“WE THINK IT’S IMPORTANT BUT DON’T QUITE KNOW WHAT IT IS” THE CULTURE OF ENGINEERING IN SCHOOLS.

Institution of MECHANICAL ENGINEERS

Supplementary Materials

Improving the world through engineering

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Student Questionnaire v7

At the Institution of Mechanical Engineers we are trying to find out what young people feel about engineering. This questionnaire is a part of that project and your answers will be a great help to us.
(All personal data will be treated as confidential.)

Thank you for taking part.

1. Your Name

2. Your school or college

3. Are you male or female?

- ◯ Male
- ◯ Female

Institution of MECHANICAL ENGINEERS

Student Questionnaire v7

How much do you agree or disagree with the following statements about engineering?

Please tick one box beside each question.

4. Engineering is mainly about making things.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

5. Engineering is all around us.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

6. Solving problems is key to engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

7. Engineers tend to work on their own.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

8. Engineering contributes a lot to most peoples' lives.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

9. Developing ideas is important in engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

10. Engineers help to make the world a better place.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

11. Engineering is mainly about repairing or maintaining things.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

12. Engineering is important to me.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

13. Engineering is the main cause of today's environmental problems.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

14. Engineering makes a big contribution to modern medicine.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

15. It is natural for more boys than girls to choose engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

16. Having a close family member or family friend who works in engineering would make me think positively about choosing an engineering career.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

Institution of MECHANICAL ENGINEERS

Student Questionnaire v7

17. How much do you think you know about engineering?

Nothing at all	I know a little	I know quite a lot	I know a great deal
○	○	○	○

18. How important do you think engineering is in the modern world?

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

How much do you agree or disagree with the following statements about engineering?

Please tick one box beside each question.

19. I would like to learn more about engineering at school.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

20. You need to go to university to become an engineer.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

21. I think engineering is creative.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

22. I have learned about careers in engineering at school.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

23. I think that engineering is a career for men.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

24. I would like to know more about engineering careers.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

25. What 3 words or phrases would you use to describe a career in engineering?

- [ ] Exciting
- [ ] Boring
- [ ] Interesting
- [ ] Dirty
- [ ] Creative
- [ ] Innovative
- [ ] Complicated
- [ ] Well paid
- [ ] Working in a team
- [ ] Challenging
- [ ] Contributing to society

Institution of MECHANICAL ENGINEERS

Student Questionnaire v7

How important do you think the following qualities/skills/personality traits are to engineers?

Please tick one box beside each question.

26. How important is - being creative?

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

27. How important are - Mathematical skills?

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

28. How important are - Team working skills?

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

29. How important is - Decision making?

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

30. How important are - Problem-solving skills?

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

31. How important are - Communication skills? (listening, speaking and writing)

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

32. How important are - Language skills?

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

33. How important is - Curiosity?

Very important	Quite important	Less important	Not important	Don't know
○	○	○	○	○

34. How important is - Perseverance?

Very important	Quite important	Less important	Not impotant	Don't know
○	○	○	○	○

Institution of MECHANICAL ENGINEERS

Student Questionnaire v7

How much of a contribution do you think engineers can make to the following challenges?

35. How much can engineers contribute to - the early detection of cancer?

No contribution	Very little contribution	Quite a big contribution	A huge contribution	Don't know
○	○	○	○	○

36. How much can engineers contribute to - increasing agricultural productivity?

No contribution	Very little contribution	Quite a big contribution	A huge contribution	Don't know
○	○	○	○	○

37. How much can engineers contribute to - improving quality of life in old age?

No contribution	Very little contribution	Quite a big contribution	A huge contribution	Don't know
○	○	○	○	○

38. How much can engineers contribute to - protecting endangered species?

No contribution	Very little contribution	Quite a big contribution	A huge contribution	Don't know
○	○	○	○	○

39. How much can engineers contribute to - understanding the fundamental laws of physics?

No contribution	Very little contribution	Quite a big contribution	A huge contribution	Don't know
○	○	○	○	○

40. How much can engineers contribute to - generating national wealth?

No contribution	Very little contribution	Quite a big contribution	A huge contribution	Don't know
○	○	○	○	○

41. How much can engineers contribute to - keeping premature babies alive?

No contribution	Very little contribution	Quite a big contribution	A huge contribution	Don't know
○	○	○	○	○

42. How much can engineers contribute to - reducing air pollution ?

No contribution	Very little contribution	Quite a big contribution	A huge contribution	Don't know
○	○	○	○	○

43. How much do you think you have learned about engineering in your lessons in Y7-9?

None	Very little	Some	A great deal	Can't remember
○	○	○	○	○

PARENT SURVEY

IMechE Parent Questionnaire v6

At the Institution of Mechanical Engineers we are trying to find out what young people feel about engineering. This questionnaire is a part of that project and your answers will be a great help to us.
(All personal data will be treated as confidential.)

Thank you for taking part.

1. Your name

2. Your child's name

3. Your child's school or college

4. Your child's gender

- ◯ Male
- ◯ Female

5. Your gender

- ◯ Male
- ◯ Female

Please complete this response before you look at the rest of the questionnaire.

* 6. It would help us to interpret your responses if we have an idea of what you think engineering is. Please briefly describe what the word ‘engineering’ means to you.

Please read the following statements and choose the response option which best fits your view.

7. In general, the UK public has a positive view of the role of engineering in society.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

8. Engineering is mainly about making things.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

9. Engineering is all around us.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

10. Solving problems is key to engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

11. Engineering careers are only suitable for those who are really good at maths and physics.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

12. Developing ideas is important in engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

13. Engineers help to make the world a better place.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

14. Engineering is mainly about repairing or maintaining things.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

15. It's natural that more boys than girls choose engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

16. Engineers will shape the future more than politicians.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

17. Engineering isn't that relevant to me.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

18. Engineering is the main cause of today's environmental problems.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

19. Engineering makes a big contribution to modern medicine.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

The next four pages start with a statement with which you may or may not agree. Each statement is followed by a set of questions relating to that statement.

"It would be beneficial for young people to develop greater understanding of the role of engineering and technology both in their own lives and in modern society. This has been called *engineering and technological literacy.*"

Please respond to the following statements:

20. It would be beneficial for young people to develop greater engineering and technological literacy.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

21. An understanding of the importance of engineering in society is only relevant to students who choose to go on to train, study or have a career in engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

22. Most people can develop sufficient engineering and technological literacy by using technology in their everyday lives.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

23. Boys develop engineering and technological literacy to a greater degree than girls.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

"Engineers of the future need to place people at the heart of everything they do – from responding to social priorities and the major challenges that societies face, to developing solutions that reflect users' needs and desires, rather than expecting users to accept and adapt to their solutions?"

Please respond to the following statements:

24. Engineers of the future need to place people at the heart of everything they do.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

25. If future engineers develop in the way the above paragraph describes, more young people might opt for engineering training, study or careers.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

26. If future engineers develop in the way the above paragraph describes,more girls might opt for engineering training, study or careers

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

27. Engineers have a role to play in tackling issues such as climate change.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

28. Engineering is largely irrelevant when it comes to dealing with issues such as droughts, earthquakes, tsunamis, global food shortages.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

29. My child learns about the impact of engineering on our lives, in school.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

"Engineering has very low 'visibility' in schools. Engineering's focus on the 'made or manufactured world' is significantly overshadowed by the emphasis on the 'natural world' that students receive in science."

Please respond to the following statements:

30. The current balance of emphasis in schools between 'natural' and 'made' worlds is about right and does not need changing.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

31. Using examples from the world of engineering (such as bridges, domestic water or energy supply, mobile phones, medicine) it is possible to teach science and maths topics that cover both the science and maths content, and teach something about engineering and the made world.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

32. Science and maths teaching should concentrate on science and maths concepts and content and not be concerned with trying to develop young people's understanding of engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

33. Engineering should be available as a separate subject for those that wish to study it.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

“Engineering is a problem-focused and a creative, design-based discipline which requires the development of a broad range of valuable life and employability skills.”

Please respond to the following statements:

34. If these skills are developed during learning about engineering this suggests more young people might benefit through closer engagement with it.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

35. Learning about engineering in school develops skills that are more useful to boys than girls.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

36. Skills developed in school through learning about engineering are not useful for a student aiming at an academic, rather than a vocational pathway later in school and beyond.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

37. Any student, given the right experiences, can become an engineer.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

38. Only students with specific skills should consider becoming an engineer.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

The following questions relate to you, your child and their school.

Please respond to the following statements:

39. The school promotes subject and career choices in the same way with both boys and girls.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

40. I feel engineering is promoted as a subject for boys at my child's school.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

41. I am aware of the types of subject choices my child would need to make in order to follow a career in engineering after school.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

42. My child is able to study engineering at their school.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

43. I would encourage my child to consider a career in engineering it they are interested.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

44. The local job market is an important factor for me in terms of advice I would give my child when considering a choice of career.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

45. We have family connections in engineering (eg one of us, a close relative or a family friend is an engineer).

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

46. Family connections would influence my advice to my child in terms of future career choice.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

47. I feel equipped to provide my child with advice if they are considering a career in engineering.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

48. Our family takes part in engineering activities such as visiting science/technology museums, industrial heritage sites, watching engineering-based TV programmes, or through hobbies.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

49. My child has done engineering-based activities in school.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

50. Students at my child's school should do more engineering activities.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

51. The school promotes a positive image of engineering and its role in society.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
○	○	○	○	○

Please read the following. It is based on research carried out by the Institution of Mechanical Engineers, which identified 5 categories or groups of student in terms of their preference for a career in engineering.

52. Which of the following most closely describes your child?

	Select the description that most closely matches your son or daughter.
Group 1 My child is not so involved with school or current affairs but likes to socialise with local friends and with our family.	○
Group 2 My child is really interested in science and maths, technology and engineering – but is also really interested in other school subjects and hobbies. S/he is not yet clear about what direction their study or training will take.	○
Group 3 My child is mostly interested in traditional creative areas such as the arts, music, literature, writing etc but no real interest in STEM. S/he works well as a member of a group and makes use of active social networks.	○
Group 4 My child is very interested in science technology, engineering in maths. They choose to pursue these in their free time, such as through hobbies, reading and other activities.	○
Group 5 My child is imaginative and an individualist, who usually likes to work on their own, rather than being a team player. S/he recognises the importance of STEM but sees it as 'not for them'.	○

53. Please use this box to add any comments about the issues raised in this questionnaire.

Thank you very much for taking part in this questionnaire.

