



GEDC INDUSTRY FORUM 2017

Industry Forum Report Designing the Future of Engineering Education

Report prepared by Petrus Communications
With the GEDC working group

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The GEDC Industry Forum was organised by:



The Global Engineering Deans Council (GEDC) was created on 9 May 2008 in Paris as a recognition of the global need for a world-wide forum of engineering deans and rectors. The main goal of the GEDC is to provide engineering deans and rectors with ideas, tools, and “best” practices necessary to become innovative leaders of engineering education.

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‘I have never been to a meeting, conference, or workshop that has brought together the collection of leaders that we have in engineering from around the world, and in such a dynamic format. We now want to take the plans and ideas designed by delegates for how to address the challenges in engineering and engineering education and implement them, using the GEDC’s unique global network of engineering educators.’

Dr. Peter Kilpatrick

Matthew H. McCloskey Dean of Engineering at
University of Notre Dame, USA and Chair, Global
Engineering Deans Council

*‘Outstanding event. Went above my expectations!
Well done!’*

(Education Representative)



Petrus Communications is a multi-award winning international agency that specialises in linking our clients - engineering and business employers - with students and the global education community. Created in 2005, Petrus now comprises a team of 30 research, communication and digital communication experts creating and implementing projects world-wide. We support our clients in building productive and results focused relationships with key university stakeholders, ensuring that their messages are heard and a meaningful dialogue established. Our hallmark is the design and delivery of creative programmes, campaigns and events that lead to impactful outcomes.

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‘With the first GEDC Industry Forum we successfully gathered inspiring leaders from the worlds of engineering and education for two valuable and enriching days. This has been an important first step. Now we must ensure that the dialogue continues, and that universities and industry continue to exchange about their needs and prepare the future together. Petrus, with our history of innovative university and industry projects - and my own passion for education - are ready to see the Industry Forum become a lasting movement for change. I am certain that many of the ideas and connections forged in Fontainebleau have the potential to positively impact and enable the next generation of global engineering leaders and I look forward to working with the great partners we have in the GEDC to make this happen.’

Kirsten Williamson

Founder and CEO, Petrus Communications

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Alongside the sponsors, we'd like to thank the many people whose commitment, hard work and creativity made the Industry Forum, and this detailed event report possible. The team at CEDEP for their warm welcome, and a special mention to Chris Anderson at AT&T who hosted the networking BBQ. The Working Group of industry and education leaders whose names you'll see below, who shaped the content to ensure its relevance. Paul Blackmore and Chantal De Barra whose engaging, challenging and good humoured facilitation was the thread that wove the forum together and ensured we delivered the event we had imagined many months before. John Beynon and Peter Kilpatrick at the GEDC for partnering so enthusiastically with us to make the event happen. And to the whole team at Petrus whose commitment to delivering an exceptional event in terms of content, experience and follow up was evident for everyone who joined us.

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1. Annex I is available in the online version of the report. The report and full programme can be found here: <http://gedc-industryforum.com/>

2. Annex II is available in the online version of the report on the Industry Forum website at <http://gedc-industryforum.com/>.

Executive Summary

The first Global Engineering Dean's Council (GEDC) Industry Forum took place in Fontainebleau, France in June 2017. It was created and organised by the GEDC and Petrus Communications, and sponsored by Total, National Instruments and Boeing. The purpose of the Industry Forum was to provide a platform for engineering education and industry leaders to come together to discuss and build viable solutions to develop the engineering experts and leaders for the future and understand better each other's needs.

Multiple challenges were addressed, such as the skills gap in the engineering and IT fields, which are attributable to a confluence of megatrends such as increased globalisation; digitalisation; and the blending of technical, economic, and societal structures, which have pushed the world into the beginning of the fourth industrial revolution.

The event included input from expert panellists in addition to highly interactive and innovative group work, during which a number of recurring themes emerged. The following were identified by delegates as areas that need to change for engineering education to best develop 21st century engineers:

- **Making accreditation systems more flexible** – a more agile system is needed to keep up with the pace of change today
- **Teaching students to learn how to learn** – so that they can continue to learn beyond their formal education, to keep up with the changing demands of the labour market, society, etc.
- **Incorporating other disciplines in engineering education** – so that future engineers better understand how their work fits into a highly-interconnected world
- **Allowing failure** – because failure is an essential part of innovation and creativity, how can universities accommodate failure in their curricula?
- **Using more problem-based learning** – turning students into more active learners and teaching them skills they need for the workplace by providing them with 'real-world' problems faced by industry
- **Increasing amount and regularity of collaboration between universities and industry** – to ensure that both communities are on the same page regarding each other's needs and expectations

Questions of ethics and of diversity were often raised during the event. Formal teaching on ethics, using projects, case studies and by integrating work with other disciplines was felt to be essential. The fast pace of technology calls more than ever for consideration of potential unintended consequences and delegates at the Forum clearly wanted engineering and engineers to make a positive contribution for the whole of society, with people of all profiles and backgrounds finding their place within engineering.

In order to help implement the above changes, Industry Forum delegates brought up the following potential solutions at multiple points during the event:

- **Incorporate Global Grand Challenges in curricula** – use the U.S. National Academy of Engineering's (NAE) Global Grand Challenges as part of problem-based learning, or implement the Global Grand Challenges Scholar Program
- **Conduct a global survey** – use a 'massive' global survey that collects input from industry, universities, students, and other stakeholders on the following: whether engineering fundamentals are changing, and, if so, how; identifying

My experience at the GEDC Industry Forum was positive and inspiring as it looks to the next generation. It is important for industry and academia to come together to define what success looks like for the engineering talent of the future. We need to continue to understand how universities prepare STEM talent for success, and events like the GEDC Industry Forum are a great opportunity.

During our time together we shared ideas around how to help engineering talent be successful, taking into account the need to increase diversity across the board and with the advantage of hearing from so many different voices in the room. We also shared our tactics on how to help academia be successful in creating skilled engineering talent that is ready to contribute upon hiring.

Lynne Hopper,

Vice President, Engineering, Modifications and Maintenance, Boeing Global Services

upcoming high-demand skills; identifying the most important non-technical skills and how they should be assessed by universities; and what skills are most in need of development in students in low resource areas

- **Create a platform for exchange** – a platform that facilitates collaboration between universities and industry was frequently mentioned. The platform would be online, and could include areas dedicated to communication between faculty members and industry representatives, a service that matches students and faculty with industry projects, instructional content, and more.

Feedback from the first Industry Forum was extremely positive, with a satisfaction level for delegates close to 100% (92% very satisfied and 8% somewhat satisfied), and an overwhelming interest in participating in the next edition (92% would like to participate in the next edition of the Industry Forum, 8% might like to participate, and no respondents answered they would not like to participate).

The solutions designed by delegates during the Industry Forum will be developed further during a workshop at the GEDC Annual Conference in Niagara Falls, October 2017. More information on these can be found on the Industry Forum website³, or in our LinkedIn group⁴.

Additional materials and resources are available online:

- The Industry Forum Concept Paper⁵
- Engineering Employability Initiatives provided by Industry Forum delegates⁶

University/Industry interaction has stood out during the event as one of the most important aspects of creating engineering leaders in the future. As an organisation that is serious about engineering training, we would like to stay close to this endeavour.

(Industry Representative)

3. <http://gedc-industryforum.com/>

4. <https://www.linkedin.com/groups/13533707>

5. <http://gedc-industryforum.com/wp-content/uploads/2017/10/GEDC-Industry-Forum-Concept-Paper.pdf>

6. <http://gedc-industryforum.com/wp-content/uploads/2017/10/GEDC-Industry-Forum-Engineering-Employability-Initiatives.pdf>

1 | INTRODUCTION AND EVENT OVERVIEW

The first GEDC Industry Forum took place in Fontainebleau, France in June 2017. It was designed by Petrus Communications⁷ and the Global Engineering Dean's Council (GEDC)⁸ to ensure that the voice of all delegates who attended was not just heard but translated into action for the future. The skills gap in the engineering and IT sectors has been the focus of much detailed analysis, producing a wealth of material on the subject. The Industry Forum set out to take this work a step further and produce viable solutions to close the clearly identified skills gap for the mutual benefit of all stakeholders involved. Given that the collective experience of all participants amounted to some 2000 years-worth of expertise, the Industry Forum was designed not to be solely an occasion for input from expert panellists but also to create a platform where a learned community made up of both industry and academic leaders would come together to build on this collective experience and know-how. The aim being to design innovative solutions for developing the engineering experts and leaders for the future and better understand each other's needs.



7. <http://petruscommunications.com/>

8. <http://www.gedcouncil.org/>

1.1 | Why Now?

The need for an event like the Industry Forum today is based on several concurrent megatrends which have been accelerating the pace of global change in the past two decades:

- **Globalisation** – this is not a new trend, but is occurring at an increasing pace and when joined by the other megatrends listed here is particularly impactful.
- **Digitalisation** – which has resulted in the blurring of boundaries ‘between nations, disciplines, and professions, between academia and industry, and between applied science and engineering.’⁹
- **Horizontalization of the socio-economic world** – with information and knowledge spread ever more rapidly and openly today, traditional hierarchies have been flattened.¹⁰
- **Blending of technical, economic, and societal structures** – innovation and business are increasingly driven by clients and consumers rather than technology, leading for example to the rise of design thinking in engineering which is centred on the end-user. Growing access to information, know-how, and inexpensive and user-friendly software, tools, and materials, means that it is now easier for nearly anyone to design, develop, manufacture, finance, and sell products.¹¹

This particular configuration of megatrends has led World Economic Forum (WEF) Founder and Executive Chairman, Klaus Schwab, to argue that we are now in the beginning of a fourth industrial revolution.¹² He argues that while ‘some academics and professionals’ consider recent developments as ‘simply part of the third industrial revolution’, his conviction is that we are indeed in the fourth industrial revolution today and is underpinned by the following reasons:

- **Velocity** – this industrial revolution is evolving at an exponential pace rather than the linear pace of past industrial revolutions
- **Breadth and Depth** – the fourth industrial revolution is ‘built on the digital revolution and combines multiple technologies that are leading to unprecedented paradigm shifts in the economy, business, society, and individually’
- **Systems Impact** – the ‘transformation of entire systems, across (and within) countries, companies, industries, and society as a whole’ marks the fourth industrial revolution¹³

Industry Forum delegates not only mentioned these megatrends and their impacts on multiple occasions throughout the event, but explicitly cited Schwab in presentations and group work.

