

IEA/WFEO Working Group

An account of the role, purpose, and composition of the IEA Graduate Attributes and Professional Competencies Working Group, the proposed and updated plans of work, a summary of the progress of work in the interval November 2019-May 2020 are given. A summary of the identified main emergent points that are taken account in a revision of GAPC tables is also included.

IEA Graduate Attributes and Professional Competencies Review

ROLE AND PURPOSE

UNESCO and WFEO recognise the IEA Graduate Attributes and Professional Competencies Framework as a valuable international engineering benchmark standard.

The IEA Graduate Attributes and Professional Competencies were approved on 21 June 2013 and it is appropriate that they are reviewed to ensure that they reflect contemporary values and employer needs as well as equip engineering professional of the future to incorporate the practices that advance the UN Sustainable Goals. It is the purpose of the Working Group to review these benchmark standards and make recommendations where appropriate.

IEA working group members

- Prof A. Bulent Ozguler (MUDEK)
- Prof Mitsunori Makino and Ms Akiko Takahashi (JABEE)
- Prof Barry Clarke (ECUK)
- Ms Bernadette Foley (Engineers Australia)

WFEO working group members

- Dr Marlene Kanga – WFEO President, 2017-2019



- Mr WANG Sunyu (Vice Director General, ICEE Tsinghua University)
- Dr Charlie Than, (President, Myanmar Engg. Council)
- Dr Michael Milligan (ABET) – representing IFEEES
- 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

PROPOSED PLAN OF WORK

The plan involves two phases with the following objectives:

Phase 1 Information gathering (October 2019 to June 2020)

- o Prepare a briefing paper on preliminary findings and progress to be reported at IAM2020.*
- o Provide a presentation to the WFEO Executive Meeting 2020.*

Phase 2 – Development of proposals for consideration by WFEO members and its partners and for consideration and decision by IEA members and signatories (June 2020 to February 2021)

- o Develop a decision paper for IEAM2021.*
- o Develop a presentation for the WFEO Executive Meeting 2021.*
- o Provide options for work beyond 2021 as required.*

This report summarizes the methods of information gathering and efforts to involve some crucial organizations and individuals in providing views that are taken into account in the work.

PROGRESS MADE IN November 2019-January 2020

- 1) A workshop "IEA WFEO Working Group on the IEA Graduate Attributes and Professional Competency benchmark standards meeting " was arranged by Dr Kanga

and Prof Taylor and held on 20th November 2019 at the WEC2019, see [1]. Participants and the outcomes of this meeting was summarized in the document [2] "GAPC IEA WFEO - WEC Nov 19 workshop notes V1" by Ms Foley (assisted by Dr Kanga, Prof Taylor). This has been an excellent start for our WG.

2) A questionnaire [3] was distributed to all IEA signatories and agreement parties as the primary target group and to a few multi-national engineering companies that we could reach as a secondary target. The list of respondents and a summary of the received responses has been given in an Appendix "Summary of Responses to the Questionnaire" to the report "WFEO-IEA-Working-Group-Report-To-IEA-GG-January-2020." The list of institutional responders to the questionnaire is as follows: *ABET-USA, COET-Thailand, HKIE-Hong Kong, ICACIT-Peru, ICEE-China, IE-India, IES-Singapore, IESL-Sri Lanka, JABEE-Japan, MEC-Myanmar, MUDEK-Turkey, NCEES-USA, PEC-Pakistan.*

3) Ms Foley has coordinated efforts by Prof Makino, Ms Takahashi, and Prof Clarke, to put together a review of drawbacks/advantages of the present GAPC based on the accreditation agencies' evaluation experiences. Ms Foley has summarized their findings in a two-page document [4], which is a beginning of an ongoing investigation.

4) Dr Milligan has continued efforts together with Dr Kanga and Prof Than to give a summary of their experience of engagement with from the IFEEES network, concerning the future engineering qualifications/competencies.

5) The WG progress report "WFEO-IEA-Working-Group-Report-To-IEA-GG-January-2020" has been conveyed by Prof. Taylor to IEA Governing Group in their February 2020 meeting.

PROGRESS MADE IN January 2020-May 2020

1) The first proposed revisions "GAPC-Tables-with-Revisions-04032020.docx" to GAPC was ready by the beginning of March 2020 and has been commented, discussed and revised by members of the WG during that month.