GOVERNORS' SURVEY

Governors Questionnaire v7

At the Institution of Mechanical Engineers we are trying to find out what young people feel about engineering. This questionnaire is a part of that project and your answers will be a great help to us.
(All personal data will be treated as confidential.)

Thank you for taking part.

1. Your name

2. Do you have any special responsibility as a governor?

3. How many years have you been a governor?

4. The name of the school.

5. Are you male or female?

- ◯ Male
- ◯ Female

Institution of MECHANICAL ENGINEERS

Governors Questionnaire v7

6. What do you understand by the term 'engineering'?

7. To what extent do we in the UK value engineering projects and the work that engineers do? (You may wish to compare with the work of doctors or people working in finance.)

8. To what extent do students learn about modern engineering in your school and in which subjects/ including outside the curriculum?

9. Engineering is a major employer of engineering graduates and technicians. To what extent should this be reflected in the school's curriculum?

10. What should be the role your school in preparing students for their future careers?

11. Should this be a key aim for schools in general?

12. What should be the role of schools in helping to produce future engineers?

Institution of MECHANICAL ENGINEERS

Governors Questionnaire v7

13. How, where and to what extent does engineering currently feature in young people's learning (e.g. as a separate subject, more visible in STEM subjects, not at all)

To what extent do the following influence the choices of students either to study engineering or embark on training in the sector after school:

14. Family background

No importance Extremely important

15. Social class

No importance Extremely important

16. Gender

No importance Extremely important

17. Cultural background

No importance Extremely important

18. The local jobs market

No importance Extremely important

19. Student experience at school

No importance Extremely important

20. Other possible influences (please try to show a 'Score 0 - 10')

21. Girls number around 7% of the students on engineering degree courses, and numbers working in engineering jobs is even lower. Why do you think this is?

22. What messages do you think girls get about engineering from school?

Thank you very much for taking part in this questionnaire.

HEADS OF DEPARTMENT SURVEY

HoD / Teachers Questionnaire v7

At the Institution of Mechanical Engineers we are trying to find out what young people feel about engineering. This questionnaire is a part of that project and your answers will be a great help to us.
(All personal data will be treated as confidential.)

Thank you for taking part.

1. Your name

2. Job title & subject taught

3. The name of your school

4. How many years have you been teaching?

5. Are you male or female?

- ◯ Male
- ◯ Female

6. What do you understand by the term 'engineering'?

7. To what extent do we in the UK value engineering projects and the work that engineers do? (You may wish to compare with the work of doctors or people working in finance.)

8. To what extent do students learn about modern engineering in your school and in which subjects/ including outside the curriculum?

9. What should be the role of subject teachers and the curriculum in preparing students for their future careers?

10. What should be the role of schools in helping to produce future engineers?

11. How, where and to what extent does engineering currently feature in young people's learning (e.g. as a separate subject, more visible in STEM subjects, not at all)

12. How could engineering feature more in young peoples learning?

13. How should engineering feature more in young peoples learning?

14. To what extent does the school currently engage with the 'world of engineering' outside of school and how do you achieve this?

Institution of MECHANICAL ENGINEERS

HoD / Teachers Questionnaire v7

To what extent do the following influence the choices of students either to study engineering or embark on training in the sector after school:

15. Family background

No importance — Extremely important

16. Social class

No importance — Extremely important

17. Gender

No importance — Extremely important

18. Cultural background

No importance — Extremely important

19. The local jobs market

No importance — Extremely important

20. Student experience at school

No importance — Extremely important

21. Other possible influences (please try to show a 'Score 0 - 10')

Looking more closely at the family dimension and the ‘visibility’ of engineering at home, how much do you think the following have an impact on subject choices?

22. A family member working in engineering

No influence A great deal of influence

23. Engineering-focused and wider STEM media participation such as watching programmes on TV, reading web/magazine articles.

No influence A great deal of influence

24. Visiting science/engineering attractions

No influence A great deal of influence

25. Other possible influences (please try to show a 'Score 0 - 10')

Institution of MECHANICAL ENGINEERS

HoD / Teachers Questionnaire v7

A number of 'engineering habits of mind' shown below have been identified. To what extent does the curriculum and ethos in your school support the development of these skills?

26. Systems thinking: Students like to look at how things fit together into a system, learn about how the whole thing works, and how the component parts fit together.

No support — A great deal of support

27. Problem finding: Students are good at looking at a situation and identifying what needs changing and what the problems are that might need fixing.

No support — A great deal of support

28. Visualising: When carrying out an experiment, a design-and-make task or an investigation students can visualise the methods, solutions and end-products and this helps them carry out the task in the real world.

No support — A great deal of support

29. Improving: When using, designing or making something, students can often see how it can be improved as they go along.

No support — A great deal of support

30. Creative problem solving: When carrying out experiments or design-and-make activities, students like to use their knowledge of different subjects to put it all together to help find the best solution.

No support — A great deal of support

31. Adapting: When carrying out experiments or design-and-make activities, students can adapt their thinking and what they am doing if things start to go wrong or not as planned.

No support A great deal of support

32. What other skills or processes would we need to consider, and how would we include these in students' experiences?

33. Girls number around 7% of the students on engineering degree courses, and numbers working in engineering jobs is even lower. Why do you think this is?

34. What messages do you think girls get about engineering from school?

Thank you very much for taking part in this questionnaire.

CAREERS STAFF SURVEY

Institution of MECHANICAL ENGINEERS

Careers Questionnaire v7

At the Institution of Mechanical Engineers we are trying to find out what young people feel about engineering. This questionnaire is a part of that project and your answers will be a great help to us.
(All personal data will be treated as confidential.)

Thank you for taking part.

1. Your name

2. What is your professional role?

3. How many years have you been in this role?

4. The name of the school taking part in this survey.

5. Are you male or female?

- ◯ Male
- ◯ Female

Institution of MECHANICAL ENGINEERS

Careers Questionnaire v7

6. What do you understand by the term 'engineering'?

7. To what extent do we in the UK value engineering projects and the work that engineers do? (You may wish to compare with the work of doctors or people working in finance.)

8. To what extent do students learn about modern engineering in your school and in which subjects/ including outside the curriculum?

9. What should be the role of subject teachers and the curriculum in preparing students for their future careers?

10. What should be the role of schools in helping to produce future engineers?

11. Describe how a student in your school might find out about modern engineering careers, study and training.

12. In most schools engineering is not taught as a separate subject. Do you think that presents a particular challenge for you to offer engineering as a career opportunity?

13. Do you feel you have enough knowledge and understanding of modern engineering careers to deal with student queries?

Institution of MECHANICAL ENGINEERS

Careers Questionnaire v7

14. How, where and to what extent does engineering currently feature in young people's learning (e.g. as a separate subject, more visible in STEM subjects, not at all)

To what extent do the following influence the choices of students either to study engineering or embark on training in the sector after school:

15. Family background

No importance Extremely important

16. Social class

No importance Extremely important

17. Gender

No importance Extremely important

18. Cultural background

No importance Extremely important

19. The local jobs market

No importance Extremely important

20. Student experience at school

No importance Extremely important

21. Other possible influences (please try to show a 'Score 0 - 10')

22. Could schools do more to help parents better support their students' career choices? What might they do?

23. What role should subject teachers play in careers programmes, particularly related to engineering?

24. How do Careers specialists and STEM teachers currently interact with and inform one another within the context of careers programmes?
Could this be improved and how?

25. Do you introduce students to the full range of engineering fields, levels of entry and opportunities? How is this achieved?

26. What would be the implications, CPD or resources needs of such developments?

27. Girls number around 7% of the students on engineering degree courses, and numbers working in engineering jobs is even lower. Why do you think this is?

28. What messages do you think girls get about engineering from school?

Thank you very much for taking part in this questionnaire.

KEY SCHOOL STAKEHOLDERS INTERVIEW SCHEDULE

Interview schedule

1. **Perceptions of engineering in the school**

a. What do you think are the students' experiences of engineering in the school?

"One way of characterising science and engineering is to see science as the study of the natural world, whereas engineering is concerned with the made world. "

b. To what extent do you agree with this?

c. Would students understand this distinction?

d. What could we do in school to develop such understanding?

e. Should we be doing more about the made world?

f. How could we do this?

2. **Under-representation in engineering**

(Links to Research Question E)

Issue Topic Card 5 (Gender and engineering).

a. What do you think we could do in schools to address under-representation of certain groups, particularly girls, when choosing engineering subjects?

b. How important do you think family orientation to engineering is? eg family member is an engineer, or is or has worked in an engineering-linked occupation

3. **Engineering skills**

(Links to Research Question F)

Issue Topic Card 3 – (Engineering Habits of Mind)

Engineering habits of mind

- Seeing whole systems, and their parts, and how they connect, eg an airport, a car
- Clarifying needs, checking existing solutions, investigating contexts. Identifying a problem that needs to be solved.
- Being able to move from abstract to concrete, to see practical design solutions
- Trying to make things better, through experimentation, trial and error, conjecturing, thinking
- Applying techniques from different disciplines, generating ideas and solutions
- Testing, analysing, reflecting and rethinking in a physical and mental sense.

a. Did seeing the descriptions of EHoM change how you perceive engineering?

b. Do you think these are important qualities for young people to develop?

c. Are these skills developed within the school? And if so where and how?

4. **For many years numerous enrichment and enhancement activities and events have been offered to schools by a wide range of organisations to promote young people's interest and enthusiasm for further study and careers in engineering.**

   a. Has the school participated in any of these on a regular basis?

   b. How effective do you think they are/were in achieving their aims?

   c. Do you have any thoughts on a new approach that could be used?

STUDENT GROUP ACTIVITIES PLAN

Student discussion agenda

Based around a series of Activities, rather than just 'asking questions'. What we are trying to address are student views related to their image of engineering and engineering careers (including its socially beneficial role), their views about their own (engineering-relevant) skills, and how they experience engineering at school and home.

Annotated script ideas:

We are here today to talk about engineering.

