Submission summary:

1. Engineers Without Borders UK’s vision is a world where people everywhere have access to the benefits of engineering.
2. To contribute towards this we work with partners in Africa, Latin America and Asia to address engineering access needs now, for example access to clean water, good sanitation, reliable energy and resilient built environments. We also recognise the valuable role engineers play in building sustainable societies all around the world and we work with schools and universities to educate the next generations of engineers to be more globally responsible. It is from this second point that we feel we can make a contribution to your inquiry.
3. As your inquiry is well aware, the UK is facing a significant shortage of engineers to meet our domestic employment needs. The UK engineering community also has some of the worst diversity figures in the world.
4. There is also a growing body of evidence to suggest that engineering education is not adequately preparing students for the current or future workplace. They are not developing the mindset needed to tackle the challenges of today and tomorrow.
5. We believe the factors highlighted in 3 and 4 are inextricably linked. They are, in party, the results of a lack of emphasis on the social purpose of engineering both in the public perception of engineering and in the education of engineers.
6. With our outreach programmes we raise awareness of the fundamental link between engineering and impact on society, in doing so engaging those who would not ordinarily consider engineering as a pathway and inspiring a diverse range of people to consider engineering. Our higher education programme then exposes ‘engineers in training’ to the skills and mindset they need to be a successful engineer in the 21st century; creativity, empathy, understanding of context, comprehension of complexity, and the ability to make, and justify, judgements in the face of uncertainty.
7. Over the past 6 years, we have engaged more than 18,000 engineering undergraduates in our experience-led higher education programme - the Engineering for People Design Challenge - to address the skills gap in engineering education. Since 2012 we have raised the awareness of more than 10,000 young people through our outreach activities to inspire the next generation of engineers.

Why we exist, and why we do what we do

Engineers Without Borders UK was established in 2003 in response to a growing desire amongst engineering undergraduates to engage with ‘real world’ projects and make a difference with the skills and knowhow they were developing at university. The organisation’s first project was in Pondicherry, India addressing access to sanitation services. Today, we recruit and train early career professionals to volunteer with our partners in Africa, Latin America and Asia to address access to the engineering skills and capacity required to bring clean water, good sanitation, reliable energy and resilient built environments to the communities we work with.

However, from the outset there has been a recognition that the skills and knowhow that engineering undergraduates gained through their university education has been inadequate when faced with these real world projects and, subsequently, the organisation has also had an equal focus on the training and education of engineers. Specifically, the missing skills and competencies from the formal education these individuals were receiving have been about
how to understand engineering in context, particularly the social context of engineering. Engineering education heavily focuses on the technology, science and mathematical aspects of the profession and is dominated by the acquisition of knowledge so that one can respond to questions with predetermined right and wrong answers. Whilst important, this leaves little room to relate to real world applications, or to allow students to develop the creative thinking abilities required to tackle the real, complex issues of the world today once they join the engineering profession. For example, the ability to analyse a context themselves, identify the problems that engineering can address and creatively apply their scientific knowhow in a way that is conscious of social, environmental and economic factors.

Whilst our roots, and this reckoning, have come from our work in the international development sector, for the past ten years it has become increasingly clear that the wider engineering community recognises there are gaps in engineering education and, that the skills we have identified through our work, are skills that are useful for all engineers whatever they go onto do after university. For example, the 2015 EngineeringUK report noted that 30% of engineering employers in the UK found weaknesses in the attitudes and aptitudes for working life among candidates and 39% struggled to find candidates with any applied experience, something they consider to be vital. The Royal Academy of Engineering has called upon educational institutions to equip students with the ability to apply theory to real problems as employers have highlighted that there is a specific skills gaps in graduate problem solving capability. Looking to the broader context, the 2016 World Economic Forum Future of Jobs report highlights the top 10 skills needed for a career in the upcoming ‘Fourth Industrial Revolution’; with complex problem solving, critical thinking and creativity being the most important (provided in the figure below). As a result, we have seen a significant increase in interest from universities to more formally engage with our work and bring tangible benefits to their curriculum. More information about our activities in this area is provided in the section on addressing the skills gap in engineering education.