2) Various reports/surveys/investigations that are composed by a number of companies/organizations and were helpful to the WG are listed among References [1]-[15] below.

3) The proposal “GAPC-Tables-with-Revisions-04032020.docx” has been updated a number of times in “File1-GAPC-Tables-with-Revisions-29032020.docx,” “File2-GAPC-Tables-with-Revisions-29032020-history-of-changes.docx” and “IEA GAPC-Tables-Revisions and Reasons 29032020_09042020_15042020_27042020” arriving at the version presented within the accompanying document.

4) A major step was taken by Dr. Kanga by her document “IEA GAPC-Tables-Revisions and Reasons 29032020_30042020.docx,” which has been the result of the following steps that involved WFEO community:

31 March 2020

On line meeting of all WFEO members of GAPC, WFEO President and IFEES Executive Director – M. Kanga presented the background and work done to date and discussions of next steps. Additional time for feedback requested from WG Chair to 30th April.

7 April 2020

Briefing on work done on GAPC Framework to UNESCO Natural Sciences Sector Capacity Building Section

8 April 2020

MEngC on-line consultations with all Chairs of Engineering Disciplines in Myanmar, led by MEngC President Dr. Charlie Than.

9 April 2020

Draft Framework changes extended to apply technologists and technicians (previously only for professional engineering degree). Background to changes updated, reviewed by Prof. Bulent Ozguler.

10 April 2020

Online consultation with Mike Milligan, representing IFEES, feedback on GAPC

14 April 2020



On line meeting with ICEE, MEngC reps, UNESCO rep and WFEO President and detailed discussion of the Framework at 9 April 2020, with further feedback during and after meeting.

17 April 2020

Updated GAPC Framework including comments from 14 April sent to all WFEO WG members for further review.

19 & 20 April 2020

MEngC on-line consultations with engineering academics in Myanmar, led by President Dr. Charlie Than, total 109 attending in two sessions.

28 April 2020

Feedback from Centre for Engg Edu. Malaysia, via the IFEES network.

30 April 2020

Updated GAPC Framework with feedback.

9 May 2020

Strong support for the Framework from IPW Germany, via the IFEES network.

5) Dr. Kanga has also communicated progress on this project to the UNESCO Natural Sciences Sector Capacity Building Section. They are supportive of the Framework, especially of the emphasis on the UN Sustainable Development Goals, Diversity and Inclusion which are priorities for UNESCO.

6) The document “A Proposal to Update the GAPC Tables.docx” is a result of these activities by IEA/WFEO GAPC Working Group in the interval **November 2019-May 2020**, to be commented¹ by all IEA and WFEO member organizations and their associated individuals.

UPDATES TO PROPOSED PLAN OF WORK

¹ 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, at the end of that row. Return the file after an extension of the filename with your name or your institution’s name, as appropriate, to [“ozguler@ee.bilkent.edu.tr.”](mailto:ozguler@ee.bilkent.edu.tr)

The plan of work given above has been updated based on the WG activities and experiences to date.

Phase 1 Information gathering (October 2019 to June 2020)

- *Prepare a briefing paper on preliminary findings and progress to be reported at IAM2020.*
- *Inform the WFEO Executive Meeting 2020.*

Phase 2 – Collect and evaluate further comments and proposals by WFEO members and its partners and by IEA members and signatories (June 2020 to February 2021)

- *Focus on the further aspect of review: Reception of GAPC in practice by educational accreditation agencies and professional organizations.*
- *Seek feedback from WFEO partners for the view of industry (FIDIC), engineering educators (IFEES) women (INWES) and WFEO member organisations*
- *Develop a decision paper for IEAM2021 and keep WFEO Executives informed until WFEO Executive Meeting 2021.*
- *Provide options for work beyond 2021 as required.*

MAIN EMERGENT POINTS FROM INVESTIGATIONS DURING November 2019-January 2020

The main points that emerged from our investigation in the interval November 2019-January 2020 are reiterated below.

VIEWS ON METHODOLOGY

- There is a suggestion that preparing a supplemental document may be a more appropriate response on social/technological trends than reviewing GAPC.
- Proposals on how to incorporate the anticipated developments in technology and disciplines can be grouped into
 - implementing changes in the curriculum and
 - enhancing some GAPC statements

- Suggestions concerning how to implement UN-SDG into GAPC are diverse ranging from "no need" to "incorporate them into GAPC/curriculum more explicitly [but with few specific suggestions]."

