

Engineering for Sustainable Development The Transformation we need in a Post COVID-19 world

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The World Federation of Engineering Organizations:

- The peak body for professional engineering organizations
- Founded in 1968
- Under the auspices of UNESCO
- 100+ national professional engineering institutions
- 12 international and continental/regional professional engineering institutions
- Representing 30 million engineers





Sustainable Development

> The Philippines Tunisia Turkey Uganda Ukraine United Arab **Emirates** United Kingdom United States Uruguay Yemen 7ambia Zimbabwe





Founded under the auspices of UNESCO and Recognised NGO

Co-Chair - Major Science and Technology Group at UN

Representation at major UN Organisations

Based in Paris at UNESCO



Engineering for Sustainable Development

The World Federation of Engineering Organizations (WFEO) has an imperative to lead engineers in their important role - to develop solutions

for sustainable development.

(Vision and Narrative developed by Dr Marlene Kanga on becoming WFEO President December 2017)



Engineering for Sustainable Development

Engineering is essential to achieve the UN SDGs

(As presented to WFEO General Assembly by Dr Marlene Kanga on becoming WFEO President December 2017)



Source: Image from International Science Council

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"The United Nations will continue to count on your engagement and support as we strive to achieve the 17 Sustainable Development Goals – the world's blueprint for building a future of peace and prosperity for all on a healthy planet. **Every one of the Goals requires solutions rooted in science, technology and engineering**."

Message from UN Secretary General H.E. Antonio Gutteres to the WFEO Global Engineering Congress, 22-26 October 2018.



Engineering and the UN Sustainable Development Goals

(As presented to WFEO General Assembly by Dr Marlene Kanga on becoming WFEO President December 2017)



- A key objective of the World Federation of Engineering Organizations is to advance the UN SDGs through engineering
- We need to ensure that we have more engineers with the right skills to develop the technologies and engineering solutions for sustainable development



Focus for today's presentation

The role of engineers and engineering in addressing four global issues:

- 1. Engineering, advanced technologies and COVID-19 responses
- 2. Engineering and advanced technologies to address climate change, energy and water for sustainable development
- 3. Sustainable Cities and the role of engineers in addressing essential needs of people (energy, water, housing transport), the planet and economic well being and jobs.
- 4. Transforming engineering through education so that we meet the need for more engineers with the right skills to address these challenges for sustainable development



1. ENGINEERING ADVANCED TECHNOLOGIES AND COVID-19



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COVID-19 – a global problem with no borders – needs engineering solutions

- COVID-19 is an unprecedented global pandemic which has resulted in infections in most countries in the world
- There is an imperative for all nations • to work together collaboratively on the detection, response and prevention of this disease
- Global institutions including the UN, World Bank, governments, NGOs and civil society are working together to solve this problem
- This is a human problem and engineers around the world, are also working together in partnership to solve this global problem which knows no borders.





Engineers, advanced technologies and COVID-19

- Rapid testing for COVID-19 uses nanosensors to detect viral RNA
- Detecting and tracking the virus fragments in raw sewage, to map and track in cities
- Using 3D printing for protective equipment such as face shields, PAPR (Positive Air Pressure Respirator).
- Using real-time geospatial mapping to assist governments to track and map the virus
- Artificial Intelligence for rapid identification of suitable vaccines. About 100 vaccines are being researched.
- Artificial Intelligence and vision technology for rapid diagnosis
- Artificial Intelligence and vision technology to manage crowds on public transport and public spaces, wearing of masks, temperature checks, social distancing.

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See <u>www.iomni.ai</u> and <u>https://www.youtube.com/watch?v=oQg_Fe015C8</u>

2. ENGINEERING AND ADVANCED TECHNOLOGIES TO ADDRESS CLIMATE CHANGE, ENERGY AND SUSTAINABLE DEVELOPMENT



Climate Change – devastating impacts around the world – requires engineering



Source: NY Times, <u>https://www.nytimes.com/spotlight/california-wildfires</u>, 10 Sept 2020

- Climate Change is affecting every country in the world.
- Engineers and engineering is producing solutions to address green house emissions and renewable energy sources.



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Climate Change – Deforestation and COVID-19



Source: CSIRO: https://ecos.csiro.au/could-saving-a-rainforest-in-india-prevent-the-next-pandemic/

- Climate Change is resulting in deforestation
- Wild animals are increasingly going to populated areas searching for food and the transmission of viruses like COVID-19 to humans is the result.