The fourth industrial revolution presents great opportunities for societies around the world, but also great challenges. Engineers are uniquely positioned to address these challenges, but this requires engineering education to adapt to this new environment in which:

- The exponential pace of technological innovation has led to increasingly rapid changes in industry needs
- The aforementioned blending of boundaries and changing paradigms mean that engineers of the future need skills that go beyond more ‘traditional’ engineering skills, for example systems thinking, the ability to work in interdisciplinary and multicultural teams, ethical leadership, etc.

Both of the above have resulted in gaps in the skills that engineers currently graduate with, and concern about whether industry will be able to articulate in a timely, accurate fashion what skills will be needed, for the education system to respond or anticipate.

9. Kamp, A. (2016). Engineering Education in the Rapidly Changing World: Rethinking the Mission and Vision on Engineering Education at TU Delft. Delft University of Technology, Delft, The Netherlands. Retrieved from <https://repository.tudelft.nl/islandora/object/uuid:ae3b30e3-5380-4a07-afb5-dafd30b7b433/datastream/OBJ/download>, p. 12

10. *Ibid*, p. 14

11. *Ibid*.

12. Schwab, K. (2016). *The Fourth Industrial Revolution*. Geneva, Switzerland: World Economic Forum.

13. Schwab, K. (2016). *The Fourth Industrial Revolution*. Geneva, Switzerland: World Economic Forum, p. 3

1.2 | The Industry Forum – A Uniquely Designed Event

To best address the changes and challenges identified above, Petrus Communications worked with the GEDC to design an event that would inspire as many innovative solutions as possible from delegates. We agreed to make several considerations critical to the success of the event; short speaker slots with much more time dedicated to dialogue, group work and networking; a very strong focus on maintaining diversity amongst speakers and facilitators (with 50% gender balance, 5 continents represented and a balance between industry and academic input); a challenge to delegates – which was enthusiastically taken up – to share and learn from each other.

1.2.1 | Event Sessions

Sessions at the Industry Forum were designed specifically to provide context for delegates and frame collaborative work. Kicking off the event was an interactive panel session entitled ‘The Engineer of the Future’ which brought together both university and industry leaders to discuss in depth the perceived gap between the skills engineering students are graduating with, and those required by industry. The session went well beyond this however, and also addressed how universities and industry can work together to best develop the skills and attributes needed of 21st century engineers.

The following day, the ‘Case for Change’ was made by two expert speakers – one from academia and the other from industry – who delivered two short, dynamic talks. These talks, in which issues and potential solutions in higher education and industry were identified and discussed, served to instigate critical thinking about the current state of affairs before group brainstorming on the overall Industry Forum themes (listed in Section 3.2) began.

In the evening, after a long day of brainstorming and group work in Dynamic Design Groups, the final Industry Forum session revolved around discussions of ‘convergence’ in engineering. The argument was that engineering will be necessarily combined with other fields in order to best innovate and solve the challenges brought about by the fourth industrial revolution.

1.2.2 | Dynamic Design Groups

Dynamic Design Groups are a concept developed specifically for the Industry Forum by its organisers and working group members. The groups (the structure of which are detailed in Section 3) are a real-life example of multi-stakeholder, collaborative innovation in practice, the benefits of which have been the subject of multiple academic studies.¹⁴

Output for Change

The end result of this collaborative and innovative event was workable output designed to be implemented by the decision-makers present at the Industry Forum. These ideas will be tested in the near future and have the potential to address the challenges presented by the rapid global change we are undergoing today, and produce well-prepared, ethical engineering leaders of the future.

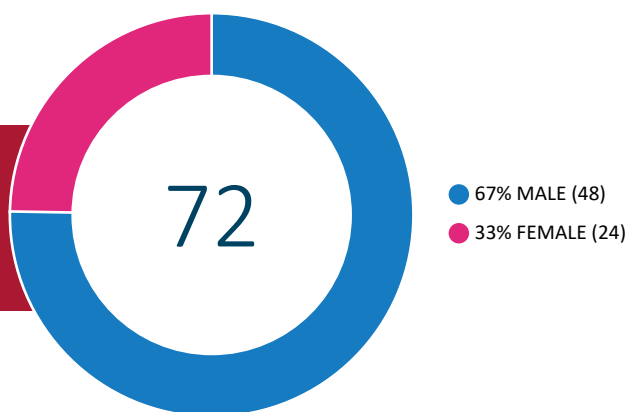
1.3 | Industry Forum Participants

Designed as a unique gathering of industry and academic engineering leaders, the event brought together over 70 delegates from global companies, innovative Small and Medium Enterprises (SMEs), and engineering schools from around the world to discuss in depth how to work together to develop the next generation of engineers and better understand each other’s needs. With delegates coming from 18 countries across 6 regions, and a 33% female representation, the GEDC Industry Forum provided global industry, Human Resources (HR) and academic leaders with a platform for expressing a diversity of thought and exchange of knowledge, experience and ideas.

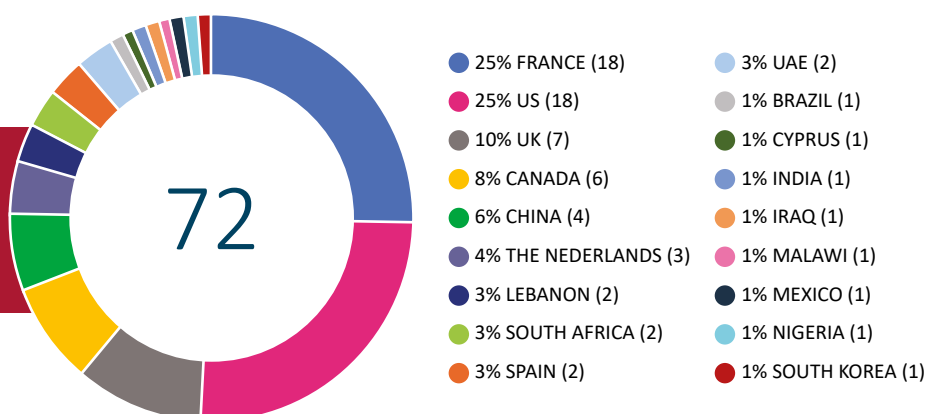
14. See for example:

- Gloor, P. A. (2005). *Swarm creativity: Competitive advantage through collaborative innovation networks*. Oxford, UK: Oxford University Press.
- Roberts, N. C., & Bradley, R. T. (1991). Stakeholder collaboration and innovation. *Journal of Applied Behavioral Science*, 27, 209-227.
- Sørensen, E. & Torfing, J. (2011). Enhancing Collaborative Innovation in the Public Sector. *Administration & Society*, 43(8), 842-868.

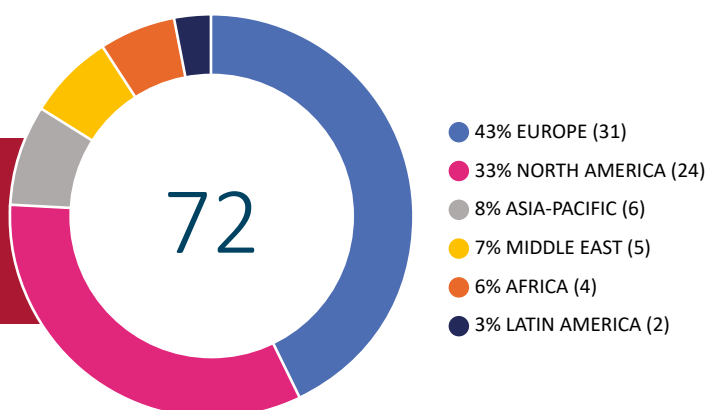
Gender Breakdown
of Industry Forum
Participants



