MÜDEK

Mühendislik Eğitim Programları Değerlendirme ve Akreditasyon Derneği
Association for Evaluation and Accreditation of Engineering Programs

Sustainable Development Goals and Engineering Attributes

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PRESENTATION OUTLINE

- IEA GAPC Review
- WFEO-IEA Agreement and the Process
- The Nature of the GAPC Review
- Engineer and Sustainability
- Engineers Acting on 17 UN SDGs
- SDG in EUR-ACE FS: Why and How

IEA-GAPC REVIEW BY IEA AND WFEO

- UNESCO and WFEO recognize the IEA Graduate Attributes and Professional Competences Framework as a valuable international engineering benchmark standard.
- The IEA GAPC were refined for about 10 years and approved on 21 June 2013 to be an exemplar or a reference.
- Presently, they are a point of reference for all member organizations of IEA in building and revising their own “graduate outcomes” or “professional competences.”
- GAPC has gone through a major review during November 2019 to June 2021 jointly by IEA and WFEO.
- A revised IEA GAPC has been endorsed and an implementation period has started in June 2021.

UNESCO/WFEO - IEA AGREEMENT

- The World Federation of Engineering Organizations **(WFEO)** was established in 1968 by representatives of 50 scientific and technical associations from all over the world under the auspices of **UNESCO.**
- WFEO and IEA signed an MoU covering two terms: 1st term 2015-2019, 2nd term 2019-2023 with the purpose:

  Raise awareness of the importance of accreditation of engineering qualifications and competence assessment to global standards.

- A WFEO IEA Working Group was established in November 2019 under the Declaration on Engineering Education that was made in Melbourne at WEC2019.
- After substantial global consultation activities, the review has been completed in June 2021. **The revision has concrete and strong international support**.

REVISED GAPC

GAPC is organized in three categories based on required qualifications (assimilated knowledge, skills, and attitudes) of a professional **engineer** (4-5 year), an **engineering technologist** (3-4 year), and an **engineering technician** (2-3 year).

Five tables, each with three columns of categories, specify the required **Range of Problem Solving Capabilities, Range of Engineering Activities**, **Knowledge and Attitude Profiles**, **Graduate Attribute Profiles, and Professional Competence Profiles.**

The revision encompassed all tables and all the categories.

The following focuses on the qualifications of a 4-5 year engineering graduate, which is prescribed by the table of Graduate Attribute Profiles.

GAPC Table 4: Graduate Attribute Profile

Graduate attributes cover:

1. Engineering knowledge
2. Problem analysis
3. Design and development of solutions
4. Investigation and research
5. Usage of appropriate tools

KNOWLEDGE

6. The engineer and society
7. Human, social and environmental impacts
8. Ethics

ENGINEER & WORLD

9. Individual and collaborative team work
10. Communication
11. Project Management and Finance
12. Preparation for lifelong learning

WAYS TO WORK

THE NATURE OF THE REVIEW

The incorporated changes in revised GAPC cover:

- Attention to the use of information technologies, data and analytics
- The ability to learn and adapt to new and emerging technologies
- Greater responsibility to society and the environment
- Embedding cultures, behaviours and values for a more diverse and inclusive profession
- A broad ethical approach and responsibility for the development of engineering solutions
- The need for on-line communication and consultations, highlighted during COVID-19 lockdowns
- **The need to address the objectives of the UN Sustainable Development Goals**

Global acceptance has been remarkably fast, demonstrating that the **profession itself has recognised the need for urgent change**.

ENGINEER AND SDG

Sustainable Development Goals can not be achieved without conscious and active participation of engineers.

It is thus vital to incorporate sustainability strongly in curricula to make every engineering graduate familiar with the 17 SDGs.

The following examples that illustrate the relevance of engineering discipline to each one of SDGs is from *UNESCO Engineering Report, March 2021* «Engineering for Sustainable Development: Delivering on the Sustainable Development Goals» with big thanks to Dr. Marlene Kanga.

NO POVERTY

End poverty in all its forms everywhere

Populations in low-income countries are demanding access to the latest technologies.

In India, more than 100 million low-income users have access to mobile phones that cost less than US$25. These enable the users to better manage their work, farm production, and finances.

An unsuccessful attempt is the Tata ‘Nano’ car experience of India. This was a breakthrough in low-cost transport with numerous innovations and a light weight of just 600 kg. It has been a victim of anti-propaganda about its safety!

Engineers are continuing to innovate in this field with the development of electric and solar-powered vehicles.