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Engineers are at the heart of energy supply solutions



 The availability of affordable energy is a key sustainable development goal as one-sixth of the world's population does not have access to a reliable source of energy



AFFORDABLE AND

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Engineers have developed sustainable renewable energy solutions





• Engineers have developed wind, solar, wave and geothermal energy solutions



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Engineering : Renewable energy will have a major impact to reduce greenhouse gas emissions





- Engineers have developed wind, solar, wave and geothermal energy solutions
- Cheap renewables energy technology and batteries are reshaping the energy sector
- By 2040, renewable energy will make up 80% of the energy mix in Europe and China

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Source: https://www.iea.org/reports/world-energy-outlook-2019/renewables



Engineers are essential to ensure access to clean water



- One –sixth of the world's population lacks access to clean water
- Climate change will make accessibility to water more important in developed and developing countries.
- Technologies for low cost sustainable use of water, capture and storage of rainwater, management of catchments, bio waste management etc. are needed

Drinking water service coverage, World, 2000 to 2015

Total population using a given drinking water source. At least basic drinking water represents an improved source within 30 minutes' round trip to collect water; 'limited' constitutes an improved water source more than a 30 minute round-trip away; 'unimproved' is one that by the nature of its construction does not adequately protect the source from outside contamination, and 'surface' is that from surface water sources.



Source: <u>https://sdg-tracker.org/water-and-sanitation</u>



Our World in Data

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Engineers are essential to ensure access to 6 REAN WATER 6 REAN WATER

Change country D Relative

Sanitation facilities coverage, World, 2000 to 2015

Number of people with access to different sanitation facilities. 'At least basic' are improved sanitation facilities not shared with other households; 'limited' are improved facilities shared with other households, 'unimproved' are facilities without a flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, or composting toilet.



One third of the world's population lacks access to basic sanitation.



Source: https://sdg-tracker.org/water-and-sanitation



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3. ENGINEERING AND SUSTAINABLE AND SMART CITIES



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Engineering sustainable cities – essential in an increasingly urbanised world 11 SUSTAINABLE CITES

- Engineering is at the core of solutions for smart cities
- More than two-thirds of the word will live in cities by 2050
- Housing, roads, transport, water and energy will be key to sustainability and liveability of cities.



Source: Centre for Innovation, Leiden University



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Arcadis Sustainable City Index 2018



 London ranked as the top city balancing the needs of people and planet with jobs and economic growth.

Source: <u>https://www.arcadis.com/media/1/D/5/%7B1D5AE7E2-</u> A348-4B6E-B1D7-6D94FA7D7567%7DSustainable Cities Index 2018 Arcadis.pdf

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ARTIFICIAL INTELLIGENCE TECHNOLOGY FOR SMART AND SAFE CITIES





Engineering is needed to mitigate the impacts of climate change and for resilient infrastructure in cities

- Engineers are at the forefront of tackling climate change through the development of a wide range of technologies that mitigate the impacts of climate change and ensure resilient infrastructure.
- The World Federation of Engineering Organizations Committee for the Environment has developed a Model Code of Practice on the Principles of Climate Change Adaptation for Engineers.



Source: Fiji Institution of Engineers: Capacity Building after cyclone disaster in Fiji



Engineering the responsible consumption of resources in cities

- Engineers play critical roles in managing resources efficiently from mining, processing essential minerals, generating energy from renewable resources, ensuring the effective use of water resources, agricultural production and the management of biodiversity.
- Engineers are developing solutions for resource management and responsible consumption through the concept of the circular economy where outputs and products can become inputs into other processes and products thereby conserving the earth's resources.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION



Recoverable mineral resources in the mobile phone



Engineering is essential for the responsible management of our ocean resources





Source: National Geographic (left) and https://pcfml.org.au/initiatives/butt-free-beaches (right)

 Oceans are a vital resource for the planet. They make possible the supply of water and marine-based foods and modes of transport, while also regulating the climate. Preserving and protecting the oceans and seas and the life within them is a vital role for engineers as part of sustainable cities.



Engineering the appropriate resources of our forests, flora and fauna is an essential task



 Trees and parks in sustainable cities are vital to combat climate change and protect biodiversity, both flora and fauna.





Source: https://www.arcadis.com/media/1/D/5/%7B1D5AE7E2-A348-4B6E-B1D7-6D94FA7D7567%7DSustainable_Cities_Index_2018_Arcadis.pdf

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Technology and Engineering enhances decent work and economic growth in cities

- Approximately half the world's population lives on less than US\$ 2 per day and access to reliable work remains uncertain.
- Engineering is now recognized as an essential enabler of economic growth.
- There is a positive relationship between economic growth and the number of engineers in a country on a global basis





Solar energy increases productivity for farmers in remote Mongolia



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Engineering for everyone – so no one is left behind 10 REDUCED

- Ensuring that the latest innovations are accessible especially in countries with low incomes is essential to reduce inequalities around the world.
- Engineering innovation is leading innovation such as the development of the low cost tablet device which enables access for students to the internet and to educational opportunities.