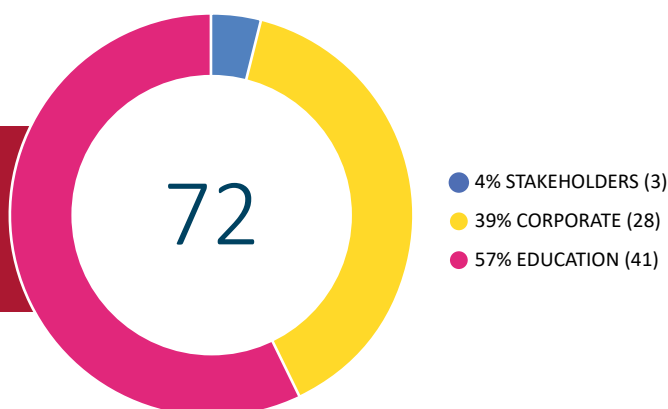
Industry Forum
Participants by Country



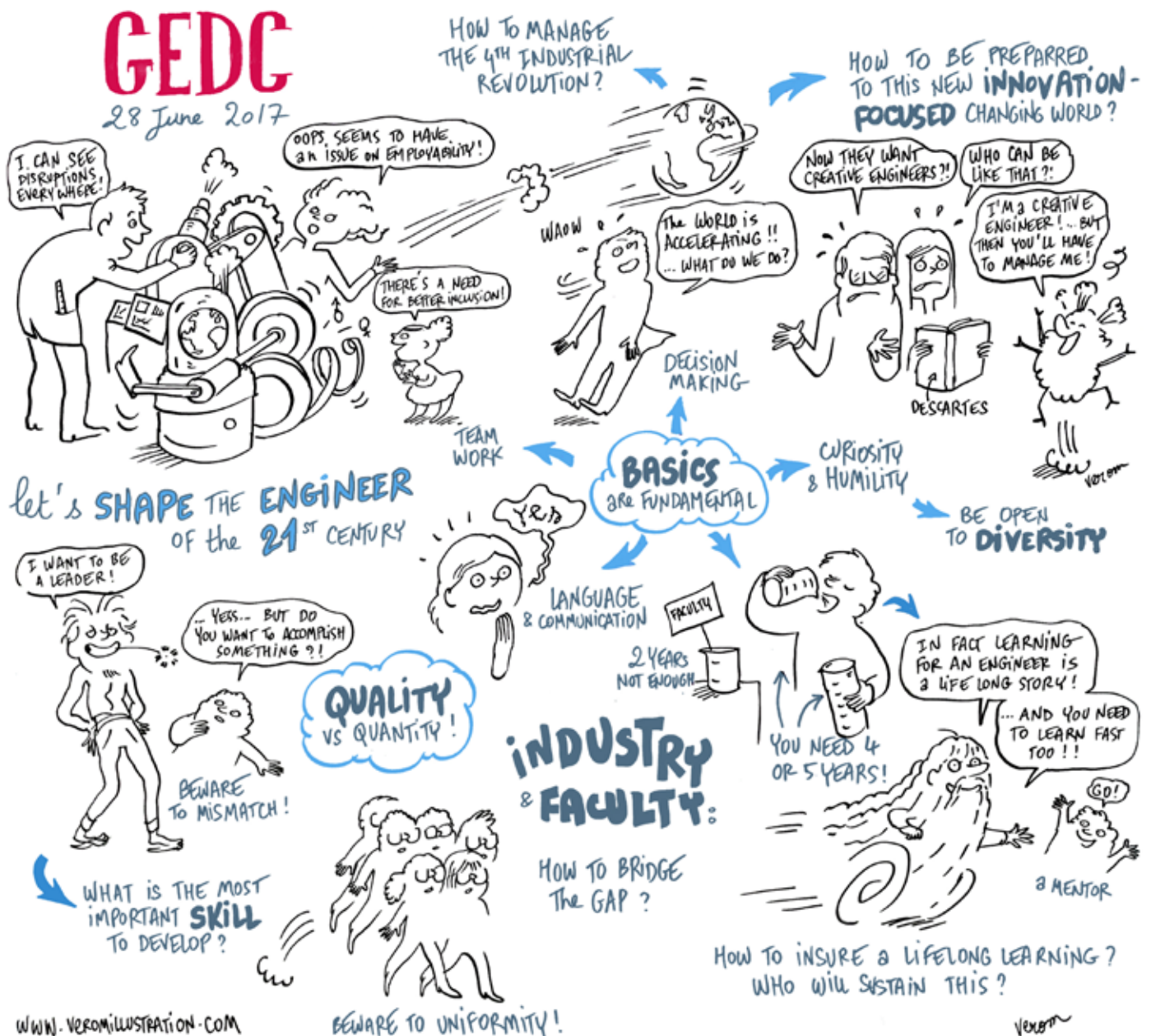
Industry Forum
Participants by Region



Mix of Education and Industry
Representatives



2 | INDUSTRY FORUM SESSIONS



2.1 | Opening Session: An Interactive Panel Discussion on the “Engineer of the Future”

Dr. Peter Kilpatrick, Matthew H. McCloskey Dean of Engineering at University of Notre Dame, USA, and Chair, Global Engineering Deans Council kicked off the event with a discussion of the remarkable sweep of changes the world is currently experiencing, which he described as being part of the fourth industrial revolution¹⁵. He explained to the assembled company that the Industry Forum was designed to bring together participants who are ‘equally interested in the education, skilling, and training of engineers’ and the ‘economic vitality of the world’. The event would also focus on how to narrow the inequality, gender and diversity gaps so that all sectors involved in engineering could fully profit from the talent available across the board. According to Dr. Kilpatrick, the meeting of minds, sharing of innovative practices and creative solutions the event was designed to facilitate and foster would lead to concrete initiatives on how to successfully navigate the ‘riptide impinging on higher education and the engineering workforce’.

This opening session was followed by a vibrant panel discussion on the ‘Engineer of the Future’, moderated by Dr. Ishwar Puri, Dean of the Faculty of Engineering and Professor of Mechanical Engineering at McMaster University, Canada. Dr. Puri began by emphasising that the goal of the panel session – and the event overall – was not to discuss what skills are needed in engineers, but rather to discuss how ‘academia and industry (can) work together to develop these skills and attributes’, particularly in the context of employability.

Host:

Dr. Peter Kilpatrick - Matthew H. McCloskey Dean of Engineering at University of Notre Dame, USA and Chair, Global Engineering Deans Council

Panel Moderator:

Dr. Ishwar Puri - Dean of the Faculty of Engineering and Professor of Mechanical Engineering McMaster University, Canada and Host of the 2017 GEDC Conference (10 – 13 October 2017, Canada)

Panelists:

Dr. Diem Ho - University Relations, IBM Europe

Prof. Dr. Henri Werij - Dean of the Faculty of Aerospace Engineering, TU Delft, Netherlands

Dr. Theresa Mkandawire - Associate Professor and Dean of Engineering, University of Malawi - The Polytechnic, Malawi

Dr. Vincent Saubestre - Vice President Group R&D Strategy & Intelligence, Total

As leadership and teamwork are two of the foremost skills continually described as essential traits for engineers over the past two decades, Dr. Puri asked the panel to describe what these skills look like in practice. For Dr. Henri Werij, the partnership between industry and academia is key to developing leadership and teamwork and understanding what these look like in practice. He provided the inspiring example of the TU Delft programme in which students work in teams on projects which are then assessed by industry. What makes this programme different is that by the end of it, participants have not just been told that teamwork is essential but have had hands-on experience of why it matters and what results such teamwork can produce in practice. The programme also allows industry to become familiar with the needs and expectations of engineering students and future employees in the engineering sector.

Panelists agreed that academia and industry must work together in order to understand what these competencies look like in practice. He added that students must be provided with global exposure so that they understand the challenges and breadth of opportunities that await them in the global labour market. Some defined explicitly what leadership meant to them. Dr. Theresa Mkandawire described how leadership includes the ability to manage budgets and projects. Dr. Henri Werij further broadened this concept of leadership by pointing out in particular that engineers need to be equipped with excellent communication skills as part of their fundamental profile.

Dr. Diem Ho presented an argument that leadership and teamwork are not necessarily the universal competencies that they have sometimes been portrayed as. He said that at IBM, competencies are defined by the role itself.

15. Klaus Schwab, Founder and Executive Chairman of the World Economic Forum, makes the argument that the world is currently undergoing a fourth industrial revolution in his book *The Fourth Industrial Revolution* (World Economic Forum, Geneva, Switzerland). See the Introduction for a synopsis of his argument.



Dr. Diem Ho, Prof. Dr. Henri Werij, Dr. Theresa Mkandawire, Dr. Vincent Saubestre, Dr. Ishwar Puri

Dr. Puri then asked the panel a probing question: ‘Are the way universities and industry view skills in sync?’ Overall, the panellists agreed that there is a misalignment between the skills graduates are equipped with on graduation and those they need in the workplace. For Dr. Vincent Saubestre, the most critical skills to acquire are the ‘fundamentals’ which he identified as ‘learning how to learn’, ‘curiosity’, ‘the ability to adapt’. They reflect the point made by Dr. Kilpatrick in the challenge he laid down to participants in his opening statement that the world is going through a period of exponential change and that future engineers must have the skills to embrace such a sweeping dynamic, not just moving with it but leading the way.

The discussion then turned to whether or not truly global skills exist, given that different organisations, regions, for example have different needs. For Dr. Werij in-demand skills are indeed becoming more similar across regions due to globalisation, which for example has resulted in students from many different areas of the world coming together in universities, quickly developing in them a global mindset. Following up on this reply, Dr. Puri asked ‘if we have diversities, representing different cultures and different attitudes’ would it then be possible to develop some ‘composite attributes and skills that would be applicable globally?’ Dr. Saubestre affirmed that this is possible, and that furthermore a number of skills and attributes are relevant in all parts of the world. These include the ability to show interest, curiosity, teamwork, humility, etc.

Panellists and audience members then debated the ideal length of a university degree in engineering, after the assertion by Dr. Ho that four- or five-year degrees are often ‘overkill’ for some professions. While there was consensus that university degrees should not be less than four years, developing some solutions for training individuals as technicians or programmers, for example, in less than four years was also considered desirable.

In closing, Dr. Puri asked whether the non-technical skills mentioned during the discussion such as humility and curiosity could be assessed within universities before students have workplace experience. Dr. Mkandawire said that she does believe this is possible, but it does still need to involve input from industry, such as during a student’s internship. Panellists all agreed that industry exposure is crucial – not just for skills assessment – and that students should have multiple exposures if possible, or more profound exposure involving programmes like mentoring.

2.2 | The Student Perspective: Global Survey on Workplace Skills for the Future

Zinyat Agharzayeva, a Master's student at the Institut Français du Pétrole (IFP School), France and Texas A&M University (TAMU), USAFrance drew the session to a close with her presentation of a global survey on workplace skills carried out by Petrus Communications for Total. The findings of the survey provide a welcome and much needed vision of how students themselves see their profile evolving. They are highlighted below.

Presented by:

Zinyat Agharzayeva - Total sponsored Master Student, IFP School France & TAMU, USA



Zinyat Agharzayeva presenting the Global Survey on Workplace Skills for the Future

2.2.1 | Survey Overview

The 'Skills for the Future' survey was launched by Petrus Communications in May 2017 on Total Campus¹⁶. The survey was completed by a global sample of 2189 respondents in May and June 2017. A further 137 respondents returned a partially completed survey from which relevant information was added to the total.

Respondents were asked a number of questions to ascertain the following:

- What skills they believe are needed to be successful in the workplace
- What activities they feel are useful for skills development, and which ones they have had the opportunity to experience
- What exposure they have had with industry, and whether they felt this was useful for their skills development
- Whether answers varied according to factors such as geography, experience or age

The majority of respondents were students, although recent graduates and professionals were also included. The majority (56%) are studying or studied engineering/IT. Others were studying Business, Geoscience, Natural Sciences, Social Sciences, etc. While around 20% do not have any workplace experience, 80% of respondents had some level of professional experience ranging from a few months to over five years.

The survey covered 686 universities, with Africa as the single biggest source of respondents. While that figure partly reflects the audience reached through Total Campus channels, it is also an indicator of the strong interest in this subject coming from that region.

2.2.2 | Results

Ms. Agharzayeva began by presenting the skills that respondents consider most important for success in the labour market. Respondents were first asked to list three skills they felt are most important in an open-ended question. They were then provided with a pre-filled list on the survey, as well as space to add any skills they thought were missing from the list.

- The top two skills from both approaches were clearly Communication and Teamwork. There was

16. The full report can be found online here: http://www.campus.total.com/sites/campus/files/atoms/files/developing_skills_for_the_future.pdf

a consensus on these skills among respondents, regardless of level of experience, geography, type of studies and so on.

- Leadership was not part of the list provided, but it stood out noticeably from the open questions as a skill respondents consider to be important.

She then covered the activities respondents believe are most useful for developing skills. The six highest scoring activities were:

Internships	Project work with companies inside the company
Working on real business or engineering projects at university	Apprenticeships
Networking opportunities with experienced professionals	In-company workshops

The three considered least useful were career presentations, MOOCs, and summer schools. Respondents who had experienced the activities listed tended to rate them higher in terms of usefulness than respondents who had not experienced such activities. Fewer respondents had experienced a MOOC or Summer School, which may explain the lower positioning in terms of usefulness.