1. Can anybody tell me what engineering is?

(*Students* make suggestions. Deductive coding[1] for

- It is a job involving fixing and mending things, eg a car mechanic, a TV repairer
- Linked to above – it is a dirty job involving overalls, workshops and getting your hands oily/dirty
- It is a job where you have to be very clever and highly skilled
- It is about the products of engineering, the kit, technology and systems
- It is focussed on solving problems that people have
- It is beneficial to us all, it makes things possible (eg telecoms/digital systems), makes things better

We are looking here for some measure of the spread of student views about what engineering is, based on the overarching aim of the research (What is the current framing in terms of the key school stakeholders (KSS) of engineering in Science, Maths and D&T at Key Stage 3, as well as in the wider curriculum and ethos of the school? - *i.e. to what degree is it perceived and communicated as a people-focussed, problem solving, socially beneficial activity?* (section in italics relevant here)

2. Issue Student Group Activity Card 1

Ask students to look at the skills in left hand column. Discuss them with students to clarify what they mean. Then ask them to chose which they are best at (1), and then to order them based on student's perception of their abiity in each (6 = least proficient).

Then ask them to order them into a sequence showing increasing importance for the world of work.

Third column asks them to think about the future. It may be difficult to imagine 20 years ahead, but in setting the activity up, talk briefl about how workis changing, such as automation, AI, 'gig economy', portfolio working, end of 'jobs for life' etc. Maybe this will not yield much of use?

After each round of scoring, ask students to talk about why they put skill x at the top and skill Y at the bottom of their lists. After 3rd round, also ask them to explain why they re-ordered their list (compared to (2)), if they did change the order.

3. Ask students 'Do you ever hear the word *engineering* used in school?'. Explore where (eg in context of a school subject like D&T, E&E activities), what it means to them, what does it make them think? Do they perceive that it is used in an inclusive way (looking for examples of where engineering is seen as the domain for a particular type of student, not the domain for some). Have

[1] This where we start the analysis with a series of answer-categories already in mind, and listed as Codes. These are based on our propositions and research questions. Responses in the discussion are allocated (coded) to our pre-exiting categories. Responses outside these 'deductive codes' can also be coded with new categories – we won't have thought of everything at the beginning.

they done any activities explicitly (or not) identified as engineering? When/where/what etc. How did they feel about it?

4. Issue Student Activity Card 2 (copied onto A5)

Ask students to read about some recent applications of engineering in medical technology.

When they have read it ask:

- What benefits might people see in using this sort of technology?
- What drawbacks might there be?
- (If not covered in discussion, raise issues like: what would be the social benefits, for individuals and society as a whole?
- Where in school would you expect to learn about this sort of development? (Ask about how much science the engineers needed to know to be able to develop this. Maths? D&T? (inc explicit reference to design element), other subjects?

5. Issue Student Activity Card 3. Say that these are starting slaries for a range of graduate jobs. Ask the to link the jobs to the salaries.

When complete, issue part 2 of the card which has salaries linked to the right jobs. Ask if there are any surprises? (If there are comments about low pay for a doctor – in Y2 after qualifying this jumps up to £28K).

6. Issue Student Activity Card 4 (on 3 pages, alternatively, on cards)

Say that this includes brief descriptions of 12 different areas of engineering. Ask them to read it through. Then ask them to score the top 5:

- In terms of which they think are the most interesting
- In terms of what they think are most beneficial to society
- In terms of ones in which they would consider a career.

If time available, ask them to explain their top choices in each case

STUDENT GROUP ACTIVITIES

Skills for today and tomorrow

Skill	Which am I best at (1 = best)	Which are important for doing a good job (1 = most important)	Which one might become more important in the future?
I like to look at how things fit together into a system, learning about how the whole thing works, and how the component parts fit together			
I am good at looking at a situation, and identifying what needs changing – what the problems are that might need fixing			
When carrying out an experiment, a design-and-make task or an investigation, I can visualise (“see in my head”) the methods, solutions and end-products, and this helps me carry out the task in the real world			
When using, designing or making something, I can often see how it can be improved as I go along			
When carrying out experiments or design-and-make activities, I like to use my knowledge of different subjects, to put it all together to help find the best solution			
When carrying out experiments or design-and-make activities, I can adapt my thinking and what I am doing if things start to go wrong or not as planned			

An example of engineering

Conditions such as asthma, diabetes and high blood pressure can be monitored by people wearing smart phone apps which can upload data directly to medical records, spotting problems immediately. Domestic care robots can monitor elderly peoples' eating habits, heart rate and whether they have taken their medication and notify local nurses of the problems. In future it will be possible to use engineering and technology in mobile phones and tablets to detect and treat heart attacks and strokes, undergo surgery by automated robots, analyse, explain and transmit all relevant physiological data to the doctor without even visiting the surgery.

An example of engineering

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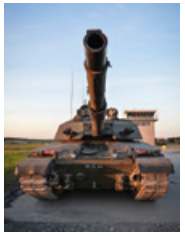
Matching starting salaries with jobs (correctly matched)

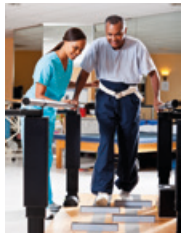
Job – graduate salaries at beginning of career	Join the salary with the job	Salary (to be mixed up in actual sheet so students have to try to mach salary with job)
Architect		£18,936
Dentist		£30,348
Chemical engineer		£28,641
Teacher		£22,224
Mechanical engineer		£26,420
Social worker		£24,004
Vet		£26,071
Doctor		£22,862
Nurse		£21,692
Solicitor		£22,572
Civil servant		£22,154
Computer scientist		£23,628

(Student version)

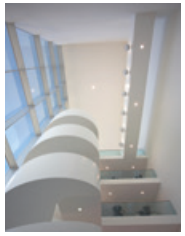
Job – graduate salaries at beginning of career	Join the salary with the job	Salary (to be mixed up in actual sheet so students have to try to mach salary with job)
Architect		£22,154
Dentist		£26,071
Chemical engineer		£18,936
Teacher		£24,004
Mechanical engineer		£22,862
Social worker		£30,348
Vet		£22,572
Doctor		£23,628
Nurse		£28,641
Solicitor		£22,224
Civil servant		£26,420
Computer scientist		£21,692

The appeal and value of different forms of technology (may be converted to a set of cards)

Technology	(1) Which are the top 5 that you are (or would be) interested in (1 = most interested)	(2) Which are the top 5 in terms of how useful they are in society (1 = most useful)	(3) In which would you consider having a career? (1 = most likely, down to 5)
 **Defence Technology** The most sophisticated equipement, vehicles and communication systems used to protect lives in conflict zones the world over. Democratic governments try to deter attacks from other nations by having the latest technology.			
 **Information Technology and Robotics** The amazing developments of computers have produced systems for storing, retrieving, and sending information that continues to change the way we live our lives. The design of robots that will do the work and take on many of the difficult jobs that people currently have to do.			
 **Environmental (Green) Technology** An increase in the planet's population size and the growth in industry have changed the Earth's sensitive atmosphere and habitats. Engineers are developing new ways of meeting our needs without polluting our environment.			

 **Electricity Generation and Electronics Technology** The world is run on electricity. Power generation is how we convert energy from other sources into the electricity that powers our lives. Electronics is the design of circuits using transistors and microchips that control most other technologies in our world.			
 **Medical & Sports Engineering** Engineering ideas and methods are used for healthcare and in the treatment of disease and illness. Examples include surgery, monitoring equipment and scanners. Modern athletes make use of science to develop more advanced technology that improves their performance and fitness, and reduces injury.			
 **Trains and Boats** In our busy and crowded world, we need to move products (and people) from place to place. Railway and marine (ships and boats) engineers design faster, safer and more efficient ways of moving large loads cheaply, quickly and safely.			

 **Aeronautical and space technology** Faster, safer and greener aircraft, 'shrink' our world and allow people to connect with others in different places. Helping to explore our solar system and discover more about our Earth and the Universe.			
 **Engineered Art & Design** Using engineering to produce sculptures and other artworks that impress and improve the quality of our lives. Making our cities and the countryside more pleasant places to live through design with people in mind.			
 **Automotive (cars, vans, lorries, buses and coaches)** Improving people's driving experience through more affordable, comfortable and practical cars, lorries and other forms of road transport. Making greener and more efficient vehicles, to limit the impact on the world we travel.			

 **Agricultural Engineering** Designing new machinery and methods to grow food in even the harshest conditions. Ensuring there is a consistent supply of food for a growing population, whilst limiting damage to the planet.			
 **Building (Civil Engineering)** Developing modern houses, offices, factories and public buildings, that are comfortable, energy efficient and durable. Building roads, bridges and tunnels that bring communities together.			
 **Manufacturing chemicals and materials** Almost everything we own and use is made from materials which began as natural resources and which engineers maufactured into new materials. This includes everything from clothes and sports equipement to technology and kitchen utensils.			

STIMULUS MATERIALS

JUNE 2016

FUTURE OF DRIVING

JUSTINE BRIAN

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MOTION:

"ALL VEHICLES SHOULD BE AUTOMATED"

FUTURE OF ENGINEERING DEBATES BY:

Institute of Ideas

Institution of MECHANICAL ENGINEERS

CONTENTS

KEY TERMS

Artificial intelligence (AI)

Autonomous car

Google self-driving car

INTRODUCTION

In 2010 technology giant Google announced its Self-Driving Car project to "make driving safer, more enjoyable and more efficient." [Ref: Google] Google ask us to imagine a point where "Deaths from traffic accidents—over 1.2 million worldwide every year—could be reduced dramatically, especially since 94% of accidents in the U.S. involve human error." [Ref: Google] The idea of 'automated vehicles' isn't a new one [Ref: Computer History Museum], but the advent of Google's recent project has caused both excitement and concern, and raises questions about responsibility, the future of driving and human autonomy. Supporters of the new technology argue that: "The strongest case for self-driving cars is safety" [Ref: Guardian], although critics are concerned that self-driving cars "introduce a whole new category of road user…that entirely lacks an understanding that all those road users share" [Ref: Slate], and question how this new automated technology will integrate into a human-controlled, human-centred environment. As well as this, some commentators ask whether automation will end our love of driving altogether, as we seem to have reached "peak car" because of, "the possibility that both car ownership and vehicle-kilometres driven may be reaching saturation in developed countries—or even be on the wane" [Ref: Economist]. In other quarters, there is anxiety about whether we are too quick to embrace automation, at the expense of human pleasure and control: "The self-driving car will only change our lives for the worst" because of what "it'll take away from future generations. The car gives many of us our first taste of true freedom. Countless weekends can be spent just driving, with no particular destination in mind. Often, after getting hopelessly lost, new places are found, and returned to throughout our lives. This is only possible because we're in complete control." [Ref: Digital Trends] So is the future of driving an automated one, or is that still a futuristic dream? What are the pros and cons of this new technology, and how might it effect humankind's relationship to machine?

