opening Prayer: Local Pastor
0835- 0850	Recap of Day 1 Activities: Engr. Ovens F. Ehimatie
0850- 0910	Feedback on WFEO CECB Water Infrastructure Training and FAEO Capacity Building Initiatives– Eng. M. Manuhwa
0910-0930	Keynote Address from the FAEO President: Ing. Carlien Bou Chedid
0930-1010	<p><i>Panel Discussion “Towards the Implementation of the SADC Engineering Needs and Numbers Study”.</i></p> <p>Moderator - Prof. Martiale Zebaze Kana – UNESCO ROSA</p> <p>Panelists:</p> <ul style="list-style-type: none"> <li>- Ms. Phathi Masimirembwa</li> <li>- Ms. Anneline Morgan - SADC Secretariat</li> <li>- Dr. Muchaneta Munamati – UNESCO</li> <li>- Dr. Eng. T. Stevenson -ZIE</li> <li>- Eng. Martin Manuhwa – WFEO CECB</li> <li>- SA Department of Science &amp; Innovation – TBA</li> <li>- Eng. Yashin Brijmohan</li> </ul>
1010- 1050	<p>Panel Discussion on Engineering Regulation, Innovation, Capacity Building, and Infrastructure in the FAEO African Regions.</p> <p>Moderator - Prof. Hodson Makurira – Dean of the Faculty of the Built Environment – University of Zimbabwe</p> <p><u>Panelists</u></p> <ul style="list-style-type: none"> <li>- Eng. Collins Juma - East African Federation of Engineering Organisations (EAFEO) President (Kenya)</li> <li>- Eng. Linda Moseki – Southern African Federation of Engineering Organisations (SAFEEO) President (Botswana)</li> <li>- Engr. Tasiu Sa’ad Gidari-Wadul – Nigerian Society of Engineers (NSE) President</li> </ul>



	<p>- Ing. Prof Rev Charles Adams – Ghana Institution of Engineering (GHiE) President</p> <p>- Eng. Erastus Mwongera – Engineers Board of Kenya (EBK) Chairman</p> <p>- Eng. Dr. Rafemoyo – ECZ CEO</p> <p>Concluding remarks for the morning Plenary session and Vote of thanks: Ing. Alex Ayeh – President West African Federation of Engineering Organisations (WAFEO)</p>		
1050-1110	<p><i>Keynote Address by our Special Guest “Education 5.0. The Doctrine”</i></p> <p>Prof. dr. Amon Murwira – Minister of Higher and Tertiary Education, Science, Innovation and Technology Development</p>		
1110 - 1130	GROUP PHOTO AND COFFEE BREAK		
FIRST BREAKAWAY SESSION			
	PARALLEL TECHNICAL SESSION 1		
1130-1300	<p><b>Venue:</b> KALUNDU</p> <p>Theme 1 – Engineering Diversity and Inclusivity</p>	<p><b>Venue:</b> KALALA (Main Room)</p> <p>Theme 2 – Capacity Building, Innovative Infrastructure</p>	<p><b>Venue:</b> MATETSI</p> <p>Theme 3 – UNESCO, ECZ, WFEO CECB Robotics Boot Camp</p>
	<p><b>Chair:</b> Dr. Eng. E. S. Maputi – Engineering Dean (HIT)</p>	<p><b>Chair:</b> Dr Eng. A. Mamuse - Engineering Dean (MSU)</p>	<p><b>FACILITATOR:</b> Dr Eng. T. Mushiri – Deputy Dean: Engineering and Built Environment (UZ)</p>
	<p><b>Speaker 1:</b> Zvikomborero Hweju</p> <p>Engineering Education for the Accomplishment of Sustainable Development Goals</p>	<p><b>Speaker 1:</b> Engr. Nnadikwe Johnson (Nigeria).</p> <p>Engineering Capacity Building in Developing Countries</p>	High School Robotics Bootcamp
	<p><b>Speaker 2:</b> Engr. Unyime Enobong Okure &amp; Engr. Ovens Ehimatie Festus -</p> <p>Engineering Institution-Industry Partnerships a Panacea for Quality Engineering Education</p>	<p><b>Speaker 2:</b> Ivy Getanda (Kenya)</p> <p>Optimization of Career Bootcamps as A Capacity Building Effort for Engineering Students and Graduate Engineers</p>	