In terms of differences based on respondent profiles:

- African respondents tend to rate the usefulness of activities higher compared to respondents from other regions while Europeans tend to rate them lower than others.

Finally, respondents were asked which activities they had had the opportunity to experience:

- 64% of respondents had completed an internship, while 63% had participated in student clubs, teams, and societies.
- Just 22% had participated in in-company project work, 21% in summer schools, and 17% in apprenticeships.

The survey shows a clear mismatch between activities that respondents deemed to be useful and the opportunity respondents had to take up that activity, as seen in the figure below.

Usefulness versus Exposure, Total 'Skills for the Future' Survey Results	Usefulness of Activities		Exposure to Activities	
	Internships	4.6		64%
	Working on real business or engineering projects at university	4.5		34%
	Networking opportunities with experienced professionals	4.4		45%
	Project work with companies inside the company	4.4		22%
	Apprenticeships	4.3		17%
	Workshops with companies	4.3		34%
	Entrepreneurship programs	4.2		24%
	Undergraduate Research Experience	4.2		39%
	Studying abroad	4.2		25%
	Taking a leadership role in a students' organization	4.2		48%
	Community engaged and volunteering projects	4.1		44%
	Tutoring programs	4.0		27%
	Participating in student clubs, teams, societies	4.0		63%
	Competitions	4.0		34%
	Visits to companies' headquarters / sites	3.9		49%
	Careers presentations by companies	3.9		48%
	Massive open online courses (MOOCs)	3.8		34%
	Summer schools	3.7		21%

Source: Total 'Developing Skills for the Future' Presentation, 28 June, 2017

With the exception of internships and networking opportunities with experienced professionals, the activities considered most useful by respondents have some of the lowest exposure rates. This demonstrates that either students are unaware of opportunities offered by their universities and/or companies, or they are located in an area where these types of activities are not available. In addition, it is worth noting that each of the top six activities in terms of usefulness rating involve industry involvement of some kind.

Responding to these above findings could include better identification and communication of available opportunities for students (by both universities and industry), as well as an expansion of activities that involve companies.

Following the panel session and presentation of the student perspective on skills, delegates were provided the opportunity to continue the discussion, network, and trade experiences and knowledge among themselves during a welcome cocktail. Dave Wilson, Vice President, Product Marketing, Academic, Customer Education, Software at National Instruments Corporation kicked off the networking discussion by encouraging delegates to find their group members for the start of the following day.

2.3 | The Case for Change: Insights from an Academic and Industry Leader

Opening by Industry Forum Lead Facilitators:

Chantal De Barra - International Publications Editor for Research, CEVIPOF, Sciences Po, France and Consultant, Petrus Communications
Paul Blackmore - Divisional Head for Student Employability & Academic Success, University of Exeter, UK

Welcome Remarks:

Prof. Luo Jianbin, Dean of the School of Mechanical Engineering, Tsinghua University, China

Speakers:

Prof. Dr. Christine Ortiz - Professor of Materials Science and Engineering, Massachusetts Institute of Technology (MIT), USA

Grazia Vittadini - Executive Vice President Head of Engineering, Airbus Defence and Space



Prof. Dr. Christine Ortiz

The second day of the Industry Forum began with welcome remarks by Prof. Luo Jianbin of Tsinghua University, who discussed how engineering education needs to change globally and move toward addressing global issues such as sustainability. Following this, further inspiring perspectives completed the university and industry view making the case for addressing skills development and employability in current and future engineering students.

2.3.1 | University Perspective

Prof. Dr. Christine Ortiz, Professor of Materials Science and Engineering and former Dean of Graduate Education at MIT made the case for change from the academic perspective. Dr. Ortiz stated that although we live in a time of enormous opportunity, we are 'in a fragile and growing state of intolerance, conflict (and) geopolitical volatility, with great challenges to our world and our society'. Challenges include unsustainability tied to economic growth, growing wealth inequality, the ethical implications of accelerating technological innovation, vulnerable employment and skills gaps, and more.

In this environment, educators must expand educational opportunity to a broader and more diverse cross section of the population, reaffirm and advance a humanistic approach to science and technology-based education, and modernise education to prepare students for our changing world. This includes addressing the 'immediate employability' of students, which Dr. Ortiz argued is 'just as important as lifelong learning, especially given the costs of higher education in some countries'. She then went further to say that it is indeed a 'moral mandate to ensure that our students are employable when they graduate'.

To ensure that graduates are both employable and ready to help create a more equitable and prosperous world, Dr. Ortiz stated that there needs to be convergence and integration in higher education, which should incorporate mindset, knowledge, and application (skills). This is in contrast to other trends in higher education such as 'unbundling' and the creation of alternative education providers, which address only the skills and application aspect of education.

Dr. Ortiz is in the process of co-founding a new university, which she said is being built 'from the ground up' with a completely new curriculum, in order to implement the changes in higher education that she argued are necessary during her presentation. The university will advance a humanistic approach to science and technology based education, and use research as pedagogy, with 'authentic, experiential, project-based inquiry' to help students generate new knowledge.

In closing, Dr. Ortiz stressed that the biggest challenges to changing the higher education system in a meaningful way are providing broad access to, and scaling high quality experiential learning. She provided some possible solutions to these challenges going forward, such as integrating subject matter experts, mentors, and collaborators from a distance; focusing on education and research areas that involve low-cost physical infrastructure; using digital technologies for supporting curricula; etc.



Illustrations drawn in real-time during the Industry Forum by Veronique Daniel.

2.3.2 | Industry Perspective

Grazia Vittadini, Executive Vice President Head of Engineering at Airbus Defence and Space made the case for change from the industry perspective. Ms. Vittadini began by arguing that one of the reasons why there needs to be change now is because of a skills gap in industry, particularly in the aerospace defence industry. This skills gap is related to 'market evolution and development' which is driven by the internationalisation of the supply chain, the need to have a stable and repeatable manufacturing process, the 'lean framework', and the fact



Grazia Vittadini

that competitiveness focuses industry on cost aspects and value engineering.

This market evolution and development, and the fact that we are now in an interconnected, digital world has led to a paradigm shift in the aerospace defence industry, according to Ms. Vittadini. Within this new paradigm, the barriers to entry in her industry are becoming lower and lower, and 'institutional businesses' like Airbus are facing competition from companies which 'look nothing like' them. Being competitive is no longer about developing hardware, said Ms. Vittadini, but rather about adding a 'layer of services' to hardware, especially software as a service.

'What does this mean for the required engineering skills?' Ms. Vittadini then asked. While fundamentals are still needed, Ms. Vittadini stressed that there is now an enhanced focus on system engineering, model-based engineering, and simulation. One

particular area in which skills gaps are especially pronounced is the field of data science and data analytics. Airbus needs people who understand the real value of data and how to exploit them, as well as those who know how to manage deep learning, algorithms, artificial intelligence, and more. Other skills in high demand are those related to the protection of not only products, but IT and industrial frameworks in an increasingly interconnected system.

Beyond engineering fundamentals and other technical skills, skills that help engineers take the increasingly important 'human factor' in industry into consideration are essential. Ms. Vittadini listed some of these non-technical skills and attributes which she found particularly important, such as: having an agile mindset, design thinking, problem framing and solving, business acumen, sensitivity to cultural bias.

In order to help develop these and other key skills and attributes, Ms. Vittadini suggested further collaboration between universities and industry. She said she sees Airbus employees visiting universities, but not often the reverse. Promoting more programmes like this, for example where professors spend 6, 12, or 18 months with Airbus, would provide an effective and useful means to help keep professors on top of what is occurring in industry and what skills and attributes are in demand.

In her thought-provoking presentation, Ms. Vittadini struck a chord among participants when she called on them to help 'find ways together to motivate, to grow, to attract, and educate more female talents'. Skills and attributes that are traditionally associated with women will be the most in-demand in the near future, she said, which means that 'womanship is the new leadership'.

2.4 | Pre-Dinner Remarks: A Conversation Between...

Thursday evening's pre-dinner session was hosted by Dr. Natacha DePaola, Dean of the Armour College of Engineering, Illinois Institute of Technology, USA and GEDC Chair-Elect, and Prof. Dr. Yannis C. Yortsos, Dean of the Viterbi School of Engineering, University of Southern California, USA. Dr. Yortsos began by giving a presentation in which he discussed the gap that exists between technology and parts of society today, which is due to different

Speakers:

Dr. Natacha DePaola - Dean of the Armour College of Engineering, Illinois Institute of Technology, USA and GEDC Chair-Elect
 Prof. Dr. Yannis C. Yortsos - Dean of the Viterbi School of Engineering, University of Southern California, USA

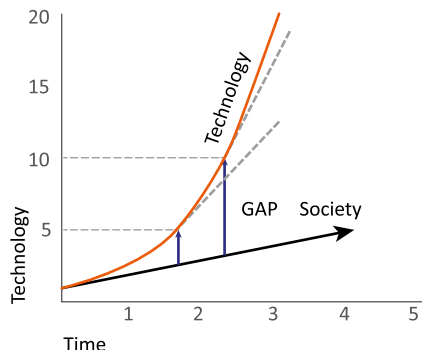


Dr. Natacha DePaola, Prof. Dr. Yannis C. Yortsos

Gap Between Technology and Society

USC Viterbi
School of Engineering

Disruption (Increasingly Shorter Time of Change)



Source: Presentation of Prof. Dr. Yannis C. Yortsos, 29 June, 2017

rates of change. Technology is progressing at an exponential rate, while much of society is still progressing linearly. To bridge this gap, Dr. Yortsos argued, major disruption is needed.

Engineering can be a part of this disruption, and play a role in bridging the gap, especially as it moves towards convergence with other disciplines. Dr. Yortsos outlined the concept of 'Engineering + X', where X is anything from media, to medicine, biology, and more. There are three 'pathways' in this convergence: E2X, X2E, and EUX.

E2X is where engineering empowers X and makes it 'smarter' and more 'efficient', and 'opens vast new dimensions, many disruptive'. It also includes the 'ubiquitous digitisation of everything'. X2E, or 'X-Mimetic', is X empowering engineering, which Dr. Yortsos said, is 'absolutely possible'. EUX is when engineering and X come together, with E making X smarter and more efficient, and X 'discovering new phenomena which create new E'.

After explaining the above three pathways, Dr. Yortsos then asked, 'How does morality intersect with technology?' For him, technology is inherently amoral, but as it is becoming more powerful, it is more important than ever to consider the societal impact and possible unintended consequences of technology.