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Safety first

One of the key motivations developers give for a move to automated cars is improving road safety. Cars that are able to anticipate risky situations and avoid them will, it is argued, reduce road-traffic accidents, "helping to make the roads safer for everyone." [Ref: Telegraph] The small fleet of Google automated cars (both commercial makes and Google's own prototype) have driven over a million miles within California since 2009 [Ref: Telegraph], but in February this year one of their vehicles had an accident and collided with a public transport bus [Ref: Financial Times]. Google admitted that the computer had made an "incorrect assumption about where [the bus] would go", and that the crash would not be the last [Ref: Daily Mail]. That incident is considered an important moment in the development of the technology, not only because it's the first one where the technology has been deemed to bear 'some responsibility' for the incident [Ref: Daily Mail], but because it highlights the concerns of some about the safety of driverless cars more broadly. Whilst future automated vehicles might be able to safely "navigate roads, they don't think like humans", and some question whether automated cars can really be safe in an environment where they need to interact with humans, and as such, "cope with the uncertainty and complexity of human behaviour." [Ref: Popular Mechanics] However, despite this, others call for perspective on the Google car crash, and ask us to consider "the number of crashes that occurred on the same day that were the result of human behaviour." [Ref: BBC News] In addition, some worry that computer-controlled cars might be 'trollable' – falsely led into reacting in a particular way for nefarious or accidental reasons – because: "As self-driving cars increase in complexity (and they are among the most complex computer systems ever made)…the number of ways they can fail will increase", as even the most sophisticated AI systems don't possess our "uniquely human intelligence" [Ref: Slate].

Man vs Machine

For writer and journalist Carl Franzen, "the biggest issue with self-driving cars lies in their inability to make moral and ethical decisions for which human drivers have so far been almost entirely responsible. Would-be autonomous carmakers might be uncomfortable programming such choices into their systems, but human drivers make such momentous split-second decisions with regularity." [Ref: Popular Mechanics] The development of artificial intelligence (AI), including in transport, has led some to consider ethical and moral questions about introducing this new technology into our lives. Human drivers make constant judgements – practical and moral – especially about the safety of ourselves and those around us, but will computers be programmed to do the same, and if so what decisions will their algorithms make? "Here is the nature of the dilemma. Imagine that in the not-too-distant future, you own a self-driving car. One day, while you are driving along, an unfortunate set of events causes the car to head toward a crowd of 10 people crossing the road. It cannot stop in time but it can avoid killing 10 people by steering into a wall. However, this collision would kill you, the owner and occupant. What should it do?"[Ref: MIT Technology Review] Others contest that: "When machines take over, the work required of the human is typically not removed", but rather our interaction with cars changes, and instead we will be a "monitor—one who constantly watches to detect and correct

technology failures". Ultimately, they argue that driving will become "a cooperative effort between humans and technology—one where the human plays a vital, active role in systems that optimize the interaction between the driver and the technology" [Ref: Newsweek]. There is also the question of responsibility, and if we can hold a machine to account in the event of accidents. Some argue that even if the law and ethics of automated vehicles are resolved: "Insurers still need to make confident judgments about risk, and this will be very difficult." [Ref: Atlantic]

The future of driving

In parts of the world where the car has been prominent in our lives and cultures over the past half century, we are driving less, due to improvements in public transport and increased city-centre living, and some point out that, "in the rich world the car's previously inexorable rise is stalling." [Ref: Economist] Those who believe we have a duty to move to automation to reduce road-deaths, argue that despite peoples "illusion of an inalienable right" to drive, "passing laws [to move to automation] that protect us from harm is a good idea, even if some liberty is lost as a result." [Ref: Fusion] But despite the obvious advantages of road safety, might the driverless-car be a "dispiriting prospect" which deprives us of our autonomy and turns the freedom of travel into something "joyless" [Ref: Guardian]? Google and other developers point to the prospect of driving being opened up to everyone, and changing how we use that time spent in a car, "everyone could get around easily and safely, regardless of their ability to drive. Ageing or visually impaired loved ones wouldn't have to give up their independence. Time spent commuting could be time spent doing what you want to do." [Ref: Google] So is a move to automation an unquestionable good for society? Will machines be granted 'personhood' in the future [Ref: Atlantic], and if so, do humans risk losing their sense of autonomy and control?

NOTES

ESSENTIAL READING

Autonomous and driverless cars case study
Institution of Mechanical Engineers 10 February 2016

Where to? A history of autonomous vehicles
Computer History Museum 2016

FOR

A future of self-driving cars? We're ready now
Stephen Shankland *Cnet* 23 January 2016

Safety first: the future of driving
Tim Gibson *Telegraph* 15 January 2016

Self-driving cars: safe, reliable – but a challenging sell for Google
Jemima Kiss *Guardian* 6 October 2015

Driving should be illegal
Kevon Roose *Fusion* 5 October 2015

AGAINST

The big question about driverless cars no one seems able to answer
Brian Fung *Washington Post* 17 February 2016

Sorry to disappoint, but driverless cars will still need drivers
Michael Nees *Newsweek* 10 May 2015

Why self-driving cars aren't ready to share the road with humans
Carl Franzen *Popular Mechanics* 5 February 2015

Driverless cars will ruin the thrill of driving
Laura Barton *Guardian* 31 July 2014

IN DEPTH

Why self-driving cars must be programmed to kill
MIT Technology Review 22 October 2015

The moral challenges of driverless cars
Communications 2015

Seeing the back of the car
Economist 22 September 2012

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BACKGROUNDERS

Can self-driving cars cope with illogical humans?
Mark Prig *Daily Mail* 14 March 2016

Driverless cars pose worrying questions of life and death
Andy Sharman *Financial Times* 20 January 2016

Google's self-driving cars aren't as good as humans—yet
Alex Davies *Wired* 12 January 2016

Humans are slamming into driverless cars and exposing a key flaw
Keith Naughton *Bloomberg* 8 December 2015

Five big tests that driverless cars will have to pass
James Titcomb *Telegraph* 15 November 2015

When humans and robots share the roads
Adrienne Lafrance *Atlantic* 9 October 2015

Future proofing: Mobility
BBC Radio 4 26 September 2015

The future of driving, in one provocative chart
Alexander C. Kauffman *Huffington Post* 4 August 2015

The driverless car debate: how safe are autonomous vehicles?
Lauren Keating *Tech Times* 28 July 2015

If a self-driving car gets in an accident, who—or what—is liable?
Alexis C. Madrigal *Atlantic* 13 August 2014

Driverless cars: increased road safety and efficiency or 'lethal weapons'?
Oliver Balch *Guardian* 1 August 2014

Will Google's autonomous cars ruin driving, or liberate us from it?
Jeffrey Van Camp *Digital Trends* 31 May 2014

The ethics of autonomous cars
Patrick Lin *Atlantic* 8 October 2013

The trollable self-driving car
Samuel English Anthony *Slate* 2012

Self-driving car project
Google

Self-driving pods
Transport Systems Catapult

The CNN 10: Future of driving
CNN

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IN THE NEWS

Google car crash 'not a surprise' - US transport secretary
BBC News 14 March 2016

Google self-driving car caught on video colliding with bus
Guardian 9 March 2016

BMW sees its future shift to ultimate self-driving machine
Bloomberg 7 March 2016

Google driverless car in road accident
Financial Times 1 March 2016

Ford speeds towards a self-driving future
Daily Mail 23 February 2016

Computers will take legal control of driverless cars
The Times 11 February 2016

Driverless cars: London wants Google vehicle trials
BBC News 6 February 2016

Autonomous vehicles will be safer, not perfect
Automotive News 10 January 2016

Self-driving vehicles expected on roads in next few years
China.org 13 April 2015

FBI warns driverless cars could be used as 'lethal weapons'
Guardian 16 July 2014

Google's driverless cars are 'safer' than human drivers
Telegraph 29 October 2013

AUDIO/VISUAL

Uber and out: is there a future for driving?
Battle of Ideas 17 October 2015

Future proofing: Mobility
BBC Radio 4 26 September 2015

The CNN 10: Future of driving
CNN

ORGANISATIONS

Google

Institution of Mechanical Engineers

NOTES

ADVICE FOR DEBATING MATTERS

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FOR STUDENTS

READ EVERYTHING .....
In the Topic Guide and in the news - not just your side of the argument either.

STATISTICS ARE GOOD BUT.....
Your opponents will have their own too. They'll support your points but they aren't a substitute for them.

BE BOLD
Get straight to the point but don't rush into things: make sure you aren't falling back on earlier assertions because interpreting a debate too narrowly might show a lack of understanding or confidence.

DON'T BACK DOWN
Try to take your case to its logical conclusion before trying to seem 'balanced' - your ability to challenge fundamental principles will be rewarded - even if you personally disagree with your arguments.

DON'T PANIC
Never assume you've lost because every question is an opportunity to explain what you know. Don't try to answer every question but don't avoid the tough ones either.

FOR JUDGES

Judges are asked to consider whether students have been brave enough to address the difficult questions asked of them. Clever semantics might demonstrate an acrobatic mind but are also likely to hinder a serious discussion by changing the terms and parameters of the debate itself.

Whilst a team might demonstrate considerable knowledge and familiarity with the topic, evading difficult issues and failing to address the main substance of the debate misses the point of the competition. Judges are therefore encouraged to consider how far students have gone in defending their side of the motion, to what extent students have taken up the more challenging parts of the debate and how far the teams were able to respond to and challenge their opponents.