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In addition, we believe our presentation of the social purpose of engineering is helping to tackle the growing skills shortage and diversity issues in the UK engineering sector. EngineeringUK’s 2016 report predicts an annual shortfall of 69,000 people who have the relevant engineering education required to meet our UK demands up to 2022. This highlights both the need to both inspire and retain talent in the engineering community. But the numbers are only half the story, in the UK there is also a serious diversity issue. Only 8% of engineers are female and only 6% are from black and ethnic minority backgrounds compared to 51% and 14% respectively of society as a whole. This imbalance needs to be redressed.

Whilst great strides have been made to engage young people in STEM, current initiatives to inspire young people to become engineers only reaches approximately 30% of young people. This narrow group, known as ‘STEM devotees’, are likely to choose STEM careers without intervention from STEM enrichment activities. A number of recent reports, including the Institution of Mechanical Engineers ‘Big Ideas’ report state that focusing on the social impact of engineering is known to engage and appeal to a greater, much more diverse range of young people. Focusing on this purpose of engineering not only increases enthusiasm but also creates better, more engaged engineers in the longer term. The report also found that currently, 75% of teachers do not think that the engineering community communicates its contribution to society well enough to the public and only 17% think that the engineering community is appealing to underrepresented groups.

To engage more young people from all backgrounds as is needed, in particular the other 70%, Engineers Without Borders UK has developed a different approach with our Youth Outreach programme. More information is provided in the section on inspiring the next generation of engineers.

What we do: addressing the skills gap in engineering education

For the past six years, we have delivered our Engineering for People Design Challenge to universities throughout the UK and Ireland. The programme is a project-based, engineering design learning programme delivered to first and second year engineering undergraduates. Over the past six years of delivery this programme has reached 18,000 undergraduates. In the academic year 2015/16 the programme was delivered in 26 universities throughout the UK and Ireland, involving 50 academics and engaging over 4,600 students, approximately 16% of first year engineering undergraduates. We provide a real world design brief based on the work of one of Engineers Without Borders UK’s international partners and challenge the students to explore the context, consider the needs of the people and propose engineering ideas that could make a difference. Embedded in academic institutional curriculums, this programme uses a project-based learning approach and encourages students to work in teams, often multidisciplinary ones, to address a real life, complex engineering challenge. Each year, the programme culminates in an inter-university competition to celebrate the learning of the participating students and showcase their ideas.

Through engagement with this programme, engineering students are given an open brief in an unfamiliar context. This encourages them to develop their problem definition skills as well as their problem solving skills. This means they develop their:

- **Emotional intelligence** through the need to develop empathy for the local people and understand their needs.
- **Complex problem solving, critical thinking, and creativity** through the need to understand the social, environmental and economic constraints of the context; challenge their own assumptions and justify new ones; and, synthesise complex information into meaningful decision making criteria.
- **Professional skills** such as **coordinating with others, negotiation, people management** through the need to work in teams, manage their project, communicate and present their ideas to others, and, most importantly using professional judgement in decision making. The opportunity to develop these skills is not often available in the first few years of undergraduate study.

These are all vital skills recognised as important for the future workplace.

In particular, the focus on developing their professional competence of judgement is something hard to achieve without presenting complex problems such those provided through this programme. With complex problems, there are often multiple possible solutions and multiple competing criteria against which decisions are guided. Whilst there are tools to

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6 This percentage is based on the total number of acceptances on to engineering courses which is likely to be higher than the total number of students on courses, it also does not account for reduced second year populations. UCAS acceptance data

aid decision making, professional judgement is still needed to use these tools effectively and appropriately to make the final decision. In a world where we are becoming increasingly reliant on the power of computers to perform calculation tasks, the ability of people to use their judgement about the outputs of these activities is increasingly important. Students engaging in this programme are therefore inspired to understand their future role as an engineer, an engineer who will be responsible for the made world around us and consequently human health and welfare.

94% of participating students surveyed in the last academic year said that the programme had improved their skills related to the engineering design cycle and 91% said it had helped to improve their creativity. In addition, the survey highlighted a positive impact on student’s employability with 88% stating it had improved their communication skills and 91% stating it had improved their ability to work in a team.

In 2016, the Engineering for People Design Challenge also received national recognition as a ‘Nesta New Radical’\(^8\). The award, given out by the UK’s leading innovation organisation, applauds our innovative approach to addressing the global challenges we now face; through embedding modules using real context into the engineering syllabus and our use of a challenge driven approach\(^9\), our programme creates globally responsible engineers as the catalysts for change.