In closing his presentation, Dr. Yortsos highlighted the U.S. National Academy of Engineering's (NAE) Global Grand Challenges Scholars Program, which he helped create. He believes the programme – which he contended covers all of the components of quality engineering education discussed that day during the Industry Forum – is 'likely to be the engineering curriculum of the future'.

Following his presentation, Dr. DePaola posed some questions to Dr. Yortsos to further develop some of the issues and ideas raised during the presentation as well as that day's events. She first asked about how engineering education and industry leaders can make sure that programmes are 'really having an impact' and maintaining the diversity that is needed.

Dr. Yortsos answered that there are three principal 'imperatives' regarding diversity: the economic imperative, or the need for more talent in the critical field of engineering; diversity of ideas, which help create knowledge; and social justice. He said that to help promote diversity in engineering, university leaders should commit to having the same output as input in terms of demographic makeup of engineering classes, as well as promote a different vision of engineering that focuses on societal impact.

Dr. DePaola then asked about the limitations universities face when trying to change mindsets from 'fixed' to 'growth', and how universities can prepare themselves and students to be more agile to adapt to the fast pace of change today. Dr. Yortsos answered that 'cultural inertia' is present in universities just as it is in any other institution. In order to move past this and change mindsets and promote agility, universities need to support faculty and other 'change agents' so that they drive the necessary change from within.

You can watch a recording of this inspiring conversation online.¹⁷

17. <https://www.youtube.com/watch?v=xNqjoQ5pum0>

3 | DYNAMIC DESIGN GROUPS

As stated earlier, the overarching aim of the Industry Forum was to draw on the collective strengths and expertise of every delegate present, ensuring that each and every voice was heard and each and every creative idea captured. With this in mind, the Dynamic Design Groups were born.



Illustrations drawn in real-time during the Industry Forum by Veronique Daniel.

3.1 | How the Dynamic Design Groups Worked

A series of eight themes were developed by the Industry Forum working group after in-depth reflection on the issues at stake (see list below). Divided up into small groups of 8 to 10, delegates were asked to brainstorm their ideas on each topic circulating from theme to theme until they had covered each one. Each theme was assigned a rapporteur who collected all the ideas aired and then made a cohesive summary of the whole. Once the main ideas had been collated and all ideas shared with the assembled company, the scene was set for delegates to decide which theme they wanted to work on and this is what they focused on for the remainder of the event.

Delegates were challenged to design solutions relative to their chosen theme, coming up with a workable concrete proposal on how to overcome the obstacles identified by all. In keeping with the underlying innovative and creative environment of the event, they were also challenged to make a presentation unlike any they had made before. The idea was that an innovative presentation format opened the gateway to innovative thinking, freeing the groups from the constraints of standard conference presentations and reflecting the Industry Forum's goal to move from theory to action, from 'this is the way it is' to 'this is the way it could be'. The resulting output was extraordinary in the dynamism of the format and the scope of ideas presented.

Throughout all of the Dynamic Design group work, Chantal De Barra, International Publications Editor for Research, CEVIPOF, Sciences Po, France and Petrus Communications Consultant and Paul Blackmore, Divisional Head for Student Employability & Academic Success, University of Exeter, UK acted as overall facilitators. They not only helped keep the groups on track and productive, but were widely praised for contributing to the enjoyment of the event.

3.2 | Overarching Themes

1. **Developing Professional Skills** – developing skills such as effective communication, teamwork, global and cultural awareness, which some employers say engineering graduates do not possess sufficiently or are not sufficiently evaluated alongside engineering skills.
2. **Educating Engineering Leaders** – developing a common understanding of what ethical leadership skills are and how to build these while still at university.
3. **Commercial Awareness and Entrepreneurship** – developing enterprise skills (commercial awareness) and then teaching how to apply those skills to create and grow organisations in order to identify and build on opportunities (entrepreneurship). As these skills are of particular importance to small and medium-sized enterprises (SMEs), the needs of SMEs will be central to this theme.
4. **Learning to Learn** – developing the ability and desire to learn throughout one's lifetime, particularly the fast-changing technical skills required for a successful ongoing career in engineering.
5. **Technical Fundamentals of 21st Century Engineering** – explores what common set of technical skills are needed in today's engineers. How are these fundamentals changing, and how can we adapt?
6. **Developing High Demand Skills of Today and the Future** – how can we quickly develop the high-demand skills of today (e.g. cybersecurity, data science, etc.)? To minimise future talent shortages when we cannot predict with certainty what skills will be needed, how can we create a kind of 'rapid response' system when it becomes clear that a certain skill will be in high demand?
7. **Authentic Assessment of Skills** – how to assess and communicate students' skillsets in a manner that reflects how industry measures such attributes, especially for high demand non-technical skills
8. **Developing Employability Programmes in Resource Poor Environments** – how to build employability programmes that develop technical and/or professional skills when there is a lack of resources, such as limited access to technical equipment.

3.3 | Theme Brainstorm Conclusions

At the end of the first phase, a summary of the brainstorming sessions was given by each rapporteur. These summaries provided a wealth of ideas that generated a full picture of the multi-faceted nature of each theme.

I have many, many more actionable ideas (than before I came). I have partners to work with in academia.

(Industry Representative)



Lynne Thompson Hopper (right, at flipchart), Theme 1 facilitator



Theme 1 Developing Professional Skills



Brainstorm Facilitator:
Lynne Thompson Hopper -
Vice President of Engineering,
Modifications and Maintenance,
Boeing Global Services, USA



Brainstorm Question:
How could universities and
industry work together to deliver
Professional Skills?

Facilitator Lynne Thompson Hopper first addressed the questions: What professional skills are needed by engineering students, and how do we all agree on those? She highlighted some of the professional skills mentioned by the groups, including some 'obvious' ones, as well as some more 'intrinsic' skills:

- Communications skills
- Presentation skills
- Ability to work productively in teams
- Focusing on what can be accomplished by the team/company rather than by oneself alone
- Cultural sensitivity
- Integrity
- Diligence
- Sacrifice
- Emotional intelligence

In order to agree on what the most important professional skills are and to successfully teach them, exchange and collaboration are necessary between industry, universities and professional associations.

There are multiple ways to go about teaching the required professional skills, including bringing industry representatives into universities to teach courses, which could include practical tasks such as creating a three-minute pitch, writing an analytical report, writing emails, etc. Mandatory internships, co-operative programmes, and project work based for example on the U.S. National Academy of Engineering's (NAE) Global Grand Challenges were also discussed.¹⁸ During these programmes, students should be allowed to fail. They should then be given feedback that stresses the positive aspects of failure, in particular the notion that 'in order to succeed, you need to risk failing', with both their professor and internship supervisor present at these feedback sessions. Ms. Hopper emphasised that professional skills should be taught throughout students' university careers, and not be limited to one class/semester.

Ms. Hopper's final point in her summary was about changing the overall 'culture of engineering' to become more diverse and inclusive. Even if students learn professional skills and leave university well-prepared to enter the workforce, they can become discouraged and disengaged if the culture surrounding engineering at their jobs is not inclusive.

18. More information on the NAE Global Grand Challenges can be found here: <http://www.engineeringchallenges.org/challenges.aspx>

19. <http://gedc-industryforum.com/>

Dr. Andrew Hogg (far right), Theme 2 facilitator



Theme 2 Educating Engineering Leaders



Brainstorm Facilitator:
Dr. Andrew Hogg - Director of
Education, TOTAL SA, France



Brainstorm Question:
How can ethical leadership skills be
built into a university engineering
programme and who would deliver
it?

To begin his summary of the brainstorming session, facilitator Andrew Hogg spoke about the objective of engineering, which is to 'leverage phenomena for useful purposes'. He then stressed, however, that 'ethical purposes' should be added to this statement, because individuals 'can be useful, but not ethical'.

In order to ensure ethical leadership skills are being incorporated into university programmes, groups suggested starting 'from scratch' and incorporating courses on ethics and philosophy into engineering programmes. Thought experiments, the honour system, and case studies on ethics should also be included, with good case studies encouraging students to think about trade-offs, grey areas, the context within which projects take place, for example country-specific aspects, and so on. Case studies would ideally be combined with projects, resulting in experiential learning of ethical issues in a global context.

Multiple stakeholders should be involved, and serve as leaders, when teaching ethical leadership to students including: deans and faculty, industry (for example, CEOs discussing their own experiences, which can be used as case studies), the government, family and society, peers, honour societies, professional associations, and more.

Ultimately, Dr. Hogg noted, ethics is also civics, and the goal is to instil the idea in students that engineers are serving beyond their own interests.

If teaching ethical leadership is successful, engineers should learn to 'do the smart thing right,' which occurs when an action is a confluence of ethical, legal, and smart.

Paul Gilbert (centre at flipchart), Theme 3 facilitator



Theme 3 Commercial Awareness and Entrepreneurship



Brainstorm Facilitator:
Paul Gilbert - CEO, Quanser, Canada



Brainstorm Question:
Imagine engineering students graduated with commercial awareness and entrepreneurship skills. How did that happen and what was the role of SMEs?

Paul Gilbert, began his summary by distinguishing between entrepreneurship skills (skills that enable individuals to create ideas and make them happen) and entrepreneurship (actually creating a business). He said that, 'if you try to convince the whole student population that they can be an entrepreneur, you're doing them a real disservice,' but that entrepreneurship skills and commercial awareness are key to the success of all students in the workplace.

Successfully teaching these skills requires a change in culture and mindsets, however. This includes communicating to students that failure is acceptable, and changing university assessment systems to allow failure. This will result in graduates who can 'fail often – quickly,' which is an important part of being in the workforce, especially for individuals who work in small- and medium-sized enterprises (SMEs). Mr. Gilbert also emphasised that a focus on positive contribution to society is important as well when teaching entrepreneurship skills.

Engaging in a meaningful way with university alumni who have succeeded in business and successful local SMEs can help in the teaching of entrepreneurial skills. For example, representatives from SMEs can communicate their experiences and the importance of developing entrepreneurial skills and commercial awareness within universities. In addition, creating an ecosystem that fosters entrepreneurship skills is crucial, and should consist of funding (government or venture capital), internships, committed resources, research, industry sponsored projects, and IP management.