As one judge remarked *'These are not debates won simply by the rather technical rules of schools competitive debating. The challenge is to dig in to the real issues.'* This assessment seems to grasp the point and is worth bearing in mind when sitting on a judging panel.

FOR TEACHERS

Hoping to start a debating club? Looking for ways to give your debaters more experience? Debaitng Matters have have a wide range of resources to help develop a culture of debate in your school and many more Topic Guides like this one to bring out the best in your students. For these and details of how to enter a team for the Debating Matters Competition visit our website, **www.debatingmatters.com**

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JANUARY 2017

HEALTH MONITORING

ADAM RAWCLIFFE

DEBATING MATTERS

TOPIC GUIDES

MOTION:

"THE CONSTANT MONITORING OF OUR HEALTH DOES MORE HARM THAN GOOD"

ABOUT DEBATING MATTERS

Debating Matters because ideas matter. This is the premise of the Institute of Ideas Debating Matters Competition for sixth form students which emphasises substance, not just style, and the importance of taking ideas seriously. Debating Matters presents schools with an innovative and engaging approach to debating, where the real-world debates and a challenging format, including panel judges who engage with the students, appeal to students from a wide range of backgrounds, including schools with a long tradition of debating and those with none.

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The University Of Sheffield.

Teesside University

WIMBLEDON BOOKFEST 2016

CONTENTS

KEY TERMS

Asthma

Diabetes

Hypertention

Wareable Technology

Worried Well

INTRODUCTION

Over the last few years, fitness bands such as Fitbit and Jawbones, have seen an explosion in popularity [Ref: Apple Insider]. These wearables, which monitor activity levels, heart rate and sleep patterns, account for three out of four of the sales of wearable technology in the United States and boast celebrity fans such as Andy Murray, George Osborne and Britney Spears [Ref: Wareable]. The popularity of fitness bands ties into a wider trend of using technology to monitor our individual health. Thousands of health apps for smart phones are now available which communicate wirelessly with your wearable and PC or tablet, providing 24-hour health monitoring, with some of these apps even endorsed by the NHS [Ref: Telegraph]. Many are so excited by the improvements that technology has made to healthcare that they deem it the next medical "revolution" [Ref: Telegraph]. A future where technology knows we are ill before we do and informs a doctor or provides medication, may sound like something from a Huxley novel, but it could be just around the corner [Ref: Guardian]. Technology and greater monitoring of our health could save the NHS money, transform how we care for the elderly, and usher in a new age of personalised care some argue [Ref: Guardian]. However, critics are less sure, suggesting that the use of fitness bands and health apps is "untested" and "unscientific", while constant health monitoring could generate anxiety and a new generation of "worried well" [Ref: Independent]. Does the constant monitoring of our health do more harm than good?

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Is perpetual monitoring good for us?

Proponents of a medical technological revolution cite how a greater use of technology could transform medicine. For example, people suffering from chronic conditions like asthma, diabetes and high blood pressure could be fitted with sensors or use smartphone apps which upload data directly to medical records, spotting problems immediately [Ref: Telegraph]. Domestic care robots can monitor elderly patients' eating habits, heart rate and whether they have taken their medication, and notify local nurses if they detect problems; in future they may even be able to treat acute episodes such as heart attacks or strokes [Ref: Guardian]. And tablets and smart phones give patients more options over how they interact with healthcare professionals - booking appointments or seeing medical records online or even Skyping with GPs [Ref: Telegraph]. It's estimated that these technological advancements could save the NHS up to £5 billion over the next decade, and make it easier for nurses and doctors to treat hard to reach patients [Ref: Telegraph]. Yet despite this, some are not convinced of the benefits. Glasgow GP Dr Des Spence describes the use of wearables and smartphones in health care as, "untested and unscientific", and risks the "over-diagnosis" of health problems, with people unable to distinguish between harmless variation, faulty readings or genuine ill-health [Ref: BMJ]. Critically, there is no scientific evidence that wearables or apps improve health [Ref: Independent], and doctors are reporting huge rises in the "worried well"- healthy patients who, fuelled by Google and WebMD searches, are diagnosing themselves with everything from food allergies to brain tumours [Ref: Telegraph]. This not only costs the NHS millions, but evidence suggests that extreme anxiety can actually be a cause for illness [Ref: Channel 4].

A healthcare revolution?

Dr Eric Topol, a Californian cardiologist, predicts a future where smartphones will easily analyse, explain and transmit all relevant physiological data to the doctor, without the patient having to visit the surgery itself [Ref: New York Times]. In this vision of the future, hospitals may be unnecessary, with services "performed in the comfort of our own home. Seeing our own data on our devices. In charge" [Ref: New York Times]. Healthcare may change so rapidly some argue, that an individual may not need to see a human doctor throughout the whole treatment process: the patient will diagnose themselves with the help of monitoring data; undergo surgery by an automated robot; and receive aftercare from C3PO in scrubs [Ref: Telegraph]. However, the role of a doctor is multi-faceted, and critics argue that it is not just clinical knowledge or analysis of data which is important, "it's communication, it's diplomacy, it's tact, it's pattern recognition" [Ref: Telegraph]. A doctor must make complex ethical decisions within an established regulatory framework, and deliver a message in a way that suits the individual patient. In this sense, the diagnostic process is a profoundly human one – after all, would you rather receive the news that you or a loved one had cancer from a text message or a sentient, understanding human?

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Is the data always useful?

Supporters of health monitoring note that the healthcare service is notoriously slow to adapt to new technology. And the testing process which a piece of technology must go through in order to be deemed safe for medical application, is deemed arduous and long-winded, so many private companies choose to skip it all together and sell their products directly to consumers [Ref: Modern Medicine]. But for opponents, such regulation is vital to ensure patient safety [Ref: Guardian]. And they argue that it takes time to show that new technology is beneficial, and so it should not be introduced widely until it is clear that the data can be interpreted accurately. That said, in the future, health monitoring could be utilised by using electronic prescribing systems, which have been shown to make prescription errors 50% less likely, and can be checked to conform to sensible drug quantities, interactions with other medication, and even clinical conditions [Ref: Guardian]. Monitoring technology can also help in the diagnostic process, as some evidence suggests that first diagnoses by a GP are frequently inaccurate [Ref: Guardian]. In these scenarios, the objective nature of monitoring technologies may allow us to mitigate the risk of human error in healthcare. However, others are cautious about such claims, and note that technology may sometimes end up doing more harm than good. For example, some doctors are querying the value of breast screening programmes, suggesting that women risk false positives and over treatment, including unnecessary breast removal and surgery on harmless cancers [Ref: Daily Mail]. Furthermore, companies such as 23andme will now screen any individual's DNA for genes associated with inheritable conditions for a fee of £125 [Ref: Guardian]. In light of this, Dr Ewan Birney queries the usefulness of this sort of data gathering, with much of the information based on "very small shifts of risk, which are better served by simply living healthier and getting more exercise". He goes on to conclude that there is "an understandable concern that this type of genetic testing could cause inappropriate harm, simply through people worrying excessively or becoming neurotic over these small increases in risk" [Ref: Guardian]. So how should we view health monitoring technology - do we really understand what all the data means? Are patients in danger of being deluged with data that they do not fully understand? Is having constant information about our health a good thing, or does it just add one more thing for us to worry about?

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Chris Cooper Independent 14 April 2015

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Professor Maureen Baker *Telegraph* 26 January 2016

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NHS and internet of things: The future of care is about the patient taking control
SA Mathieson *Guardian* 8 June 2015

We stand on the brink of a healthcare revolution
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Zach Guzman *CNBC* 3 May 2016

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[NHS]

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LORD BOATENG, FORMER BRITISH HIGH COMMISSIONER TO SOUTH AFRICA

JUNE 2016

TECHNOLOGY AND THE ENVIRONMENT

ANWAR ODURO-KWARTENG

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"TECHNOLOGICAL PROGRESS WILL NOT SOLVE SOCIETY'S ENVIRONMENTAL ISSUES"

FUTURE OF ENGINEERING DEBATES BY:

Institute of Ideas

Institution of MECHANICAL ENGINEERS

CONTENTS

KEY TERMS

Climate change

Disruptive innovation

Ecomodernism

Environmentalism

Fossil Fuel

Geo-engineering

INTRODUCTION

Arguably, climate change, and the environmental problems that will occur as a result, are the most pressing issues that mankind faces. The Paris climate change summit last year was hailed as a momentous deal, in which countries pledged, among other things, to cap emissions, and seek to limit temperature rises to 1.5C – below the 2C which most accept would be disastrous for the planet [Ref: Guardian]. However despite this, debate still rages about whether this is enough to combat climate change, and if, reductions, caps and restrictions are the path that we should be following at all. Indeed, there are some that argue that we need far more radical thinking, and that even if, "we had found cheap renewable energy technologies that could gradually replace all of the world's coal plants…it still wouldn't have solved climate change." [Ref: Spectrum] As such, they argue that radical new technological means of producing and storing energy, as well as carbon capture and storage for example – disruptive technologies which change the energy and environmental landscape totally, are what is needed. For these advocates of technological innovation, cutting emissions, and changing our lifestyles is not the answer. That said, others are not convinced. Instead, they are critical of those who put their faith in technology and innovation as the answer to our environmental problems, with one commentator noting that this amounts to, "an alibi for excess", going on to state that: "We have placed our faith in something called progress, in the untestable belief that things will always get better." [Ref: Guardian] So, should we embrace the promise of technological innovation to solve society's environmental issues? Or in doing so, do we ignore the fact that we are responsible for the behaviour change that society needs to tackle climate change?

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The climate change conundrum

Central to the debate about climate change, is the discussion about how best to reduce it, or halt its progress altogether; through reductions and behaviour change, or through technology and innovation. Many now suggest that despite attempts at finding political solutions through international agreements, it is highly unlikely that these methods will reap meaningful rewards going forward. For instance, economist and commentator Will Hutton observes that in the midst of the discussion on climate change, rapidly developing countries such as India want the same opportunities to grow their economies as Western countries did during industrialisation, and will continue to burn coal unless there are alternatives that are as cost effective [Ref: Guardian]. As such, he adds that: "Prime Minister Modi is clear: if the choice is between poverty and climate change, India will choose the latter", and so it is obvious that: "It will be innovation that will save the planet. This is the blistering truth that should be written in neon in the skies" [Ref: Guardian]. However, others are critical of this approach, and accuse its proponents of attempting to have their cake and eat it. They argue that we cannot continue to live the way that we do, and that it is our attitude towards growth and progress, and its impact on the environment that needs to change, as environmentalist George Monbiot suggests: "We seem unable to face the fact that our utopia is also our dystopia; that production appears to be indistinguishable from destruction." [Ref: Guardian]

Is technological progress the answer?

