World Federation of Engineering Organisations (WFEO) Consultation Webinar

Overview of the Framework and proposed changes to Graduate Attributes (Table 4) of the IEA GAPC Framework

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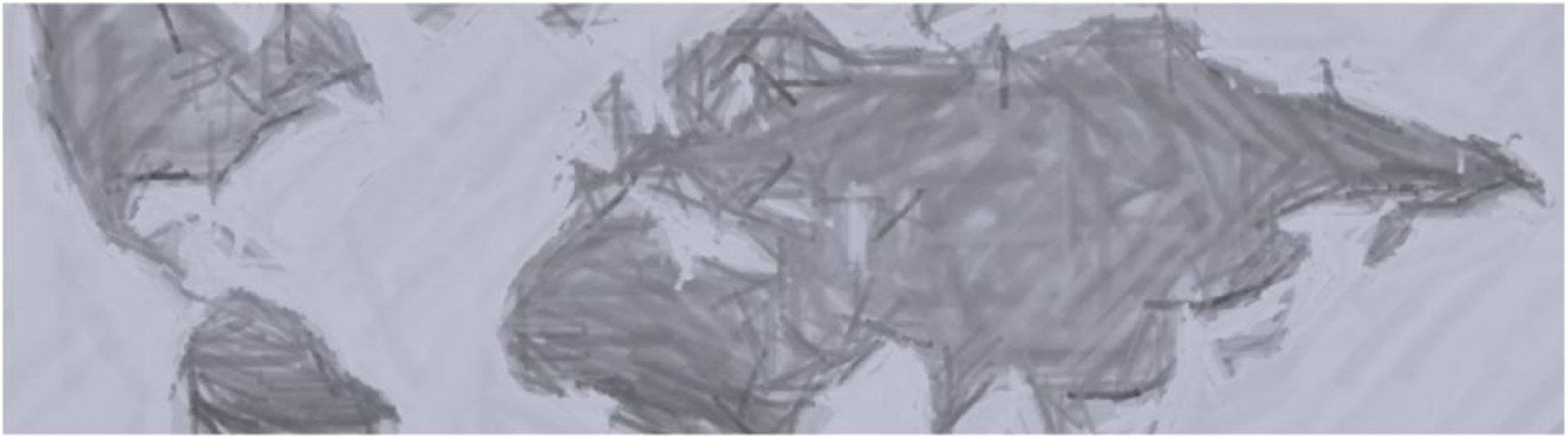
WFEO President 2017-19
18 July 2020



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

Engineering for Sustainable Development

Algeria
Argentina
Australia
Bahrain
Bangladesh
Belize
Bolivia
Brazil
Bulgaria
Cameroon
Canada
Chile
China
Chinese Taipei
Colombia
Costa Rica
Croatia
Cuba
Cyprus
Czech Republic
Ecuador
Egypt
Ethiopia
Fiji
France
Germany
Ghana
Greece
Honduras
Hong Kong, China
Hungary
India
Iraq
Italy
Ivory Coast
Japan
Jordan
Kenya
Korea
Kuwait
Lebanon
Libya
Macedonia (FYROM)
Madagascar
Malawi
Malaysia
Malta
Mauritius
Mexico
Moldavia
Mongolia
Montenegro
Morocco
Nepal
New Zealand
Nigeria
Pakistan
Palestine
Peru
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Puerto Rico
Qatar
Romania
Russia
Rwanda
Saudi Arabia
Senegal
Serbia
Sierra Leone
Singapore
Slovakia
Slovenia
South Africa
Spain
Sri Lanka
Sudan
Switzerland
Syria
Tanzania
The Philippines
Tunisia
Turkey
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Yemen
Zambia
Zimbabwe

Recognised NGO for engineering at UNESCO

Co-Chair of the Science and Technology Major Group at the UN

Representation at major UN Organisations

Based in Paris at UNESCO

Engineering and the UN Sustainable Development Goals

- 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

***Engineering* for Sustainable Development**

A key goal is to ensure that engineering graduates have the attributes and skills to meet current and future needs by employers, industry and the community and to work in partnership with peer organisations to meet this objective

Partnering with our international peers

- **This project has been progressed in partnership with our 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)**

The International Engineering Alliance (IEA) and the benchmark Framework for Graduate Attributes and Professional Competencies (GAPC)

- **IEA is an umbrella organisation that provides governance for the three Accords and four Agreements that provide international multilateral recognition of graduate attributes and professional competencies across 30 countries.**
- **For graduation after tertiary engineering education course*:**
  - **Washington Accord – Professional Engineer usually 4-5 years**
  - **Sydney Accord – Engineering Technologist usually – 3-4 years**
  - **Dublin Accord – Engineering Technician usually -2 years**
- **After graduation for professional registration, after a period of work experience:**
  - **Intl. Professional Engr. Agreement – Prof. Engineer**
  - **Intl. Technologist Engr. Agreement – Eng. Technologist**
  - **Intl. Associate Engr. Agreement – Eng. Technician**
  - **APEC Engineering Agreement – APEC Region- Prof. Engineer**

* Note: The duration of academic formation will normally be at least sixteen years (Washington Accord), fifteen years (Sydney Accord) and 13 years (Dublin Accord).