Whilst universities are now beginning to recognise the importance of bringing ‘real world contexts’ into the classroom and the benefits of using project-based learning approaches, there are very few practical options that academics can make use of with ease. With limited resources at their disposal, competing priorities and multiple internal processes to overcome, only a few academics are able to implement project-based learning at their institutions. For a small fee (£1,250), the Engineering for People Design Challenge offers more academics the opportunity to deliver project-based learning experiences to their undergraduates by providing them with all the tools they need in an accessible way.

This programme costs us approximately £170,000 a year to run and is supported through fees charged to universities for access to the resources and sponsorship from our corporate partners who see the benefit in the learning outcomes of the programme and brand alignment with our organisation.

**What we do: inspiring the next generation of engineers**

Throughout the 13 years of Engineers Without Borders UK’s activities, we have successfully attracted a diverse range of people to join our movement and support our cause. In a sector suffering from skills shortage and loss of talent, and where at best 9% of the professional community is female, our membership is 50% men, 50% women, each with an inspiring story to tell about how our cause has given them new, or renewed, purpose in their choice to become an engineer and kept them as part of the profession.

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Engineers Without Borders UK has been distinctive within the engineering community for highlighting the difference engineering makes to people. Our unique Youth Outreach programme demonstrates the social purpose of engineering, and the innovation and creativity that is required by engineers to meet the needs of people around the world. The programme is able to engage and appeal to a greater range of diverse young people, not only increasing interest and engineering literacy, but also creating committed engineers in the long-term. There is a critical need for engineers who are able to deliver creative solutions that enable society to address the global and local challenges we now face and drive technological innovation forwards. To achieve this, we need to inspire young people to become engineers because of the difference they can make.

To inspire young people, we deliver two workshops that showcase the important role engineering plays as an enabler of access to safe water and reliable clean electricity around the world. Managed centrally, these workshops are presented by our trained, committed and inspiring volunteers as part of the STEM Ambassadors Programme in both primary and secondary schools across the UK. Our 900 volunteers are enthusiastic men and women studying and working in engineering across the UK. They provide living examples for how young people can pursue STEM subjects to carve out interesting, successful and rewarding careers. In the last year alone we have reached over 1,800 young people across the UK with these inspiring, hands-on workshops and the demand for our impactful programme has grown significantly. Appetite for the programme and its impact can be seen in our recent increase in volunteers, rising from 50 to 900 people over 6 months along with a sharp rise in school requesting the workshops. In the near future, funding dependant, we will build on this successful model to increase the reach of our programme through developing long term relationships with schools and deliver year-on-year activities to ensure we have a greater impact on young people’s perceptions of engineering and consequently their future choices.

Our current resources are designed for upper primary and secondary level education, encompassing ages 9-16 (Upper Key Stage 2, and Key Stages 3 and 4). We engage young people at key points in their development and when they are making the subject choices that will affect their future career opportunities. In doing so, we offer them the opportunity to contextualise their subject lessons, in particular STEM subjects, with career options and include engineering in their decision making about their future. Through our workshops, young people benefit from the following learning outcomes:

- Understand the importance of engineers in delivering vital services to people around the world, such as electricity and water, and that access is not equal.
- Exposure to innovations deployed around the world to address access to these important services, in particular the innovations of decentralised, community level technologies.
- Explore the creative skills engineers require through designing, building and testing their own model turbine (in the workshop about access to electricity) or water filter (in the workshop about access to water).
- Understand how cross-curricular knowledge and skills are needed to understand the challenges engineers face and bring practical solutions to meeting people's needs around the world.
- Understand how they can contribute as responsible global citizens.
Engaging in the workshops enables young people to build their SMSC (spiritual, moral, social and cultural) development through the incorporation of global issues, exploration of different local approaches from around the world, working in pairs and small teams and communicating their ideas to the wider class.

These resources provide teachers with materials demonstrating the social impact that engineering has, and a way to discuss how cross-curricular knowledge and skills are important to career opportunities. In particular this supports young people to understand the relevance of STEM subjects which are often considered too abstract. Through the provision of these materials, teachers’ confidence to recommend engineering to young people is increased.

This programme has been funded through EU grants and corporate sponsorship. Currently our activities for this programme are significantly reduced due to funding cuts but we are seeking funding to scale and enhance the programme of approximately £90,000 per year.

Thank you for taking the time to read our submission to your inquiry. I hope that you have found it interesting. Should you require further information please do not hesitate to get in touch and good luck with the rest of your inquiry.

January 2017