For advocates: "It's not true that we can't solve big problems with technology; we can. We must." [Ref: Technology Review] And outlining the technological argument, science writer Leigh Phillips notes that: "Through technological advance, we can use less of something to produce the same amount, or replace one raw material with another. We didn't 'run out' of whale blubber. We replaced it with kerosene." [Ref: Guardian] Moreover, in light of the fact that 2015 is likely to have gone down as the hottest year since 1880, and with the attempts to move to renewable energy barely reducing carbon dioxide emissions [Ref: Economist], supporters of technology and innovation claim that global warming cannot be dealt with using todays tools and mindset, and suggest that we need to create some new ones. From this perspective, humans have the potential to solve climate and environmental problems through technology and progress, as an Economist editorial argues: "The climate is changing because of extraordinary inventions like the steam turbine and internal combustion engine. The best way to cope is to keep inventing." [Ref: Economist] In this way, they dismiss environmentalist arguments, which suggest, "that the best way to save the planet is to curtail human activity, whether in the form of breeding, building, burning or business" [Ref: Telegraph], and instead posit the idea that the answer is not retreat and de-modernisation, but innovation and radical solutions. Ideas such as geoengineering [Ref: BBC News], which involves modifying the Earth's environment, are being researched – with Dubai currently looking to build an artificial mountain to increase rainfall to combat drought [Ref: New Scientist]. Others suggest that: "Our society needs to fund scientists and engineers to

propose new ideas, fail quickly, and share what they learn" [Ref: Spectrum], and argue that R&D needs to be properly financed, with more onus placed on funding radical 'disruptive' [Ref: Wikipedia] projects which may have the potential to solve our environmental problems. This is because: "There are, no doubt, all manner of unpredictable inventions that are possible…if imagination, science, and engineering run wild." [Ref: Spectrum]

Less is more? The environmental case

Professor Clive Hamilton laments the notion that technological fixes can solve environmental problems, and suggests that the real reason why some are wedded to them, is because it allows us to believe that nothing needs to change. He says that: "Technofixes – technical solutions to social problems – are appealing when we are unwilling to change ourselves and our social institutions" [Ref: Scientific American], and argues that it is profound behavioural change that is needed instead of the, "unbridled techno-industrialism", which illustrates "our unwillingness to change the way we live." [Ref: Scientific American] Furthermore, critics of technological fixes are suspicious of the idea posited by some Ecomodernists [Ref: Wikipedia] – that our actions, and modernity per se, are not the problem, and claim that these assertions represent, "an illusion, created by the irrational accounting of our environmental impacts." [Ref: Guardian] A key argument for opponents of technological answers to climate change, is that we need to be realistic about what we can hope to do, because innovations that are put forward are often, "emerging technologies, that are barely proven, yet to be successfully commercialised, or downright illusory." [Ref: MIT Technology Review] In a similar vein, further interrogating the argument that technology holds all of the answers, one writer opines that: "Climate change is an energy problem. Burning fossil fuels to produce electricity or heat is responsible for roughly half of global warming pollution… Changes are required not just in technology, but also in people's behaviour." [Ref: Scientific American] Opponents also note that in this debate, technology is often used as a smokescreen for politicians to hide behind, allowing them to postpone making unpopular decisions that will actually help lower CO2 emissions. As George Monbiot argues: "Governments urge us to both consume more and to preserve more. We must extract more fossil fuel from the ground, but burn less of it…These policies are irreconcilable." [Ref: Guardian] With these arguments in mind, where does the balance lie? Are critics right that the key to combatting environmental issues is behaviour change on a global scale, which may mean that aspects of life in industrial countries may have to change? Or should we put our faith in radical, new technologies, and innovation, because: "The end is not nigh, and we do not need to rein in industrial society. If anything, we must accelerate our modernity." [Ref: Guardian]

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CONTENTS

KEY TERMS

Engineering

Innate

STEM

INTRODUCTION

The UK is suffering an engineering skills shortfall, prompting many in the industry to ask the question: can anyone become a scientist or engineer? [Ref: Bloomberg]. The Warwick Institute for Employment Research suggests that for a prosperous UK economy, an additional 1.82 million people will be needed in engineering jobs between 2012 and 2022 [Ref: Institution of Mechanical Engineers]. Engineering UK suggests that over the same timeframe there will be a shortfall of some 550,000 engineers and skilled technicians [Ref: Institution of Mechanical Engineers]. In a world which is ever more reliant on technology, there is "a danger that the UK as a whole, could miss out on the opportunities within advanced manufacturing and engineering due to ignorance and a lack of skills" [Ref: Telegraph]. If you dig deeper the trend only becomes more concerning. A tiny 7% of UK engineers are female, the lowest proportion in Europe, despite girls on the whole outperforming boys in science GCSEs [Ref: New Scientist]. In Singapore, where applied science is arguably more valued, 40% of graduates are engineers - skills incredibly attractive to foreign investors [Ref: Telegraph]. Within this context, Christine Cunningham, an education researcher and vice president at the Museum of Science in Boston, believes young children do not know what engineers are. When prompted to draw a picture of an engineer, students frequently depict train drivers or construction workers assembling buildings, bridges or roads [Ref: Discover Magazine]. With all of this in mind, are certain individuals inclined towards a STEM career, with an innate engineering disposition so strong, that it does not need developing in the way we assume other skills do? Or are lots of young people missing out on a technology or engineering career because they don't know what engineering is or what engineers do? Would better education prove that anyone can be an engineer, or are certain people born for a career in engineering?

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Can anyone become an engineer?

Whilst many of us believe we can do anything we set our mind to, some in the science education community question whether we all have the capacity to become scientists or engineers. Greg Blonder argues that by the time we reach 11 years old, "the scientists, engineers, poets, basketball players, and beauty queens" have all sorted themselves out, "some by natural inclination, and some by peer pressure" [Ref: Bloomberg]. Whilst all children may be naturally inquisitive, some suggest that engineers think in a more analytical, methodical and detail-orientated way than the average person, perhaps making it a job for a specialised minority of people [Ref: Planet Analog]. Yet others argue that all children from an early age play in a way which lets them work out cause and effect, displaying the early signs of scientifically inquisitive minds [Ref: Scientific American]. Another aspect of the debate is the distinction between males and females, with some arguing that there is evidence that men and women's brains are 'wired differently' – potentially leading one gender to prefer certain types of activity to others [Ref: BBC News]. Cambridge Professor, Simon Baron Cohen, suggests "that both sexes have equal scientific ability but females have a stronger interest in people", leading more women into fields such as medicine and men into subjects such as maths and physics [Ref: Telegraph]. However, opponents are wary of these conclusions, and instead claim that societal pressures are what really influence such decisions, rather than innate female or male traits. Dame Mary Archer offers the explanation that women may not choose careers in science and engineering because such disciplines are associated with masculinity, and "there's a sense that 'I can't be as womanly as a scientist as I could be as a beautician or a journalist'" [Ref: Telegraph].

How do we solve the engineering shortfall?

Those who believe there is a naturally inclined pool of would-be engineers, argue that the education system is not doing enough to nurture those who are interested in STEM subjects. From this perspective, there are those who claim that educators must "hunt and gather" the few natural technologists, rather than try to "sow and reap" a new crop from seed [Ref: Bloomberg]. While beneficial for all of us to be scientifically literate, not everyone needs to know how to solve redox equations or memorise the nomenclature of chemistry, biology and physics [Ref: Bloomberg]. But more broadly, there is the sense that the current education system in the UK is failing would-be engineers. The fact that children in the UK have to make specialist subject choices, often choosing between arts and sciences, as young as 14 years old means that many give up on STEM subjects too early [Ref: Cooling Post]. A broader curriculum up until the age of 18, with engineering as a subject, might lead more people to consider STEM related careers some argue [Ref: Institution of Mechanical Engineers]. Subjects such as Design and Technology could be greater utilised to teach the problem-solving, socially beneficial nature of engineering, in the hope that if the industry is portrayed in a better light, we may increase the pool from which future engineers are drawn [Ref: Telegraph]. Despite these suggestions, critics disagree, arguing instead that attracting the best and brightest from overseas, and removing barriers that prevent scientifically-inclined minds from fulfilling their potential, because of things such as poverty and discrimination, would do far more than broader scientific education for all [Ref: Bloomberg]. In the same vein, some think that academic snobbery is what actually pushes students away from technical

occupations, and assert that careers counsellors should do more to promote vocational qualifications and apprenticeships, thus allowing young people reach the top of the industry. Without such measures, engineering's 300 year history at the heart of the UK economy will be in jeopardy [Ref: Telegraph].

The role of engineers in society

Evidence suggests that a high proportion of engineers come from an engineering family background – thus learning about the discipline through family or friends [Ref: Institution of Mechanical Engineers]. Proponents of broader STEM education argue that we need a new understanding of what it means to be an engineer: "We need to raise the profile of an engineer to that of a doctor or solicitor," Tracy Radford argues. "It's vital to spread the word and ensure young people understand that engineering is a highly rewarding career, offering many paths and exciting experiences both at home and abroad" [Ref: Telegraph]. Engineering should be promoted as a people-focused and socially beneficial discipline referenced in the curriculum from primary school to university level [Ref: Institution of Mechanical Engineers]. However, for others, while technological literacy will be of upmost importance in the future, it is not necessary for everyone to be able to 'think like a researcher' [Ref: Galileo's Pendulum]. Courses separated into the general and the professional would give us all a common language and appreciation for the vast promise, and limits, of technology, while increasing the base of home-grown scientists and engineers by directing our efforts where they will have most impact [Ref: Bloomberg]. In a future world where we all travel in driverless cars, receive healthcare from robots, and can tackle the world's greatest problems like climate change with technology - how do we make sure that we have the engineers necessary to make these systems function? Are scientists and engineers unique groups of people born to follow certain vocational interests? Or, are we not doing enough to give all young people the opportunities to pursue engineering careers?