The International Engineering Alliance (IEA) and the benchmark Framework for Graduate Attributes and Professional Competencies (GAPC) (2)

- **IEA has established a benchmark for expected graduate outcomes and professional competencies which are used by its signatories to establish substantial equivalence.**
- **WFEO has an MoU with the IEA and has established a Working Group with members from both organisations to review the benchmarks**

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."*

United Nations Educational, Scientific and Cultural Organization

acting together 4 education

WFEO IEA Working Group for review of Graduate Attributes and Professional Competencies (GAPC)

- **Chair: IEA Nominated – Prof. Ari Bulent Ozguler MUDEK , Turkey**
- **IEA Members (all signatories)**
  - **Prof Mitsunori Makino and Ms Akiko Takahashi (JABEE), Japan**
  - **Prof Barry Clarke (Engineering Council UK) , UK**
  - **Ms Bernadette Foley (Engineers Australia), Australia**
- **WFEO Members –**
  - **Dr Marlene Kanga – WFEO President 2017-2019, Australia**
  - **Mr WANG Sunyu (Vice Director General, ICEE Tsinghua University), China**
  - **Prof. Dr Charlie Than, (President, Myanmar Engg. Council) , Myanmar**
  - **Dr Michael Milligan (Chief Executive, ABET) – representing IFEES, USA**

  Others from ICEE China:
  - **Mr KANG Jincheng, Strategic Specialist, ICEE**
  - **Mr QIAO Weifeng, Asst Professor Inst. Of Education Tsinghua University and ICEE**
  - **Mr XU Lihui, Research Associate, Inst. Of Education Tsinghua University and ICEE**
- **Schedule:**
- **Review current frameworks, draft discussion document for consultation Oct-2019 - June 2020**
- **Draft presented to IEA Annual meeting in June 2020**
- **Consultation: July 2020 – Dec 2020 (in progress)**
- **Revise and Finalise IEA Annual meeting June 2021 and WFEO General Assembly 2021**

Emerging engineering disciplines and skills needed by engineers of the future

- **Core knowledge and skills, analytic background, knowledge specific to discipline, basic transferable skills will continue to be needed.**
- **IT skills, ability to write code, rely on 3D printing, digital skills (information literacy, media literacy, and information and communication technologies) will be core.**
- **Data driven analytics, digital proficiency, digital learning platforms**
- **`liberal arts training` become important**
- **Multi-disciplinary issues - social, legal, economic will need consideration in solutions**
- **The complexity (scale, diversity, globalism, disruptiveness) in engineering problems will increase - need for inclusive and sustainable solutions.**
- **Emphasis on `entrepreneurial skills`, `risk-taking`, and `critical thinking`**
- **Ability to work collaboratively with diverse teams, remote and virtual workplaces.**
- **Artificial Intelligence, Machine Learning, Automation, Human-Machine, and Machine-Machine interaction will have rapid growth**
- **And so on….**

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 engineering and artificial intelligence will be used for many tasks with little human intervention.**

Key focus areas for change

1. **Accommodate future needs** of engineering professionals and the profession – strengthen the required attributes on team work, communication, ethics, sustainability.
2. **Emerging technologies** – incorporate digital learning, active work experience, lifelong learning.
3. **Emerging and future engineering disciplines and practice areas** – while retaining discipline independent approach, enhance the skills on data sciences, other sciences, life-long learning.
4. **Incorporate UN Sustainable Goals** - in the development of solutions that consider diverse impacts – technical, environment, social, cultural, economic, financial and global responsibility
5. **Diversity and Inclusion** – include these considerations within ways of working in teams, communication, compliance, environment, legal etc. systems.
6. **Intellectual agility, creativity and innovation** – emphasize critical thinking and innovative processes in design and development of solutions