4. TRANSFORMING ENGINEERING THROUGH EDUCATION AND PROFESSIONAL DEVELOPMENT



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Engineering Education – a key enabler to advance the SDGs

- Engineering education needs to transform to ensure engineers have the skills to implement sustainable development by applying their specialised knowledge, exercise judgement, and act ethically.
- Teaching and learning modes are appropriate to a rapidly changing technological world
- Engineering gradates meet the current needs of industry
- Professional development sustains career-long training and competency







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The Fourth Industrial Revolution is transforming our world of work





- Industry 4.0 Robotics, IoT, Sensors, Block Chain, Augmented Reality
- Data Machine learning Artificial Intelligence
- Quantum Computing
- 3D Printing



Civil and Construction Engineering : Disruptive technologies

- Artificial Intelligence: using building codes for automated design
- Building Information Management (BIM): Design, project management, construction and maintenance
- 3D Printing: Building models and services
- Cloud collaboration/Automation for teams: shared information on project plans, drawing, specifications, procurement
- Data: predictive analytics: construction, condition monitoring, maintenance
- Energy: Kinetic Roadways harnessing the energy of vibration
- PV Glazing/Tiles: using passive structures for energy generation







Example – civil engineering - skills needed by engineers of the future



- It is estimated that 90% of the work of civil engineers is embedded in the excellent codes and standards that underpin much of civil engineering. These can be used to build automated systems that may take over routine design work and tasks that once took many months of effort will be processed by a computer in a matter of hours.
- Building Information Modelling (BIM), Simulation, optimization, and automation are transforming civil engineering and will be used for many tasks with little human intervention.



The Issue: How many engineers are there, how many are needed?

Global Engineering Capability Review, 27 Feb 2020, Provides a ranking of engineering capability but no information on numbers of engineers globally.

Recommendations:

- 1. Strengthen the evidence base use technology to collect data on engineers to inform government policy
- 2. Improve quality not quantity:
 - a. On the job learning, more practical work, industry placement for academics etc.
 - b. National professional Engg. Institutions should provide on going training
 - c. Develop national certification standards for engineers
 - d. Develop accreditation programs for engineering qualifications and transnational programs for recognition



WFEO – UNESCO Declaration, signed on March 7, 2018



CELEBRATING 50 YEARS OF INTERNATIONAL ENGINEERING LEADERSHIP

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Cultural Organizat

Paris Declaration

Advancing the United Nations Sustainable Development Goals through Engineering



The World Federation of Engineering Organizations [WFE0] is the main body for engineering globally, representing nearly 100 nations and some 30 million engineers.

The members of WFEO are the national and regional professional engineering institutions of the world. WFEO is a member of the United Nations Scientific and Technological Community (UN STC) Major Group and has an official Associate status with UNESCO.

UNESCO, as the United Nations agency for education, science and culture, supports engineering through its Natural Sciences Sector, and acknowledges engineering as a powerful means to achieve sustainable development, capacity-building in engineering education and gender equality in developing countries, as well as the safeguarding of world heritage.



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Increase the number and quality of engineering graduates...

Inform global standards for engineering education, support the development of a range of engineering education systems to comply with agreed standards...

wreu is committed to playing a key role in leading and coordinating projects to achieve the SDGs through engineering. WFEO can bring together its

Support Capacity Building through strong institutions for engineering education...

stage in bringing together the WFEO members and partners to develop the WFEO Engineering 2030 Plan. Accordingly, we declare:

WFEO, a recognized member of the UN STC Major Group and UNESCO, through its Natural Sciences Sector, will work together and in cooperation with other UN organizations, including UNEP, UNFCCC and UNISDR towards achieving the SDGs through engineering.

WFED and UNESCO are committed to the following principles for action through engineering to achieve the SDGs:

a. Increase the numbers and quality of engineering graduates that meet the needs of sustainable development with rapidly changing technologies, in collaboration with educators, government and industry;

 Inform global standards for engineering education, support the development of a range of engineering education systems to comply with agreed standards and facilitate the mobility of engineers;

 Support capacity-building through strong institutions for engineering education and the development of accreditation bodies for the recognition of professional credentials;

Establish policy frameworks and best practices, notably through WFE0 Standing Technical Committees, as digital technologies, data sciences and artificial intelligence have ethical and social implications.