Two questions are posed:

- What methodology will we use to distil the information and produce the proposed attributes and competencies?
- Encompassing the soft skill within a program means that something will have to be removed. Should we address this?

VIEWS ON FUTURE NEEDS

- There is unanimous agreement that Artificial Intelligence, Machine Learning, Automation, Human-Machine, and Machine-Machine interaction will have rapid growth.
- Digital proficiency, digital learning platforms, computer specialty will assume the responsibility for issues such as IE [Intelligent Environments?], augmented reality, and those in the previous item.
- Multi-disciplinary talents (with as broad a range for `multi` as possible to include social, managerial, humanitarian sciences, legal aspects) will be more in demand.
- There seems also to be an agreement that `core knowledge and skills` will still and persistently be in demand.
- The complexity (scale, diversity, globalism, disruptiveness) in engineering problems will increase, triggering the need for sustainable solutions.
- The need for `entrepreneurial skills`, `risk-taking`, and `critical thinking` is emphasized a number of times.
- It is remarked (more than once) that work habits will change; more freelance, more virtual workplaces.
- Emphasis for more `liberal arts training` usually goes hand in hand with `thorough foundation in basic sciences and mathematics`!
- The ability to write code, appreciate 3D printing, use of digital skills (information literacy, media literacy, and information and communication technologies) are gaining more ground.

VIEWS ON HOW TO DEAL WITH FUTURE NEEDS

- There are views that the emerging disciplines, UN-SDG, and diversity and inclusion are universal values and they do not have an explicit place in GAPC.
- A connection between `diversity and inclusion` and `engineering` has been strikingly made by the question "How different a city would look if pregnant mothers designed it?"
- There is a suggestion that WK5 of Knowledge Profile, which WA3 (engineering design) refers to, could be a bit more detailed to include some UN-SDG.
- `Efficient resource use`, `whole of life design approaches`, `creating a circular economy` are all relevant to sustainable engineering outcomes, regardless of discipline. The GAPC items EA4 (Consequences to society and the environment), WA1 (Engineering Knowledge), WA6 (The Engineer and Society), WA7 (Environment and Sustainability) and EC6 (Protection of society) should be reviewed.
- It is also suggested that diversity and inclusion may be emphasized in WA6, WA7, EC6 and EC7 (Legal and Regulatory), in addition to WA9 (Diversity of Team) and WA8 (Ethics).
- One view is to extend KSA to KSAT as knowledge, skills, attitude, and *thinking* to emphasize the importance of creativity and innovation. One view is to introduce a subject [in curriculum?] such as "critical thinking." A number of comments indicate that creativity and innovation are acquired (or demonstrated) only when faced by real cases of design and development requirements.
- Lifelong learning, continuous development is almost unanimously emphasized for dealing with new challenges. There is no specific suggestion that goes beyond what the present GA WA12 (Lifelong Learning) prescribes.
- It is suggested that `entrepreneurial skills` is included in GA WA3 (Breadth and Uniqueness), WA5 (Modern Tool Usage), and WA12.
- By way of coping with emergent disciplines, WK1, WA1 (engineering knowledge), and WA2 (engineering analysis) are proposed to be expanded to cover other domains of science (social etc.) in addition to the "natural science" dimension.
- Creativity distinguishes engineers from scientists, which means there has to be a greater emphasis on creativity, innovation and management of change.
- Automation is replacing 'routine' work, which means technicians will have to have higher and different skills.

- Sustainability should be made more prominent throughout such that engineering design truly addresses safety, fit for purpose and sustainability.
- A key attribute of an engineer should be selection, use and evaluation of information, and in defining problems that require a broader education.
- Tools of collecting, cleaning, mining and visualizing data, and data-ethics need be taught.