ZERO HUNGER

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Earlier, increased food production has been possible mainly through the work of agricultural, mechanical, and chemical engineers. More recently,

- Automated sensors for condition monitoring of soil moisture
- Robotics for the application of pesticides, fertilizers, for weeding and planting
- Communications technology for weather monitoring, forecasting and disaster

are crucial to achieving global food security.

Satellites are used to monitor the climate and therefore food security in 34 countries in Africa and Asia.

FarmerLink, is an innovative mobile-based farmer advisory service that links poor coconut farmers to an early warning system and market buyers in the Philippines.

GOOD HEALTH AND WELL-BEING

Ensure healthy lives and promote well-being for all at all ages

Universal and inclusive access to health technologies is a key goal for sustainable development:

- GE-developed portable electrocardiograph machine requires only battery power, costs less than10 per cent of conventional machines enabling access to health diagnostics in rural areas.
- ‘Jaipur Foot’22, a rubber-based leg prosthetic enables thousands of people with disabilities to become more mobile.
- Healthcubed is a start-up that provides access to low-cost medical diagnostics for chronic health conditions in developing countries, particularly in remote areas.
- Engineering responses during the COVID-19 lockdowns have accelerated the uptake of tele-health technologies.

QUALITY EDUCATION

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Software and telecommunication engineers are fast expanding access to the internet and a world of connectivity.

Engineers are developing learning systems that use AI in providing personalized content and instruction that is locally relevant, gender- and ethnically inclusive, and dynamic and interactive.

- With over a billion students impacted globally by lockdown measures and unable to attend school, telecommunications networks have been crucial in sustaining inclusive learning
- Access to low-cost technologies such as the ‘Aakash’ or ‘Ubislate’ tablets, available for US$35, is enabling the Government of India to link 25,000 colleges and 400 universities to e-learning programs
- E-learning is currently delivering a wide range of education programs from the world’s top universities to the poorest countries

GENDER EQUALITY

Achieve gender equality and empower all women and girls

Ensuring women's access to technology and engineering will close many gender gaps and ensure that women can benefit from and participate in the technology revolution, as well as take up leadership positions.

Examples of work by engineering institutions:

- Engineers Canada have been developing strategic approaches to increase the participation of women in engineering
- Breakthrough programs such as WomEng are set to attract one million girls/women into science, technology, engineering and mathematics (STEM) by 2027, and are having a particularly significant impact in Africa (INWES)
- IFEES have showcased the achievement of women engineers as leaders, as well as strategies to change the work culture for a more inclusive profession

CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

More than one billion people still lack access to clean water and two billion lack access to basic sanitation. Urgent action is required.

- Agenda for Change (A4C) is providing water and sanitation services via partnerships of non-government agencies for cost-effective, sustainable delivery (WASH Agenda for Change).
- Engineers are developing smart sensors to assess groundwater availability
- Engineers are making advances in the use of Metal Organic Frameworks for low-energy water purification systems
- The women-led company *Banka BioLoo* has developed a sustainable small-scale approach to eliminating open defecation and managing solid bio-waste.

AFFORDABLE AND CLEAN ENERGY

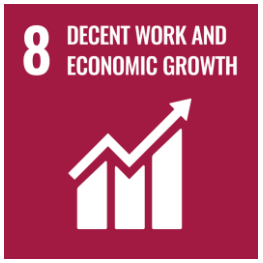
Ensure access to affordable, reliable, sustainable and modern energy for all

Electricity is essential for economic growth and improved living standards. Electrical, mechanical, and environmental engineers develop low-cost renewable energy solutions:

- Photovoltaic cells were instrumental to 20 per cent of the world having access to solar power, with reduction in greenhouse gas emissions. The World Bank is facilitating the delivery of solar technologies in Africa
- Household energy generation and distribution, mini-grids and smart grids are all innovations that are providing access to energy while reducing environmental impacts
- Advances in energy storage are making sources of reliable energy accessible and affordable
- Access to clean renewable energy is supporting agriculture by irrigation pumps, enabling refrigeration for food and medicine, and providing power for all household appliances.

DECENT WORK AND ECONOMIC GROWTH

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all



Approximately half the world's population lives on less than US$2 per day with uncertain access to regular work.

Engineering is recognized as an essential enabler of economic growth. A recent report by Royal Academy of Engineering demonstrated the positive relationship between economic growth and the number of engineers.

Engineers also diversify national economies and create new job opportunities while managing resource consumption.

The need to build and maintain infrastructure is a source of employment in many developing countries. For example, renewable energy projects have created expanded employment opportunities in Africa and Asia.