Prof. Sarah Ann Rajala, Theme 4 facilitator



creating discomfort by
introducing students to
new disciplines
- prototyping, film, get
feedback
- build failure into each
learning experience
- value of failure
- make students feel confident not
in field



Theme 4
Learning to Learn



Brainstorm Facilitator:
Prof. Sarah Ann Rajala - Dean,
College of Engineering, Iowa State
University, USA



Brainstorm Question:
How can we ensure that
engineering students have acquired
the tools needed for knowing how
to learn throughout their career?

Prof. Sarah Rajala began by addressing what lifelong learning means, saying it is crucial to have a clear understanding and definition of the concept. Once we do this, the next questions to address are: how do we give people the necessary tools to learn throughout a lifetime, and what are these tools?

First, it is important to adapt to personal learning styles, and make education (at all levels) more personal, for example by finding ways to tap into students' passions. Some other ways of equipping students with the tools for lifelong learning are: project-based learning; introducing more open-ended, large, and complex problems (for example the NAE Global Grand Challenges); mandatory learning of a second language; having students teach their subject to others; creating opportunities for students to learn in digestible modules, quickly; and encouraging and valuing failure as part of learning.

Students should also learn from people outside of their regular programmes, such as inspirational and successful alumni, people who are practising lifelong learning in their careers, and those in the humanities, arts, and social sciences.

Finally, the management of information is critical to lifelong learning. Students should be encouraged to access information on their own, using multiple sources, and then understand how to discriminate information. In addition, due to the enormous amount of information available easily today, teaching students focus is more important than ever.

Dr. Wayne Thomas Davis, Theme 5 facilitator



How can we ensure that we understand and are teaching the fundamental technical skills needed by a 21st century engineer?

- Input from industry
- Sabbaticals
- Joint appointments
- Structured feedback
- Dept. funding for course
- Engage with all stakeholders



Theme 5 Technical Fundamentals of 21st Century Engineering



Brainstorm Facilitator:
Dr. Wayne Thomas Davis - Dean
of Engineering, Tickle College
of Engineering, University of
Tennessee, USA



Brainstorm Question:
How can we ensure that we
understand and are teaching the
fundamental technical skills needed
by a 21st century engineer?


Dr. Wayne Davis began his summary presentation by pointing out that the brainstorming question is not about identifying fundamental technical skills now, but about assessing skills and identifying them for the future. To do this, all groups agreed that more university-industry collaboration is necessary.

Some ideas to increase this collaboration included: implementing 'mini-sabbaticals,' or short-term (e.g. 1–3 months) sabbaticals in which faculty go to work in industry, and/or vice versa; hiring Professors of Practice, or those with *current* industry experience, at universities; increasing joint R&D in universities or R&D centres, which could be either industry- or government-funded; creating industry advisory boards both at university and department levels; developing and participating in more 'real world' student competitions, which industry provide real problems for and feedback; debriefing students *and* faculty after student internships; involving not only industry clients but faculty in industry symposia; and addressing accreditation systems that are slow to change.

Dr. Davis said that groups discussed implementing a 'massive global survey' to determine if engineering fundamentals are changing, and how. This could help all involved keep on top of trends in skills, especially if such a survey is carried out regularly.

Ultimately, Dr. Davis said, if it proves impossible to create a system that guarantees teaching the fundamental skills for 21st century engineering, then the focus should be on teaching students how to learn.

Rachel Schroeder, Theme 6 facilitator



Theme 6 Developing High Demand Skills

Brainstorm Facilitator:
Rachel Schroeder - Head of
Employment Marketing, Airbus

Brainstorm Question:
What rapid response system could
employers and universities develop
to provide essential technical skills
when emerging technologies create
gaps?

Rachel Schroeder organised her output summary into two principle categories: how to identify high-demand skills, and how to create a system that can respond to changing skills rapidly. Regarding identifying skills, industry needs to take more responsibility, but ultimately collaboration among multiple stakeholders is required.

Ideas from groups on identifying high-demand skills included: regular (quarterly or even monthly) exchange between industry and universities, e.g. through corporate advisory boards; the development of an ongoing crowd-sourced survey that collects input from industry, universities, students, and other stakeholders on what upcoming high-demand skills are; and the creation of transnational, cross-industry groups that include professional societies for skills identification. Because it is not always easy for industry to identify upcoming scarce or priority skills, 'visionary people in industry' are also vital. Once the skills have been identified, however, it is essential that industry is then able to translate what they've identified into something 'meaningful for those in universities to teach'.

In terms of creating a rapid response system, ideas discussed by groups included: developing a platform to facilitate exchange between universities and industry; swapping individuals between universities and industry, for example a 'faculty internship'; creating a software platform for curriculum development; bringing in a third party to manage relationships between universities and industry; and spreading apprenticeships programmes, which are 'well-known and work well'.

Regarding the 'main challenge' of how to modify curricula quickly given the lack of flexibility in this area – in part due to the accreditation system that does not encourage change – groups also discussed creating short courses with flexible curricula given by universities, and certified by industry. Outside of universities, industry should also focus on upskilling their employees, Ms. Schroeder said. This could include badging, online courses, short courses for employees at universities, for example.

Dr. Ishwar Kanwar Puri, Theme 7 facilitator



Theme 7 Authentic Assessment of Skills



Brainstorm Facilitator:

Dr. Ishwar Kanwar Puri - Dean and Professor, Faculty of Engineering, McMaster University, Canada



Brainstorm Question:

How could we assess the non- technical skills we would like engineering students to be equipped with for reliable global and widely available certification?


For Dr. Ishwar Puri, the overarching issue was that assessment should focus on groups rather than on individuals and particularly groups undertaking project-based work. There was also consensus among groups that assessment should not be done sporadically, but continuously before, during, and after projects.

In terms of which activities to assess, the majority of groups preferred assessing out-of-class work, such as that done in internships, in student clubs and teams, or during capstone projects that deal with 'real-world problems and real-world clients'. Some delegates argued that separate certification is not needed, and that assessment should be part of the curriculum. This would entail massive curriculum changes however, which require shifting engineering education from reductive to systemic thinking. Curriculum changes are also needed, said Dr. Puri, in order to form partnerships with liberal arts and social sciences.

Assessment methods favoured by groups included: peer assessment, although concerns about bias were raised; self-reflection, such as journaling; and assessment during internships, which should be changed from what it is now to become more authentic. Regarding what should actually be assessed, the themes that arose most often included: teamwork, communications, critical thinking, creativity, intercultural competencies, ethics, and social consciousness.

Dr. Puri made some calls to action at the end of his summary presentation, which included the GEDC carrying out a 'massive' global survey on whether the non-technical skills listed above are indeed the correct ones to assess. The GEDC should also consider adopting the NAE Grand Challenges Scholar programme as an organisation-wide pilot to *demonstrate* and *assess* skills. Engineering programmes that include liberal arts and social sciences should also be promoted by the GEDC.

Dr. Natacha DePaola (center), Theme 8 facilitator



Theme 8

Developing Employability Programmes in Resource Poor Environments

Brainstorm Facilitator:
Dr. Natacha DePaola - Dean of the Armour College of Engineering, Illinois Institute of Technology, USA and GEDC Chair-Elect

Brainstorm Question:
What creative ideas do you have for increasing employability skills (technical/professional) in areas of the world where resources are limited?

Dr. Natacha DePaola started her summary by posing the question: what does 'resource limited' mean? Does it mean a lack of funds, of infrastructure, equipment? Essentially, the best resource of all is people, and so developing skills in resource poor areas should be principally about 'empowering people, and empowering students'.

In order to do this, and to increase employability skills, it is necessary to train engineers who are connected with the local community and are therefore equipped to address the issues specific to their communities. Creativity, agility, and adaptability should be particularly fostered in students to help them use available resources to contribute to their communities. Often people are quite innovative and entrepreneurial in resource poor environments because they need to create what is given in other environments. This creativity and entrepreneurial spirit could be leveraged by industry in the area.

'It's a mindset' said Dr. DePaola, as she spoke of how groups discussed nurturing and fostering open minds in students, and helping them to develop a sense of purpose, an understanding of the holistic purpose of engineering, and sensitivity to their environments. Helping students define their passions and teaching them how to learn is also a key part of fostering this mindset.

Some possible methods discussed by groups to be used in resource poor areas included: alumni providing mentoring; using case studies to teach; tapping into local sponsors and industry; and providing students with instruments of leisure that can foster creativity and help students identify their passions.

3.4 | Designing the Future

Once the energising summaries were completed, delegates were asked to sign up for the theme of their choice. The groups then decided which aspect of the problematic they wanted to focus on collectively and then, working closely together as a team, spent the afternoon designing practical proposals in answer to the issues raised. Their challenge was to turn the present into the future. And rise to the challenge they did, as we saw in the output sessions the following morning.

Let's encourage industry to help provide funding support in greater measure for the event!

(Education Representative)



4 | PATHWAY TO THE FUTURE: PRESENTATIONS WITH A DIFFERENCE

On the final day of the Industry Forum, delegates showcased their ideas on how to turn the present into the future with a series of team designs that were as innovative in their format as they were in their content. During this part of the event, given the breadth of techniques used to present their ideas, the atmosphere could only be described as electric.

Again, Paul Blackmore and Chantal de Barra as facilitators kept the teams on track, ensuring that the morning was both inspiring and fun. What follows is a summary of the concrete proposals put forward.

*Terrific participation, thoughtful
contribution, great engagement.*

(Education Representative)



Group 1 presentation



The first Design Team developed the idea of a 'Certified Internship' to deliver professional skills to students. In their presentation, the team role-played an unfortunate student wading through the difficulties of finding an appropriate internship and then pressed the replay button to show how internships could be organised so that they become universally successful for both students and industry.

A Certified Internship involves engaged university career centres and employers, who work together to ensure that students are acquiring the skills they need during their internships. When students visit their career centres looking for an internship opportunity, they are matched with a company, which they are given details about on the spot. Students then attend an orientation session delivered by the career centre, which is essentially a short course on professional skills, including discussions about the importance of a positive attitude, working on a team, being proactive, being a good listener, etc. Students are also given practical information such as how to write an email, what the workplace dress code is, and more.

Once students arrive at their internship, they are prepared to hit the ground running because the employer has given them on-boarding information and FAQs in advance. The student is assigned a mentor at the company, who assists with his/her career development plan and outlines which technical and non-technical skills the student is expected to develop during the internship. At the end of the internship, students are given detailed feedback by employers, which is used by career centres to certify the internship.