Signed in Paris, 7 March 2018

Marlene Kanja

Marlene Kanga President World Federation of Engineering Organizations

a.i. Flavia Schlegel Assistant Director-General for Netural Sciences UNESCO



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Engineering 2030 – Principles for Action

- 1. Encourage young people To consider engineering as a career
- 2. Graduate Outcomes Agree with educators, government, industry
- 3. Global standards for engineering education and professional development
- 4. Partnerships with international standard setting organisations for consistent international framework
- 5. Support development of national engineering education systems to comply with agreed standards
- 6. Capacity Building for accreditation of engineering education and accreditation bodies
- 7. Capacity Building for professional engineering institutions
- 8. Develop professional competency pathways so graduates meet employer needs
- 9. Support national and international registration for recognition of qualifications and experienced of practising engineers
- 10. Liaise with governments to establish consistent regulation policies for engineers
- 11. Establish an international platform for engineering standards Education and professional development, under auspices of WFEO and UNESCO
- 12. Report on progress to UNESCO and other international organisations

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Partnering with our international peers

- This project has been progressed in partnership with our national and international members and peer international organisations in engineering
- Together we are working on joint objectives in education, training and sustainable development
- Partnerships with:
 - International Engineering Alliance (IEA)
 - International Federation of Engineering Education Societies (IFEES)
 - Federation of International Consulting Engineers (FIDIC)
 - International Network for Women Engineers and Scientists (INWES)
 - International Centre for Engineering Education (ICEE, UNESCO Category II Centre) at Tsinghua University
 - International Science Technology and Innovation Centre for South-South Cooperation (ISTIC, Malaysia, UNESCO Category II Centre)



17 PARTNERSHIPS FOR THE GOALS



WFEO and IEA: Working Group #1: Review of IEA Framework for Engineering Graduate Attributes & Professional Competencies

- 1. Review Global standards for engineering graduate outcomes
- Graduate Outcomes: Reviewing current framework for graduate outcomes in view of:
 - UN Sustainable Development Goals
 - Diversity and Inclusion
 - Emerging technologies and disciplines in engineering
 - Rapidly changing technology environment and learning systems
 - Critical thinking, innovation, ethics, professional judgement
- 2. Review Global standards professional competencies so graduates and engineering practitioners meet employer / employability needs/expectations including requirements for lifelong learning
- 3. WFEO partnerships to support the development and validate the updated framework: UNESCO, ICEE, FIDIC, INWES and WFEO members



WFEO and IEA: Working Group #2:

Building strong professional engg. and accreditation institutions

- 1. Development national engineering education systems to comply with agreed benchmarks
 - 1. Training for mentoring and support for development of education assessment systems and accreditation of programs
 - 2. Training for educators complementary programs by partners e.g. IFEES
- 2. Build institutional capacity for accreditation bodies and professional engineering institutions
 - 1. Governance for accreditation bodies and Professional Engineering Institutions (PEIs), recognising that these are the national members of WFEO
 - 2. Support development of regulatory framework for engineering appropriate to the country's national systems and priorities
 - 3. Training and development for PEI leadership and systems
 - 1. Training in and Assessments in country
 - 2. Supported and facilitated by WFEO national and international members
 - 4. Accreditation bodies -should be recognized by the engineering profession
 - 5. Registration bodies may be government or led by PEIs registration covers requirements for engineering education and professional competencies

UNESCO is a key partner for the review of engineering benchmarks for Graduate Attributes and Professional Competencies

The second UNESCO Engineering Report recommends:

1. "Government, engineering educators, industry and professional engineering institutions need to collaborate to increase the number and quality of engineers.





- 2. There is also a need to work in partnership to develop the necessary international engineering education benchmarks for sustainable development.
- 3. These need to be recognised across the world and form the basis of national engineering education systems for engineers with the right skills especially Asia, Africa and Latin America."



Excellent progress with reviewing the international benchmark (WG#1) - Feedback received has been overwhelmingly positive

WG#2 – work in progress – focus on support for Africa, Asia and Latin America

"The GAPC framework is truly transformative in outlook for engineering education, and of major importance."

Professor Tim Ibell FREng Professor of Structural Engineering Department of Architecture and Civil Engineering, University of Bath, U.K.



5. CLOSING REMARKS



Implications for the Future

- COVID-19 is has accelerated collaboration between governments, universities, research institutions and companies at an unprecedented pace.
- Seemingly insurmountable barriers have fallen away in a few weeks.
- We have invented new technologies in many fields of engineering.
- The good will of engineers around the world, working together in partnership will help to solve not only the problems of COVID-19 but many other global problems.
- We need more engineers to facilitate the advancement of the UN Sustainable Development Goals leaving no one behind. The work of WFEO is more important than ever.

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Communicating the impact of Engineering



- World Engineering Day for Sustainable Development 4th March every year
- An opportunity to celebrate the impact and outcomes of engineering for a better world
- See: <u>www.worldengineeringday.net</u>









The world's engineers united in rising to the world's challenges. For a better, sustainable world.



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

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