	<p><b>Speaker 3:</b> Aldridge Takura Nyamowa - Inclusivity and sustainability: a perspective of young people</p>	<p><b>Speaker 3:</b> Eng. Mary Nyaradzayi Chikuruwo, et al. - Development of a Computerised Maintenance Management System (CMMS) Learning Tool: Case Study for Harare Institute of Technology</p>	
	<p><b>Speaker 4: Hagreaves Kumba (SA)</b> Review on how to bridge the gap between Engineering Education and Industrialisation for Sustainable Development in Zimbabwe</p>		
13:00	LUNCH		
<b>SECOND BREAKAWAY SESSION</b>			
14:00 - 16:30	<b>PARALLEL TECHNICAL SESSIONS</b>		
	<p><b>Venue: KALUNDU</b> Theme 1 – Capacity Building</p>	<p><b>Venue: KALALA (Main Room)</b> Theme 2. Innovative Infrastructure</p>	<p><b>Venue: MATETSI</b> Theme 3 – UNESCO, ECZ, WFEO-CECB Robotics Boot Camp</p>
	<p><b>Chair :</b> Engr. Aishatu Umar (WCCE &amp; NSE NIGERIA)</p>	<p><b>Chair:</b> Eng. Margret Ogai (EBK-KENYA)</p>	<p><b>FACILITATOR:</b> Dr. Tawanda Mushiri – UZ Deputy Dean - Built Environment</p>
	<p><b>Speaker 1: Ben Edenseting (Nigeria)</b> Bioethanol Production through Simultaneous Saccharification and</p>	<p><b>Speaker 1:</b> Engr. Unyime Enobong O. (Niger) Novel Algorithm for Enhancing Power</p>	<p>High School Robotics Bootcamp</p>

	Fermentation Process	Transformer Protection Sensitivity	
	<b>Speaker 2: Engr. Ibe Raymond Obinna (Nigeria)</b> Implications of Engineering Education & Capacity Building in Africa	<b>Speaker 2: Eng. Mary Chikuruwo</b> The Ergonomic Impact on General Complications on Tractor Drivers in Zimbabwe	
	<b>Speaker 3: Engr. Nnadikwe Johnson (Nigeria)</b> Design Method of Engineering Education Standard Assurance in African Educational Field	<b>Speaker 3: Engr. Unyime Enobong O. (Niger)</b> Achieving Sustainability in Robotics through Eliminating the Skill Gap in Academia and Industry	
1630-1700	NETWORKING & VISIT OF EXHIBITION STANDS		
Thursday, August 18, 2022			
OFFICIAL OPENING DAY PLENARY SESSIONS - <b>KALALA MAIN CONFERENCE ROOM</b>			
SESSION MODERATOR: Director of Ceremonies – Mavimba Mapuranga			
<b>PAPER PRESENTATIONS</b>			
08:30	Prayer - Local Pastor		
08:35	<b>Official Opening Address by:</b>  ECZ Chairman – Eng. Israel Rwodzi  ZIE President – Eng. Thami Mpala		
09:00	<b>Keynote Opening Address by the UNESCO DIRECTOR GENERAL – Prof Lidia Arthur Brito, UNESCO Regional Director for Southern Africa</b>		
09:20	<b>Keynote Opening Address from WFEO VP &amp; CECB Chair:</b> Eng. Martin Manuhwa. “Digital Transformation through Engineering Capacity Building and Quality Education for New National Development Models: A Disruptive New World Order in Zimbabwe and Africa’s Favour”.		
09:40	<b>Keynote Opening Address from :</b> Eng. Joy Pedzisayi Makumbe (Zim); “A Review of the Role Played by Sustainable Infrastructure in Zimbabwean Cities: A Focus on the Contributions to the Economic Growth of the Country.”		
10:00	INTERACTIVE TEA BREAK (Guest of Honour Debriefing)		

OFFICIAL OPENING	
10:30	National Anthem
10:35	Introduction of the Guest of Honour: TBA
10:40	<b>SPEECH by the Guest of Honour:</b> His Excellency, President Dr. E. D. Mnangagwa
11:15	Gift Presentation & Group Photo
11:30	<b>Keynote Address from the</b> Engineering Council of South Africa (ECSA) President – Eng. Refilwe Buthelezi - Building and Regulating Engineering Capacity in South Africa.
11:50	Engineering Education: A case of Zimbabwe: Dr. Eng. Stevenson
12:10	Internet of Things (IoT) and Road Safety: Challenges and Opportunities for Africa- <b>Cliford Gobo</b> - Acting Managing Director: Traffic Safety Council of Zimbabwe
12:30	<b>Keynote Address</b> by WFEO President Elect Engr Mustafa Shehu – Vision and Roadmap for Africa Engineering for the Decade of Action and the Africa We Want.
12:50	<b>CORPORATE MARKETING INTERFACE, DISCUSSION, CONFERENCE RESOLUTIONS AND WRAP-UP</b>
13:35	Vote of Thanks: Eng. Farai Mavhiya – ZIE Deputy President
13:40	<b>LUNCH, NETWORKING &amp; VISIT OF EXHIBITION STANDS</b>
16:00	<b>SUNSET BOAT CRUISE AND TECHNICAL TOURS AND OTHER ACTIVITIES</b>
19:00	<b>CLOSING CEREMONY, GALA DINNER &amp; RECEPTION (FORMAL DRESS)</b>
22:00	<b>END OF CONFERENCE</b>
Friday, August 19, 2022	
GOLF DAY AND DEPARTURE FOR NON-GOLFER / EXCURSION (optional) <b>TOUR ZIMBABWE AND VICTORIA FALLS!</b>	

**The 2022 Africa Asia Pacific Accord, WFEO-CECB  
 Capacity Building in Engineering Education International Forum,  
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