Louise Andersson from Common Purpose, presenting for Group 2



Group 2

Educational Framework to Foster Ethical Leadership in Engineering Practice

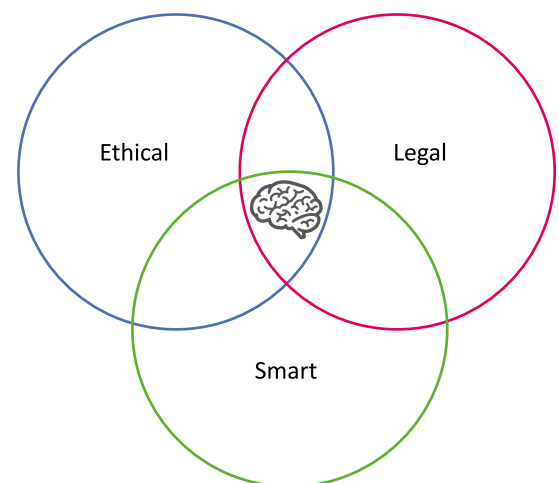
Theme:
Educating Engineering Leaders

This Design Team developed a solution for teaching ethical leadership in engineering practice that could work for any university, regardless of its structure. The educational framework to foster ethical leadership they envisioned is a flexible framework applicable at any university that focuses on encouraging students to make ethical, legal, and smart decisions, as discussed during the brainstorming session.

The framework incorporates four elements: learning outcomes, support infrastructure, curricular and co-curricular activities, and assessment and feedback. Learning outcomes are not set, but would vary between universities, and could include outcomes such as appreciation of ethical principles, ability to incorporate the United Nations' Sustainable Development Goals (SDGs) into engineering decision-making, understanding of the philosophical ethical frameworks, and more. Universities would also identify and develop their own support infrastructure, which could include things such as partnerships with experts in ethical leadership, assignment of an 'Ethical Leadership Champion', monitoring and support of co-curricular activities.

Some approaches the group suggested for incorporating the framework into existing curricula included: embedding and integrating ethics throughout the programme; incorporating project-based learning, case studies, and scenarios so that students can 'learn by doing'; promoting self-reflection. The group also listed some possible co-curricular activities to promote ethical leadership such as international experiences, internships, and community engagement. And finally, the group stated that the framework should be assessed by 'measuring the transformation of both the individual and the university to foster a more ethical society'.

Ethical Actions



Source: Presentation, 'Educational Framework to Foster Ethical Leadership in Engineering Practice', 30 June, 2017

Group 3 presentation



Group 3

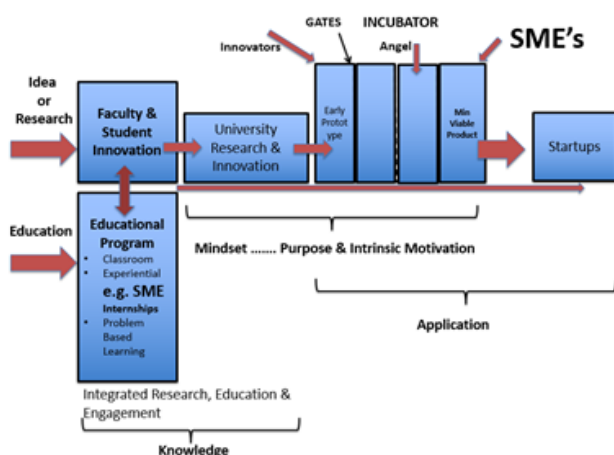
Develop Business Oriented Ecosystem with SMEs

**Theme:**

Commercial Awareness and Entrepreneurship

The next Design Team used a role-playing sketch to outline their ecosystem solution for teaching commercial awareness and entrepreneurship skills to engineering students. With great hilarity, they contrasted a character called 'Conservative Dean' with one called 'Dynamic Dean'. A despairing Conservative Dean felt that teaching commercial awareness and entrepreneurship skills is an impossible task, and could not see a way forward.

Dynamic Dean rushed in to the rescue the design. He believed that although the process of teaching these skills 'does not happen overnight', there are multiple steps that universities can take to teach entrepreneurship.


Ecosystem for Success


In addition to teaching students engineering fundamentals, universities could also incorporate experiential learning and project-based activities. A platform that brings together universities, their students, and companies – especially SMEs – would be used to identify activities. Students would benefit from this because they learn entrepreneurship skills and commercial awareness, and SMEs would benefit from access to bright minds, faculty ideas, university resources.


Funds brought in through the educational programme part of the ecosystem could then be used to fund student and faculty ideas and/or research, leading to innovation. This would then translate into university research and innovation, leading to prototyping – with help from SMEs – and eventually start-ups.

Source: Presentation, 'Develop Business Oriented Ecosystem with SMEs', 30 June, 2017

Group 4 presentation







Group 4

A GEDC Collaborative Platform for Lifelong Learning

Theme:
Learning to Learn

This Design Team opened their presentation with a thesis statement they had devised themselves: ‘The earliest exposure to project-based, industry-connected, diverse team, experiential learning is a vital foundation for building the positive curiosity that drives lifelong learning. These projects and this work should be the foundation for a lifelong network as well.’

Before going into detail on their collaborative platform solution for promoting lifelong learning in engineering students, the group highlighted four best practices which foster lifelong learning. The first, *Crème de la Crème*, is an online platform which matches freelancer students with companies for work on projects. Second, National Instruments has a database of student projects it maintains. Third, AT&T created an online platform, called the *Opportunity Marketplace*, aimed at their employees who are in the middle of a large upskilling process. The platform provides employees with the opportunity to put the new skills they are acquiring into practice by working on a wide variety of projects listed on the platform. The fourth is the example provided by the Station 1 project, a new university being created by Prof. Dr. Christine Ortiz. At Station 1, the pedagogical approach centres on problem-based learning which is authentic, impactful, and long-term in duration with ‘scaffolding’ to provide students with structure, and a built-in feedback loop.

The collaborative online platform the team proposed as their solution for promoting lifelong learning used the above best practices for inspiration. The platform would be managed by the GEDC, and would match industry projects with students and faculty, thereby lowering the barrier to problem-based learning.

Dave Wilson from National Instruments, presenting for Group 5



Group 5

Connecting Young Faculty to Industry via Micro Sabbaticals

Theme:
Technical Fundamentals of 21st Century Engineering

In their presentation, this Design Team first identified what they considered to be the three primary challenges to understanding and teaching fundamental engineering skills for the 21st century:

1. Difficult to anticipate the correct new trends and their timing
2. Rate at which we can update university faculty
 - Inertia due to some faculty resistance
 - Professors do not get enough industry experience
3. Not enough think-time and conflicting demands on time for faculty

To each challenge, they proposed multiple possible solutions. For the first challenge, for example, they listed possible solutions such as: professors of practice; collaboration with industry investment, e.g. industry forecasts; and industry-to-university investments such as a Professor's lab, campus research centre, or student competitions.

Some possible solutions to the second challenge included: cluster hiring, or multiple departments collaborating to hire across departments to serve a multidisciplinary emerging field; incentivizing potential existing resistant faculty for example by giving them a bonus for updating their knowledge and bringing it to the university; and feedback loops.

To the third challenge, the group suggested conducting time-studies, which includes optimizing the amount of time available for solutioning, choosing what to do and what to eliminate, and establishing a time metric.

The group's final proposed solution for ensuring universities are teaching the engineering fundamentals for the 21st century was micro sabbaticals. These would bring young faculty members into industry for short periods of time, ranging from one week to one month, in order to keep track of the latest developments in industry and the skills in demand.

Group 6 presentation



Group 6 GEDC Working Group for Rapid Response Mechanism



Theme:
Developing High-Demand Skills

The next Design Team used a role-play panel session format to discuss their solution to skills gaps caused by the ‘exponential growth of technology and the linear growth of society.’ To address this skills gap, they noted that as a first step, it is imperative to quickly identify the gap on an ongoing basis, a step which they labelled ‘*Mind the Gap.*’

Minding the gap can be done through university and industry collaboration on an ongoing basis, they said. To foster this collaboration, the group proposed that the GEDC make a working group of universities and industry that is agile, representative, and that manages a constantly evolving list of high-demand skills that is distributed to deans worldwide.

After this, the next step is to ‘*Bridge the Gap.*’ This involves short-term solutions that can be implemented immediately in order to alleviate gaps, for example short courses certified by industry and/or industry-sponsored student competitions and challenges. Professional engineering bodies could get involved at this stage to aid with short- and long-term solutions.

The final step, ‘*Fill the Gap.*’ involves long-term changes that would work to prevent skills gaps from occurring, such as curriculum change, structural changes in universities, etc. In closing, the group emphasised that for their rapid response mechanism to work, already available resources would need to be identified so that low resource universities can use these to make changes as well at lower costs.

Group 7 presentation



Group 7

Establish Validated Soft Skill Toolbox for Assessment and Certification

**Theme:**

Authentic Assessment of Skills

The Design Team used a highly original format to present their solution for authentically assessing non-technical skills in engineering students in the form of a broadcast from a Mars colony 50 years into the future, where non-technical skills had played a substantial role in the success of the colony. They began by listing some of the 'soft' skills that they considered key (and which contributed to the Mars mission): creativity, innovation, good leadership, autonomy, teamwork, communications, ethics, humility, sacrifice, diligence, and more.

To reach a consensus on which non-technical skills were important, they proposed starting with those listed at the GEDC Industry Forum way back in 2017, and then asked a colleague and former student in 2017 to confirm whether he had been trained in these skills which he duly did. Having used the role-play to show the results of adopting the educational changes listed by the former student, the design team moved back to the present, and suggested that once this list has been put together after the Industry Forum, the GEDC would be in a position to help universities and industry with developing a certification, for example by providing a template. The certification would be granted to students following an assessment of their non-technical skills by universities and industry on completion of an internship.

Returning to the future, they concluded that the visionary measures the GEDC had put in place some 50 years previously led to radical changes in the engineer profile which in turn made their Mars colony, unthinkable in 2017, possible.

Group 8 presentation



Group 8 Skills Shared Through GEDC Collaborative Partnerships

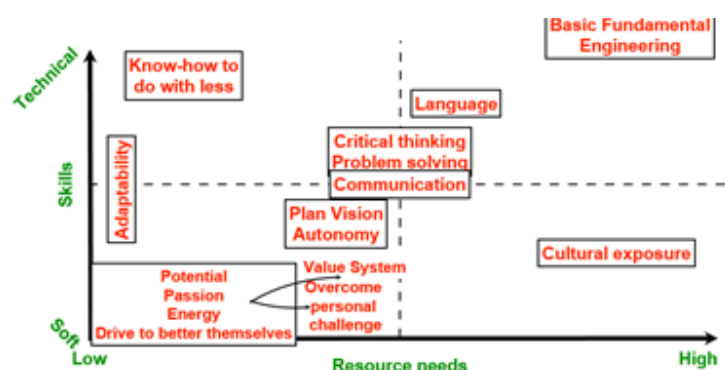
**Theme:**

Developing Employability Programmes in Resource Poor Environments

The final Design Team brought the house down with its portrayal of a panel session TV broadcast in Malawi in the year 2027 to present their solution to increasing employability skills in low resource environments. After using a survey to determine the employability skills that are most in need of development for students in low resource areas, the group proposed forming collaborative partnerships involving multiple stakeholders.