COMMENTS BY WORKING GROUP

- The suggestions on the content of the engineering curricula are of interest to this WG. We cannot promote changes in engineering curricula, it is neither among this WG's defined objectives nor has it ever been a practice of IEA. We can, however, indirectly indicate a good practice for an engineering curriculum through the Knowledge Profile and to some extent through Range specs of GAPC.
- WG may focus on how to modify GAPC in such a way that it brings forth those knowledge and skills that will not be in the domain of a machine in the next 20 years. (If this could be accomplished, then comments on the significance of creativity, innovation, emerging disciplines will have mostly been taken into account).
- The GAPC have been developed using a traditional education system model but how knowledge is acquired and further developed has now changed to include active learning, modular through-career learning, and the like.
- The notion of an engineering mindset or way of thinking potentially could be an overarching element within the GAPC as there are aspects (e.g. creativity, diversity) that need to be applied across knowledge, attributes, and competencies. The feasibility of emphasizing "the growth mindset" needs to be considered.

REFERENCES²

[1] **WFEO WEC2019 Workshop on IEA/WFEO Working Group**

² Any of these reference documents will be made available upon request from "ozguler@ee.bilkent.edu.tr."



<https://ipenz.basecamphq.com/projects/14572382/file/254073201/WFEO-Conference-GAPC-WG-WorkshopMelbourne.pdf>

[2] Summary Notes from WFEO WEC2019 Workshop on IEA/WFEO Working Group

<https://ipenz.basecamphq.com/projects/14572382/file/254273614/GAPC%20IEA%20WFEO%20-%20WEC%20Nov%2019%20workshop%20notes%20V1.pdf>

[3] IEA/WFEO GAPC Questionnaire (Survey) Form

<https://ipenz.basecamphq.com/projects/14572382/file/254226042/IEA-GAPC-Questionnaire.docx>

[4] Appendix-Summary of Responses to the Questionnaire

[https://ipenz.basecamphq.com/projects/14572382/file/255050735/Appendix Summary%20of%20Responses%20to%20the%20Questionnaire.docx](https://ipenz.basecamphq.com/projects/14572382/file/255050735/Appendix%20Summary%20of%20Responses%20to%20the%20Questionnaire.docx)

[5] IEA-WFEO GAPC drawbacks and advantages B. Foley, M. Makino, A. Takahashi, B. Clarke

<https://ipenz.basecamphq.com/projects/14572382/file/255002227/IEA-WFEO%20GAPC%20drawbacks%20and%20advantages%20DRAFT%20v0.3.docx>

[6] Engineering Futures 2035_Stage 1 report for ACED_May_16_2019 (Engineering Australia)

https://ipenz.basecamphq.com/projects/14572382/file/254273613/Engineering%20Futures%202035_Stage%201%20report%20for%20ACED_May_16_2019.pdf

[7] WG on GA and PC Agenda for 20 Nov 19 101019

<https://ipenz.basecamphq.com/projects/14572382/file/254174210/WG%20on%20GA%20and%20PC%20Agenda%20for%2020Nov19%20v5%2016112019.pdf>



[8] TUEE Phase 1 Workshop Report

https://ipenz.basecamphq.com/projects/14572382/file/254638362/TUEE_PhaseI_WorkshopReport.pdf

[9] TUEE Phase 2

<https://ipenz.basecamphq.com/projects/14572382/file/254638363/2017TUEEPhase2.pdf>

[10] TUEE Phase 3

<https://ipenz.basecamphq.com/projects/14572382/file/254638364/2017TUEEPhase3.pdf>

[11] TUEE Phase 4

<https://ipenz.basecamphq.com/projects/14572382/file/254638365/2018TUEEPhase4.pdf>

[12] ECUK Standards Review- Consultation Questions

ECUK-standards-review-consultation-questions-pdf

[13] IBM Skills for Future 2019

<https://ipenz.basecamphq.com/projects/14572382/file/254421374/ibm-skills-for-future-2019.pdf>

[14] A UK Perspective, Barry C. Clarke

<https://ipenz.basecamphq.com/projects/14572382/file/254998121/WFEO%20IEA%20Graduate%20Attributes%20-%20BGC.docx>

[15] A Thoughtbook to Reimagine the Future of Engineering, Human Anchored with Digital Possibilities. GHD Digital, 2018

<https://www.ghd.com/en/about-us/free-ebook-tomorrow-s-thinking-today-s-people.aspx>



[16] Global Engineering Capability Review, Royal Academy of Engineering, UK, 2020
<https://services.eiu.com/the-global-engineering-capability-review/>