Table 4: Graduate Attribute Profile

- **Graduate Attribute Profile - the qualifications (assimilated knowledge, skills, and attitudes) of a professional engineer/technologist (3-4 year)/technician (2-3 year) are described.**
- **In this presentation - focus is on the professional engineer – 4-5 year degree.**
- **Attributes for technologists and technicians are described in the full Framework which is available on the WFEO website https://bit.ly/3fg8Fdh**

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 & SOCIETY

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

WAYS TO WORK

GAPC Table 4: Graduate Attributes – (1)

Differentiating Characteristics	… for Professional Engineeer Graduate	Reason for change
Engineering Knowledge	WA1: Apply knowledge of mathematics, natural science, computing and engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop the solution of complex engineering problems.	The graduate is expected to also develop the necessary skills **in computing** addition to knowledge of mathematics, natural science and engineering fundamentals.
Problem Analysis - Complexity of analysis	WA2: Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences with holistic considerations for sustainable development. (WK1 to WK4)	The graduate is expected to apply the latest thinking and holistically consider the **implications for sustainable development**
Design/ development of solutions: Breadth and uniqueness of engineering problems i.e. the extent to which problems are original and to where solutions have not previously been identified or codified	WA3: Design solutions for complex engineering problems and design systems, components or processes that meet identified ~~specified~~ needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon, resource, cultural, societal, and environmental considerations. (WK5)	A graduate is expected to consider the **whole of life cost** and net zero carbon of solutions from cradle to cradle.

GAPC Table 4: Graduate Attributes (2)

Differentiating Characteristics	… for Professional Engineeer Graduate	Reason for change
Investigation: Breadth and depth of investigation and experimentation	WA4: Conduct investigations of complex problems and systems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions	
~~**Modern Digital**~~ **Tool Usage:** Level of understanding of the appropriateness of technologies and ~~various~~ tools	WA5: Create, select and apply appropriate techniques, including prediction and modelling, computing and information tools, and data analytics ~~and modern engineering and IT tools, including prediction and modelling~~, to complex engineering problems, with an understanding of the limitations. (WK6)	The graduate is expected to use **data, modelling and computational techniques** to simulate possible solutions while understanding the implications of assumptions made and limitations of the data being used.
The Engineer and Society: Level of knowledge and respoonsibility	WA6: Apply reasoning within sound decision making frameworks that are informed by contextual knowledge and stakeholder consultation to assess societal, health, safety, legal, historical and cultural issues and the consequent responsibilities for sustainable development relevant to professional engineering practice and solutions to complex engineering problems. (WK7)	The ability to **consult with stakeholders** from a wide cross-section of society and consider a range of requirements, has been added.

GAPC Table 4: Graduate Attributes (3)