Stakeholders include the GEDC, universities, industry, NGOs, alumni, students, etc. The GEDC would oversee a programme, which the group called '17/27,' that involves creating a large range of projects and programmes to foster two-way transfers between resource rich nations and universities, and resource poor nations and universities.

The principle solution proposed by the group to example of a student at the University of Malawi - the Polytechnic in 2027 who used the portal to receive a donated computer so that she could watch videos – also on the portal – to learn French language skills, practical and technical skills, and more. Looking back to the past in 2017 from 2027, they showed that if countries come together, they can share knowledge and know-how to the benefit of all stakeholders.

Employability Skills in Resource Poor Environments

Source: Presentation, 'Skills Shared Through GEDC Collaborative Partnerships', 30 June, 2017

4.1 | Dynamic Design Group Idea Selection

Once the eight Dynamic Design Groups had presented their solutions, all delegates were asked to vote not only on their fellow delegates' ideas, but also on their delivery.

4.1.1 | Top Groups for Creativity

1. Group 8 – Skills Shared Through GEDC Collaborative Partnerships
2. Group 1 – Certified Internships
3. Group 3 – Develop Business Oriented Ecosystem with SMEs (tied for third)
Group 7 – Establish Validated Soft Skills Toolbox for Assessment and Certification (tied for third)

4.1.2 | Top Ideas to Take Forward

1. Group 3 – Develop Business Oriented Ecosystem with SMEs
2. Group 7 – Establish Validated Soft Skills Toolbox for Assessment and Certification (tied for second)
Group 8 – Skills Shared Through GEDC Collaborative Partnerships (tied for second)
3. Group 1 – Certified Internships (tied for third)
Group 4 – A GEDC Collaborative Platform for Lifelong Learning (tied for third)

*Meeting amazing people and
learning from them.*

(Student)

5 | CONCLUSION: WHAT NEXT?

Throughout the sessions where a wealth of knowledge was shared, and the Dynamic Design Groups which produced a number of concrete solutions, some common themes emerged. These included areas in need of change, and ideas for implementing change. They are all outlined briefly in this chapter.

‘The GEDC Industry Forum gave an excellent opportunity to discuss and generate ideas on how universities and industries can work together to better prepare students for their careers. There is an urgency for future engineers and scientists to deliver on key innovations in areas such as health, transportation, energy and communications, and the collaboration between academia and industry leaders towards that goal is critical. The forum was a unique opportunity for professionals and Deans to share constructive ideas in a vibrant structure designed to facilitate insightful solutions. The path from teaching to innovation is best defined from the powerful insights found at the cross-section of R&D, marketing and human resources—where all are working towards the goal of better preparing students for STEM careers.’

Dave Wilson,
Vice President, Product Marketing
Academic, Customer Education, Software, National Instruments
Corporation

5.1 | Outputs for Change

5.1.1 | Areas for Improvement

The following were mentioned repeatedly by Industry Forum delegates during the event, who argued that these areas need to change in order for engineering education to best develop 21st century engineers and better understand each other's needs.

Make Accreditation Systems More Flexible

National accreditation systems for engineering schools were identified as being too rigid to allow for the adoption of an agile system of engineering education that responds to the needs of industry and society, and should be reconsidered.

Teach Students to Learn How to Learn

In order to ensure that engineering students are prepared to be contributing members of society over their lifetimes in a world marked by rapid change, Industry Forum delegates frequently emphasised that engineering education (and higher education in general) should increase their focus on teaching students how to learn beyond their formal education.

Incorporate Other Disciplines into Engineering Education

The challenges the world faces in the fourth industrial revolution require a broader understanding of their complexity and collaboration between disciplines. In this environment, an effort should be made for engineering education to incorporate other disciplines so that engineering students have a better understanding of how their work fits into an interconnected world.

Allow Failure

Innovation and creativity are crucial when working to solve this century's 'global grand challenges'. Innovation does not mean a 100% success rate, but rather trying out many new ideas and strategies, some of which are bound to fail. Engineering education should not penalise students for failure, but should guide them to continue trying until they find an idea that works.

Use More Problem-Based Learning

Problem-based learning moves students from passive recipients of knowledge to active participants in their own education. Problems, when possible, should be based on 'real world' issues and can be provided by industry.

Increased and More Regular Collaboration Between Universities and Industry

Every session and group presentation during the Industry Forum included calls for increased and more regular collaboration between universities and industry. Such collaboration is needed to place universities and industry on the same page in terms of each other's needs and expectations.

Questions of ethics and of diversity were often raised during the event. Formal teaching on ethics, using projects, case studies and by integrating work with other disciplines was felt to be essential. The fast pace of technology calls more than ever for consideration of potential unintended consequences and delegates at the Forum clearly wanted engineering and engineers to make a positive contribution for the whole of society, with people of all profiles and backgrounds finding their place within engineering.

'Education is fundamental to the future of Total. We employ people in all different sorts of disciplines – business, lawyers, scientists, and engineers who need the skills to be able to work together to develop the energy of the future. This is why we sponsored the GEDC Industry Forum, because we believe that it is vital to bring together a group of passionate engineers, engineering educators, and industry representatives in order to be able to discuss the future of engineering skills and make things happen. The ideas that emerged during the Industry Forum have been absolutely amazing.'

Andrew Hogg, Director of Education,
Total SA, France

5.1.2 | Ideas to Implement Change

Industry Forum delegates brought up the following potential solutions at multiple points during the event.

Incorporate Global Grand Challenges in Curriculum

Implementing the U.S. NAE's Global Grand Challenges Scholar Program, or using the Global Grand Challenges as part of a problem-based learning approach would help engineering students acquire many of the skills that will be required of 21st century engineers.

Global Survey

Using a 'massive' global survey that collects input from industry, universities, students, etc. on the following was proposed repeatedly by delegates: whether engineering fundamentals are changing, and, if so, how; identifying upcoming high-demand skills; identifying the most important non-technical skills and how they should be assessed by universities; and what skills are most in need of development in students in low resource areas.

Platform for Exchange

A platform that facilitates collaboration between universities and industry was discussed on multiple occasions by Industry Forum groups. This platform would be online, and could include areas dedicated to communication between faculty members and industry representatives, a service that matches students and faculty with industry projects, instructional content, etc.

'The GEDC Industry Forum was an opportunity for both industry and universities to co-create solutions and approaches that will deliver the talent that companies want and need. The market for early career employees is evolving - employers are now looking beyond traditional graduate talent, and are seeking a diverse mix of apprentices, school leavers, post-Doctoral studies graduates and other specialists. Sitting at the heart of this dynamic market, we have changed our name to the Institute of Student Employers, which better reflects our wide range of activities.'

Stephen Isherwood – Chief Executive, Institute of Student Employers (ISE)

5.2 | Delegate Feedback

Beyond the ideas and actions, we asked if the Industry Forum itself was a good idea. Feedback was gathered from 59 participants who completed a survey following the event (36 Education representatives, 21 Industry representatives, 1 Working group member, and 1 Student).

- Feedback was very positive, with 92% of delegates very satisfied and 8% somewhat satisfied. There was also great interest in participating in the next edition of the Industry forum (92% would like to participate in the next edition, 8% might like to participate, and no respondents answered they would not like to participate). The vast majority of activities were highly rated (26 of 28 scored over 4 out of 5) and the documents shared during the event were considered to be impactful and useful.
- The most valued aspects were the networking opportunities with industry and education representatives, the dynamic design groups, the sharing of ideas during the brainstorming sessions, and interactive format of the event.
- Activities particularly highlighted by participants (all scoring close to 5/5) were the Introduction by Peter Kilpatrick; and the Dynamic Design Groups Rotating Brainstorm and Presentations.
- The GEDC Industry Forum Concept Paper was held in high regard by participants who considered it to be rich and useful for their activity.²⁰
- Participants consider the impact of the event to be best achieved by providing follow up on the ideas and suggestions made, receiving documents, presentations and conclusions generated from the event, and being updated on ongoing progress of agreed actions.
- Suggestions on the event format included allowing more time for informal discussions, involving SME and students in future events.

20. The GEDC Industry Forum Concept Paper can be found at this link: <http://gedc-industryforum.com/wp-content/uploads/2017/10/GEDC-Industry-Forum-Concept-Paper.pdf>

5.3 | Next Steps

Building on the momentum of the first edition of the GEDC Industry Forum will be essential for meaningful change to occur. The first opportunity to continue the collaboration between university and industry leaders will come during the GEDC Annual Conference in Niagara Falls, Canada, in October 2017.

Given the extremely positive feedback from delegates and overwhelming interest in continuing the collaboration and work done, a second GEDC Industry Forum is also expected, which will allow delegates further opportunity to progress with ideas they have begun to implement at their organisations.

For more information and updates on actions and timelines, please visit the GEDC Industry Forum website²¹, or join our LinkedIn group²².

Additional materials and resources are also available online:

- The Industry Forum Concept Paper²³
- Engineering Employability Initiatives provided by Industry Forum delegates²⁴

It was exhilarating to see the engagement. Well done Petrus!

(Industry Representative)



21. <http://gedc-industryforum.com/>

22. <https://www.linkedin.com/groups/13533707>

23. <http://gedc-industryforum.com/wp-content/uploads/2017/10/GEDC-Industry-Forum-Concept-Paper.pdf>

24. <http://gedc-industryforum.com/wp-content/uploads/2017/10/GEDC-Industry-Forum-Engineering-Employability-Initiatives.pdf>



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The 2017 Industry Forum was held at CEDEP in Fontainebleau, France. CEDEP is a highly regarded international executive education centre less than 1 hour from central Paris.

CEDEP's campus is an open creative design space designed exclusively to encourage innovation and inspiration. It has a variety of spaces available which are continually adapting and are ideal for the type of work that took place at the Industry Forum.

Find more information here: <http://www.cedep.fr/>