INDUSTRY, INNOVATION AND INFRASTRUCTURE

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Infrastructure enables industry to develop and thrive. Industry needs engineers of every description in areas such as mining, petroleum, chemical, and food processing. Every type of manufacturing is underpinned by engineers: civil, mechanical, electrical, chemical, and environmental.

Engineering is also the source of innovation. Innovations in AI, robotics, cloud computing, and big data are emerging rapidly and will drive future economic growth and employment.

- AI is transforming *healthcare* to gain insights into chronic diseases, *finance* to monitor fraudulent activities, *shipping and transport* to drive logistics and autonomous vehicles, and *education* to develop student-specific programs
- Robotics are being used in a wide range of industries to replace repetitive or dangerous tasks, or where high precision is required.

REDUCED INEQUALITIES

Reduce inequality within and among countries

No one should be left behind in terms of incomes, health, education and asset ownership.

To encompass the low-income countries, reducing inequality requires
i) low-cost communications, information, and education through low-cost devices,
ii) low-cost medical diagnostics and treatment, and
iii) national data and identity systems that enable the protection of assets.

Smart innovations include:

- The ‘Chotukool’ fridge, which costs US$69 and keeps food cool, enabling women to spend more time on economic activities
- The mobile-based ‘M-Pesa’ money transfer system enables financial transactions, including for individuals without a bank account.

SUSTAINABLE CITIES AND ECONOMIES

Make cities and human settlements inclusive, safe, resilient and sustainable

More than two-thirds of the world will live in cities by 2050.

Affordable housing and public transport, clean air, water and energy, the protection of natural and cultural heritage assets, and resilience against natural disasters are key issues.

- India is building 100 smart cities by 2022, all of which will require engineering for sustainable solutions
- Geospatial engineering, Building Information Modelling, and data analytics can be used in smart cities to make transportation systems more efficient and sustainable
- The blue LED light bulb invented by engineers and scientists significantly reduces greenhouse gas emissions.

These energy-efficient devices are now installed in the city of Bhubaneshwar, India, as a low-cost, low-energy, sustainable solution that improves safety and security for citizens.

RESPONSIBLE PRODUCTION AND CONSUMPTION

Ensure sustainable consumption and production patterns

Engineers are developing solutions for resource management and responsible consumption:

- The Kenya-based company EcoPost recycles urban plastic waste into plastic lumber with applications such as fencing, road signage and outdoor furniture
- Chemical engineers are also developing technological solutions to increase plastic recyclability by addressing the molecular structure of the component chemicals, enabling reuse into new products
- Engineers have developed processes to extract metals from e-waste, which can then be recycled into other products. Another company has developed a 3D-printing machine from discarded components found in e-waste dumps
- Technologies to extract energy from biomass, and thus also reduce greenhouse gas emissions, are increasingly becoming mainstream.

CLIMATE ACTION

Take urgent action to combat climate change and its impacts

Engineers have developed new technologies for alternative sources of energy that have zero carbon emissions.

Carbon capture and sequestration underground or the transformation of bio-solids into gas energy is now in use worldwide. Methods used to absorb carbon from the atmosphere include ocean fertilization and building with timber from rapid growth forestation projects.

- Chemical engineers developed chemical processing to remove carbon from air for use as chemical feedstock by industry
- Collaborative research on low carbon living in cities with a focus on building and construction materials, energy and water use, and smart transportation technologies is ongoing
- WFEO developed a guide for engineers on key principles in developing infrastructure that is resilient to natural disasters and mitigates the impacts of climate change.

LIFE BELOW WATER

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Oceans supply water and marine-based foods and provide modes of transport, while also regulating the climate. Preserving and protecting the oceans and seas, and the life within them, is a vital task for engineers.

The work of engineers in analyzing plastic materials and developing a viable solution is crucial to undertaking a successful clean-up of the oceans.

- Engineers are working on a clean-up solution for the Great Pacific Garbage Patch, which comprises approximately 80,000 tons of plastic waste
- The Reef 2050 Long-Term Sustainability Plan for the Great Barrier Reef Australia provides clear actions and outcomes for its management.

LIFE ON LAND

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

The protection of forests, which cover 30 per cent of the Earth's surface, is vital to combating climate change and protecting biodiversity in terms of both flora and fauna, as well as preventing desertification and ensuring food supplies.