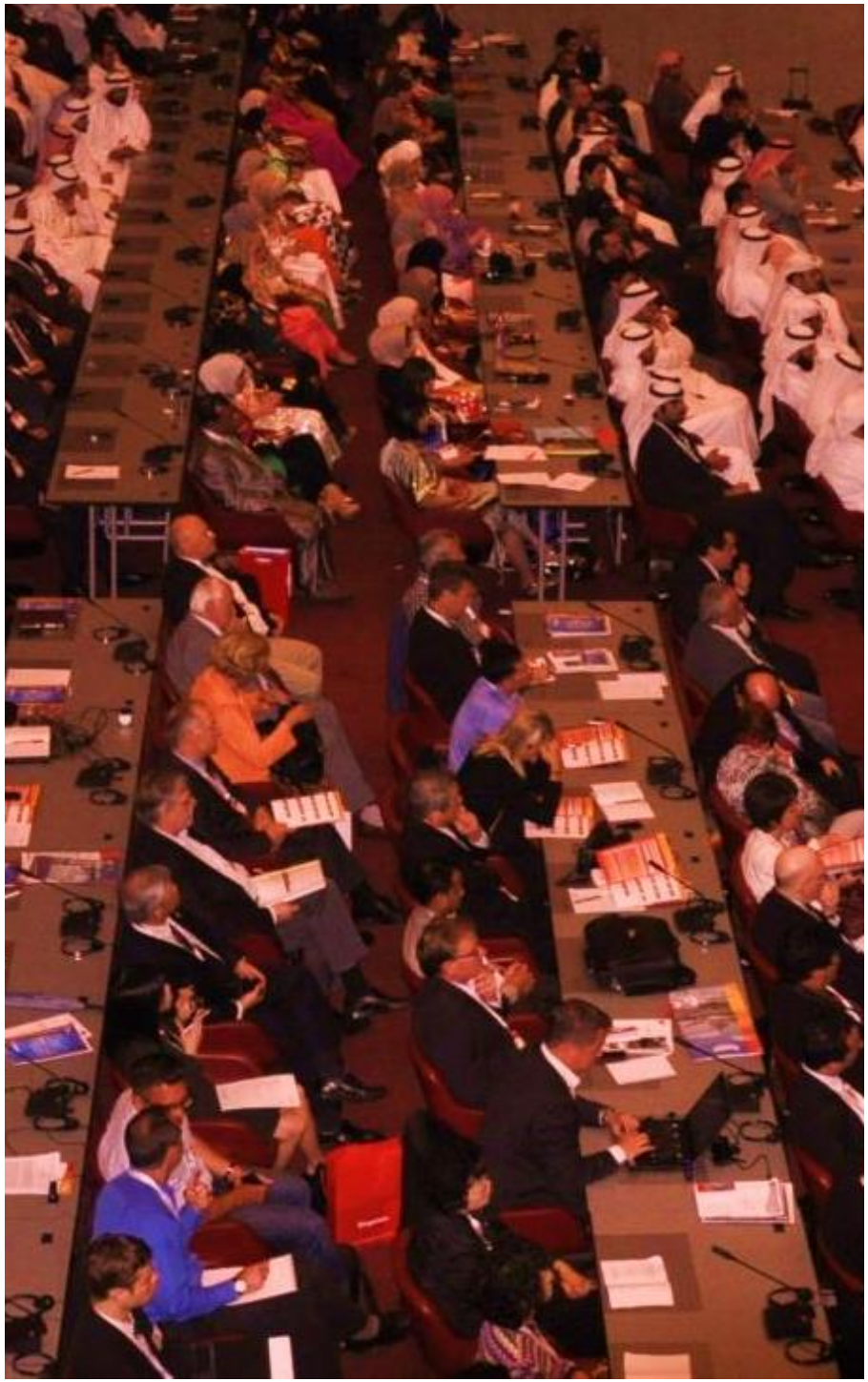
Differentiating Characteristics	… for Professional Engineeer Graduate	Reason for change
Human, Social, Economic and Environmental impacts ~~and type of solutions~~	WA7: Understand and evaluate the sustainability ~~and~~ impact of professional engineering work in the solution of complex engineering problems in human, cultural, economic, social ~~etal~~ and environmental contexts. (WK7)	The ability to evaluate the **impact of engineering solutions on people, the economy and the environment** has been added
Ethics: Understanding and level of practice	WA8: Apply ethical principles and commit to professional ethics, technology ethics, data ethics, global responsibilities, ~~and responsibilities~~ and norms of engineering practice; and adhere to relevant national and international laws. Comprehend the need for diversity and inclusion (WK9) (WK7)	The importance of the **responsible use of data** in engineering solutions, ethical responsibilities for compliance with national and international law has been added
Individual and Collaborative Team work: Role in and diversity of team	WA9: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary and long-distance settings.	The importance of working effectively in **diverse teams** by ethnicity, gender, age, location etc. has been added

GAPC Table 4: Graduate Attributes (4)

Differentiating Characteristics	… for Professional Engineeer Graduate	Reason for change
Communication: Level of communication according to type of activities performed	WA10: Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend, write and present in a variety of ways effectively considering cultural, language and learning differences ~~reports and design documentation, make effective presentations, and give and receive clear instructions.~~	The importance of **inclusive communication**, written and verbal, taking account of cultural, language and other differences, has been added
Project Management and Finance: Level of management required for differing types of activity	WA11: Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	
Continual **Lifelong learning:** Preparation for and depth of continuing learning.	WA12: Recognize the need for, and have the preparation and ability to engage in i) independent and life-long learning ii) creativity and) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK9)	The importance of **creativity, critical thinking and lifelong learning**, has been added

Please provide your feedback

- **The entire table "A Proposal to Update the GAPC Tables.docx" is available at : https://bit.ly/3fg8Fdh**
- **The document contains the five tables relating to graduate attributes and professional competencies for the professional engineer, the technologist and technicians with changes (deletions and additions) on the present GAPC Framework.**
- **In order to add your comments, use the same file "A Proposal to Update the GAPC Tables.docx" and the tables therein, and insert or delete your suggestions of changes in the relevant cell using a new font color. Insert your explanatory notes, if any, in the last column.**
- **Please return the file, after an extension of the filename with your name or your institution's name, as appropriate, to secretariat@wfeo.org.**
- **Please send your feedback no later than 31 August 2020.**



Engineering for Sustainable Development

- Participation
- Influence
- Representation

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

WFEO / FMOI

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

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