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Strong engineering industry hindered by skills shortage
Institution of Mechanical Engineers 1 February 2016

A chance for the UK to stem its skills shortage
Financial Times 26 November 2015

UK needs over one million new engineers and technicians, says Royal Academy of Engineering
Independent 22 June 2015

15 signs you were born to be an engineer
Buzzfeed 25 September 2014

Men and women's brains are 'wired differently'
BBC News 3 December 2013

Report reveals scale of UK's engineering skills shortage
Engineer 1 October 2012

ORGANISATIONS

Institution of Mechanical Engineers

The Institution of Engineering and Technology

NOTES

ADVICE FOR DEBATING MATTERS

DEBATING MATTERS
TOPIC GUIDES
www.debatingmatters.com

FOR STUDENTS

READ EVERYTHING .....
In the Topic Guide and in the news - not just your side of the argument either.

STATISTICS ARE GOOD BUT.....
Your opponents will have their own too. They'll support your points but they aren't a substitute for them.

BE BOLD
Get straight to the point but don't rush into things: make sure you aren't falling back on earlier assertions because interpreting a debate too narrowly might show a lack of understanding or confidence.

DON'T BACK DOWN
Try to take your case to its logical conclusion before trying to seem 'balanced' - your ability to challenge fundamental principles will be rewarded - even if you personally disagree with your arguments.

DON'T PANIC
Never assume you've lost because every question is an opportunity to explain what you know. Don't try to answer every question but don't avoid the tough ones either.

FOR JUDGES

Judges are asked to consider whether students have been brave enough to address the difficult questions asked of them. Clever semantics might demonstrate an acrobatic mind but are also likely to hinder a serious discussion by changing the terms and parameters of the debate itself.

Whilst a team might demonstrate considerable knowledge and familiarity with the topic, evading difficult issues and failing to address the main substance of the debate misses the point of the competition. Judges are therefore encouraged to consider how far students have gone in defending their side of the motion, to what extent students have taken up the more challenging parts of the debate and how far the teams were able to respond to and challenge their opponents.

As one judge remarked *'These are not debates won simply by the rather technical rules of schools competitive debating. The challenge is to dig in to the real issues.'* This assessment seems to grasp the point and is worth bearing in mind when sitting on a judging panel.

FOR TEACHERS

Hoping to start a debating club? Looking for ways to give your debaters more experience? Debaitng Matters have have a wide range of resources to help develop a culture of debate in your school and many more Topic Guides like this one to bring out the best in your students. For these and details of how to enter a team for the Debating Matters Competition visit our website, **www.debatingmatters.com**

DEBATING MATTERS

TOPIC GUIDES

www.debatingmatters.com

"A COMPLEX WORLD REQUIRES THE CAPACITY TO MARSHALL CHALLENGING IDEAS AND ARGUMENTS"

LORD BOATENG, FORMER BRITISH HIGH COMMISSIONER TO SOUTH AFRICA

STUDENT DISCUSSION GROUP PROMPTS

Debating Matters discussion prompts

- Perceptions of engineering
    - "When you first started preparing for today's debate, what words would you have associated with engineering?" [encourage them to throw out words or simple phrases; or allow general discussion about perceptions of engineering]
    - "Following your research and preparation, are there new words you would now choose? Or words you now think are less suitable?" [encourage general discussion about whether/how perceptions of engineering changed]

- Qualities of engineers
    - "We're now going to look at a few traits and skills – I'd like you to say how relevant you think they are to engineering:
        - Creativity
        - Practical skills (making things)
        - Problem-solving
        - Scientific (physics/chemistry/maths) knowledge
        - Rebelliousness
        - Physical strength
        - Communication skills

- Promoting engineering
    - "Does your school promote engineering?"
    - "What could your school do to make engineering more appealing to those who would not normally consider it?"
    - "What specifically could be done to make engineering more appealing to under-represented groups such as girls?"

- Meeting society's needs
    - "What benefits do you think engineers provide to society?"
    - "How could they benefit society more in the future?"

STUDENT SURVEYS

Future of Engineering

1. Future of Engineering Research

The Institute of Ideas and the Institution of Mechanical Engineers have been running a Debating Matters competition based on topics related to engineers. We're interested in capturing the thoughts of young people about these topics and engineering more generally. It doesn't matter if you weren't involved in the competition – we're still interested in your views.

This questionnaire should take about 10 minutes to complete. It's totally confidential and there are no right or wrong answers.

1. Name

2. School/College

3. What is your current school year?

- ◯ Year 9 or S2
- ◯ Year 10 or S3
- ◯ Year 11 or S4
- ◯ Year 12 or S5
- ◯ Year 13 or S6

4. In which country is your school based?

- ◯ England
- ◯ Scotland
- ◯ Wales

5. Sex

- ◯ Male
- ◯ Female

Future of Engineering

2.

6. What subjects are you currently studying?

- ◯ Mostly STEM subjects (sciences, maths, design technology, computing)
- ◯ Mixed STEM and non-STEM
- ◯ No STEM

7. Are you considering studying engineering after school?

- ◯ Definitely
- ◯ Maybe
- ◯ Definitely not
- ◯ Don't know

Future of Engineering

3.

8. How well informed do you feel about what engineering is?

- ◯ Not well informed
- ◯ Quite well informed
- ◯ Well informed
- ◯ Expert

9. How important do you feel engineering is in the modern world?

- ◯ Not at all important
- ◯ Quite important
- ◯ Very important
- ◯ Essential
- ◯ I don't know

Future of Engineering

4.

10. Indicate the extent to which you agree or disagree with the following statements about engineering

	I totally agree	I largely agree	I agree to some extent	I disagree	I totally disagree	I don't know
Engineering is mainly about making things	◯	◯	◯	◯	◯	◯
Engineering is all around us.	◯	◯	◯	◯	◯	◯
Ethical and social questions aren’t very relevant to engineering	◯	◯	◯	◯	◯	◯
Solving problems is key to engineering	◯	◯	◯	◯	◯	◯
Engineers tend to work on their own	◯	◯	◯	◯	◯	◯
Engineering doesn’t do much for most people	◯	◯	◯	◯	◯	◯
Engineering careers are only suitable for those who are really good at maths and physics	◯	◯	◯	◯	◯	◯
Developing ideas is important in engineering	◯	◯	◯	◯	◯	◯
Engineers help to make the world a better place	◯	◯	◯	◯	◯	◯
Engineering is mainly about repairing or maintaining things	◯	◯	◯	◯	◯	◯
It’s natural that more boys than girls choose engineering	◯	◯	◯	◯	◯	◯
Engineers will shape the future more than politicians	◯	◯	◯	◯	◯	◯
Engineering isn’t that relevant to me	◯	◯	◯	◯	◯	◯
Engineering is the main cause of today’s environmental problems	◯	◯	◯	◯	◯	◯
Engineering makes a big contribution to modern medicine	◯	◯	◯	◯	◯	◯
We need environmentalists more than engineers’	◯	◯	◯	◯	◯	◯

Future of Engineering

5.

11. How important is each of the following for an engineer?

	Extremely important	Very important	Important	Slightly important	Not important at all	I don't know
Creativity	○	○	○	○	○	○
A sense of humour	○	○	○	○	○	○
Mathematical skills	○	○	○	○	○	○
Ability to work in teams	○	○	○	○	○	○
Empathy/listening skills	○	○	○	○	○	○
Being a rebel	○	○	○	○	○	○
The ability to solve problems	○	○	○	○	○	○
Practical skills	○	○	○	○	○	○
Being able to speak more than one language	○	○	○	○	○	○
Perseverance	○	○	○	○	○	○
Being a good communicator	○	○	○	○	○	○

Future of Engineering

6.

12. How much exposure do you have to engineering in your school?

- ○ None at all
- ○ Not much
- ○ Some
- ○ A lot

13. How much do you feel engineering featured in the first three years of your secondary education?

- ○ None at all
- ○ Not much
- ○ Some
- ○ A lot

Future of Engineering

7.

14. Relatively few women become engineers. Suggest possible reasons

	Strongly agree	Agree	Disagree	Strongly disagree	I'm not sure
There’s too much maths in engineering	◯	◯	◯	◯	◯
It’s is not a subject you can study at school	◯	◯	◯	◯	◯
There is lack of awareness of possible careers	◯	◯	◯	◯	◯
There's too much focus on machines and engines	◯	◯	◯	◯	◯
There is a lack of awareness of what engineers do	◯	◯	◯	◯	◯
The influence of family	◯	◯	◯	◯	◯
It’s seen as a boy’s thing	◯	◯	◯	◯	◯
Peer pressure	◯	◯	◯	◯	◯
It’s seen as too difficult	◯	◯	◯	◯	◯
It's about facts and not creativity	◯	◯	◯	◯	◯

Other (please specify)

Future of Engineering

8.

15. How effective do you think the following approaches would be at persuading more students, including girls, to study engineering?

	Highly effective	Fairly effective	Slightly effective	Not effective	Don't know
More positive role models	○	○	○	○	○
Communicating better how engineering affects everyday life	○	○	○	○	○
More visits by engineers to schools	○	○	○	○	○
More opportunities to visit modern clean engineering companies	○	○	○	○	○
More opportunities for group-based problem-solving projects	○	○	○	○	○
Providing students with online mentors working as engineers	○	○	○	○	○
Having more engineering-oriented activities in lessons during early secondary years	○	○	○	○	○
Raising awareness of engineering careers and how much engineers earn	○	○	○	○	○
Communicating better how engineers can make the world a better place	○	○	○	○	○
Teachers who have had experience of seeing or experiencing modern industry	○	○	○	○	○
More emphasis on the skills needed to be an engineer	○	○	○	○	○

What else do you think might persuade a greater range of students to study engineering?

16. How much of a contribution do you think engineers can make to the following challenges?

	A lot	A great deal	Some	Little	None
Reducing pollution	○	○	○	○	○
Earlier cancer detection	○	○	○	○	○
Developing safer cars	○	○	○	○	○
More efficient production of food	○	○	○	○	○
Producing new types of antibiotics	○	○	○	○	○
Improving quality of life in old age	○	○	○	○	○
Making buildings more likely to survive earthquakes	○	○	○	○	○
Protecting rainforests	○	○	○	○	○
Understanding more about the universe	○	○	○	○	○
Making our economy richer	○	○	○	○	○
Keeping premature babies alive	○	○	○	○	○

Future of Engineering

9.