- Participatory geographic information systems and 3D-modelling is an effective means to map, analyze, and negotiate for protecting natural forests and other resources. These tools have been used effectively in Africa, the Caribbean and the South Pacific Islands
- Sensor and drone technologies are being used to map populations of endangered animals. DNA sequencing is also being used to track animals from water samples in known habitats
- The International Meridian Circle Project is an example of collaboration between engineers in China, Poland, and the Russian Federation. It uses satellite information to monitor the Earth and provides early warning of earthquakes.

PEACE, JUSTICE AND STRONG INSTITUTIONS

Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

The promotion of peace, justice and inclusive societies through good governance and strong institutions is a priority for everyone in society, including engineers.

Engineering practice involves embracing the values of diversity and inclusion, sustainable practices and ethical engineering.

- The WFEO has developed a Model Code of Ethics for engineers
- The Committee on Anti-Corruption of the WFEO has partnered with other international organizations such as the OECD and the World Justice Project to promote frameworks to address corruption in engineering
- The Global Infrastructure Anti-Corruption Centre (GIACC) in the United Kingdom is an independent non-profit organization that provides resources to assist in understanding, identifying and preventing corruption in the infrastructure, construction, and engineering sectors.

PARTNERSHIPS FOR THE GOALS

Strengthen the means of implementation and revitalize the global partnership for sustainable development

Partnerships in engineering are essential to advancing the goals of sustainable development, whether within engineering disciplines or across national and international engineering institutions involving government, industry, and universities.

- In March 2018 peer engineering organizations signed the Paris Declaration as a statement of commitment to advance the SDGs through engineering
- The Resilient Cities Network is a collaborative network that shares best practices to achieve SDG 11 on sustainable cities and communities
- The WASH Agenda for Change is a partnership between a number of non-governmental agencies that is driving national and local system approaches for cost-effective and sustainable delivery of water, sanitation and hygiene (WASH) services in Africa and Asia, which are essential for the advancement of SDG 6 on clean water and sanitation.

ENGINEERS WERE NOT ALWAYS PIONEERS

1) **Hippocratic Oath**: 5th-3rd Century BC
   Archimedean Oath:1990 (Ecole Polytechnique)
   Order of the Engineers:1925-1970: Canada/US
   WFEO Code of Ethics, 2010
2) **Women Involvement**: Complaint is «workplace climate»!
   Engineers behind Law, Health, Science, Language, ...
3) **Environmentalism** or **Ecology Consciousness**: Engineers behind Scientists, Philosophers, Villagers, ...
4) **Innovative Teaching Methods**: Engineers behind Medicine, Linguistics, Nursing, …

Conscious employment of UN SDG in analysis and design of engineering problems will be an exemplar for other disciplines.

POTENTIAL DISCUSSION POINTS

1. The sustainibility or all 17 UN-SDG actually need to be learned from the cradle in a sense. Why do we need to require them at such a stage of development from an engineer? UN itself does not think so. They promote the 17 UN SDGs on the jerseys of players in some team sports like basketball.

2. Need we make a reference to sustainability issues all in analysis, design, investigations, and practice? It is necessary that an engineer must have an eye on sustainability at all stages of problem identification, definition, analysis as well as while developing solutions and their evaluation stages.

3. Should we list issues of sustainability or simply refer to UN-SDG from inside the EUR-ACE FS? The «design» being a very central engineering activity, the important sustainability items are better listed. In other learning areas, a reference (perhaps footnote style) may suffice.

POTENTIAL DISCUSSION POINTS

4. The UN SDG will be reviewed by 2030. Wouldn't a reference to the current SDG put a time-based limitation on the document? Next review will be an enhancement of the present one with small adjustments. EUR-ACE FS will perhaps need to be assessed by that time anyway.
5. Is a reference to other organizations appropriate from an ENAEE document? UN-SDG is a collective product of all disciplines. ENAEE promotes a multi-disciplinary approach at a number of standards. Better follow its own advice in this instance.
6. Is there a risk of reviewers (panel members) taking the reference to UN SDG seriously and expect to see a literal teaching of UN SDG in program curricula? The reviewers need to be trained on what constitutes a demonstration (proof) that a program's graduates are actually aware of (conscious of) SDGs!

THANK YOU

References:

[1] IEA Graduate Attributes and Professional Competencies-Version 4, June 2021
https://www.ieagreements.org/assets/Uploads/Documents/Policy/Graduate-Attributes-and-Professional-Competencies.pdf

[2] ‘’Engineering for Sustainable Development:,”*UNESCO Engineering Report, March 2021*
http://worldengineeringday.net/wp-content/uploads/2021/03/UNESCO-Engineering-Report-Engineering-for-Sustainable-Development-EN.pdf