17. Use the drop down to rank the following groups in order of their importance for shaping the future of our lives (1=Most important 9= least important)

- [ ] Teachers
- [ ] Lawyers
- [ ] Celebrities
- [ ] Engineers
- [ ] Doctors
- [ ] Politicians
- [ ] Religious leaders
- [ ] Actors
- [ ] Scientists

Future of Engineering

10.

18. What was your involvement in the Debating Matters*Future of Engineering* competition?

- ( ) I took part in the competition
- ( ) I contributed to the preparation for the team that took part in the competition
- ( ) I had no involvement in the competition

Future of Engineering

11.

19. How much did you enjoy the Debating Matters*Future of Engineering* competition?

- ( ) Not at all
- ( ) Not much
- ( ) Some
- ( ) A lot

20. To what extent did participating in Debating Matters *Future of Engineering* competition change how you feel about engineering?

- ◯ A lot
- ◯ Some
- ◯ Not much
- ◯ Not at all

21. To what extent did participating in Debating Matters *Future of Engineering* improve your understanding of what engineering is and what engineers do?

- ◯ A lot
- ◯ Some
- ◯ Not much
- ◯ Not at all

Future of Engineering

12.

22. How has it affected your views about engineering?

- ◯ More positive
- ◯ More negative
- ◯ No change

23. How has it changed the likelihood that you would consider a career in engineering?

- ◯ More likely
- ◯ Less likely
- ◯ No change

Future of Engineering

13.

During the debates, various arguments were put forward for and against each motion. Whether you were at the debate or not, state how strongly you agree with the following arguments

24. All vehicles should be automated

	Strongly agree	Agree	Disagree	Strongly disagree
Automation will make driving safer as there will be fewer driver errors	○	○	○	○
Technology can never be foolproof, which means there will still be accidents	○	○	○	○
Automation will allow more people, including old and disabled people, to enjoy transport freedom	○	○	○	○
Smarter driving will reduce emissions and be better for the environment	○	○	○	○
When accidents happen, working out who is to blame will be complex and cause problems	○	○	○	○
There will be chaos when only some traffic is automated	○	○	○	○

25. Do you support the motion:*All vehicles should be automated*?

- ○ Yes
- ○ No

Future of Engineering

14.

26. Technological progress will *not* solve society's environmental issues

	Strongly agree	Agree	Disagree	Strongly disagree
Technology will give us the tools and understanding we need to protect the environment	○	○	○	○
Technology contributes to problems by using up valuable resources	○	○	○	○
Politicians promote technology as it is easier than changing people's behaviour	○	○	○	○
Climate change problems are more likely to be solved by technology than politics or by changes in individual behaviour	○	○	○	○
Technology has a long history of solving humankind's problems	○	○	○	○
New technologies are expensive so not accessible to all countries	○	○	○	○
The claims for technology are never fulfilled	○	○	○	○

27. Do you support the motion: *Technological progress will not solve society's environmental issues*?

- ◯ Yes
- ◯ No

Future of Engineering

15.

28. The constant monitoring of our health does more harm than good

	Strongly agree	Agree	Disagree	Strongly disagree
Monitoring generates lots of data that can help doctors care for us better	◯	◯	◯	◯
Having more information encourages us to live a more healthy life	◯	◯	◯	◯
Constant monitoring just makes us anxious about our health	◯	◯	◯	◯
Technology helps patients take more control of their lives	◯	◯	◯	◯
There's little evidence that wearable devices do us any good	◯	◯	◯	◯
Monitoring makes life easier for doctors and the health service but doesn't really help patients	◯	◯	◯	◯

29. Do you support the motion: *The constant monitoring of our health does more harm than good*?

- ◯ Yes
- ◯ No

30. Engineers are born, not made

	Strongly agree	Agree	Disagree	Strongly disagree
Engineering skills are mainly inherited and not easily taught	○	○	○	○
Our education system should talent-spot young people with an aptitude for engineering early on, and focus on them	○	○	○	○
Engineering is as much about passion for the subject as well as skill& ability	○	○	○	○
If more young people could be made aware of engineering there wouldn't be a shortage of professional engineers and skilled technicians	○	○	○	○
Almost anyone could become an engineer, given the right opportunities and encouragement	○	○	○	○

31. Do you support the motion:*Engineers are born and not made?*

- ○ Yes
- ○ No

Future of Engineering

16.

Thank you for your response

Future of Engineering (ScotlandPre)

1. Future of Engineering Research

The Institute of Ideas and the Institution of Mechanical Engineers have been running a Debating Matters competition based on topics related to engineering. We're interested in capturing the thoughts of young people about these topics and engineering more generally.

This questionnaire should take about 10 minutes to complete. It's totally confidential but we will need you to give your name and school. There are no right or wrong answers.

1. Name

2. School/College

3. What is your current school year?

- ◯ S2
- ◯ S3
- ◯ S4
- ◯ S5
- ◯ S6
- ◯ other

4. Sex

- ◯ Male
- ◯ Female

Future of Engineering (ScotlandPre)

2.

5. What subjects are you currently studying?

- ◯ Mostly STEM subjects (sciences, maths, design technology, computing)
- ◯ Mixed STEM and non-STEM
- ◯ No STEM

6. Are you considering studying engineering after school?

- ◯ Definitely
- ◯ Maybe
- ◯ Definitely not
- ◯ Don't know

Future of Engineering (ScotlandPre)

3.

7. How well informed do you feel about what engineering is?

- ◯ Not well informed
- ◯ Quite well informed
- ◯ Well informed
- ◯ Expert

8. How important do you feel engineering is in the modern world?

- ◯ Not at all important
- ◯ Quite important
- ◯ Very important
- ◯ Essential
- ◯ I don't know

Future of Engineering (ScotlandPre)

4.

9. Indicate the extent to which you agree or disagree with the following statements about engineering

	I totally agree	I largely agree	I agree to some extent	I disagree	I totally disagree	I don't know
Engineering is mainly about making things	○	○	○	○	○	○
Engineering is all around us.	○	○	○	○	○	○
Ethical and social questions aren't very relevant to engineering	○	○	○	○	○	○
Solving problems is key to engineering	○	○	○	○	○	○
Engineers tend to work on their own	○	○	○	○	○	○
Engineering doesn't do much for most people	○	○	○	○	○	○
Engineering careers are only suitable for those who are really good at maths and physics	○	○	○	○	○	○
Developing ideas is important in engineering	○	○	○	○	○	○
Engineers help to make the world a better place	○	○	○	○	○	○
Engineering is mainly about repairing or maintaining things	○	○	○	○	○	○
It's natural that more boys than girls choose engineering	○	○	○	○	○	○
Engineers will shape the future more than politicians	○	○	○	○	○	○
Engineering isn't that relevant to me	○	○	○	○	○	○
Engineering is the main cause of today's environmental problems	○	○	○	○	○	○
Engineering makes a big contribution to modern medicine	○	○	○	○	○	○
We need environmentalists more than engineers'	○	○	○	○	○	○

Future of Engineering (ScotlandPre)

5.

10. How important is each of the following for an engineer?

	Extremely important	Very important	Important	Slightly important	Not important at all	I don't know
Creativity	○	○	○	○	○	○
A sense of humour	○	○	○	○	○	○
Mathematical skills	○	○	○	○	○	○
Ability to work in teams	○	○	○	○	○	○
Empathy/listening skills	○	○	○	○	○	○
Being a rebel	○	○	○	○	○	○
The ability to solve problems	○	○	○	○	○	○
Practical skills	○	○	○	○	○	○
Being able to speak more than one language	○	○	○	○	○	○
Perseverance	○	○	○	○	○	○
Being a good communicator	○	○	○	○	○	○

Institution of MECHANICAL ENGINEERS

INSTITUTE OF IDEAS DEBATING MATTERS COMPETITION

Future of Engineering (ScotlandPre)

6.

11. How much exposure do you have to engineering in your school?

- ○ None at all
- ○ Not much
- ○ Some
- ○ A lot

12. How much do you feel engineering featured in the first three years of your secondary education?

- ○ None at all
- ○ Not much
- ○ Some
- ○ A lot

Future of Engineering (ScotlandPre)

7.

13. Relatively few women become engineers. Suggest possible reasons

	Strongly agree	Agree	Disagree	Strongly disagree	I'm not sure
There's too much maths in engineering	◯	◯	◯	◯	◯
It's is not a subject you can study at school	◯	◯	◯	◯	◯
There is lack of awareness of possible careers	◯	◯	◯	◯	◯
There's too much focus on machines and engines	◯	◯	◯	◯	◯
There is a lack of awareness of what engineers do	◯	◯	◯	◯	◯
The influence of family	◯	◯	◯	◯	◯
It's seen as a boy's thing	◯	◯	◯	◯	◯
Peer pressure	◯	◯	◯	◯	◯
It's seen as too difficult	◯	◯	◯	◯	◯
It's about facts and not creativity	◯	◯	◯	◯	◯

Other (please specify)

Future of Engineering (ScotlandPre)

8.

14. How effective do you think the following approaches would be at persuading more students, including girls, to study engineering?

	Highly effective	Fairly effective	Slightly effective	Not effective	Don't know
More positive role models	○	○	○	○	○
Communicating better how engineering affects everyday life	○	○	○	○	○
More visits by engineers to schools	○	○	○	○	○
More opportunities to visit modern clean engineering companies	○	○	○	○	○
More opportunities for group-based problem-solving projects	○	○	○	○	○
Providing students with online mentors working as engineers	○	○	○	○	○
Having more engineering-oriented activities in lessons during early secondary years	○	○	○	○	○
Raising awareness of engineering careers and how much engineers earn	○	○	○	○	○
Communicating better how engineers can make the world a better place	○	○	○	○	○
Teachers who have had experience of seeing or experiencing modern industry	○	○	○	○	○
More emphasis on the skills needed to be an engineer	○	○	○	○	○

What else do you think might persuade a greater range of students to study engineering?

15. How much of a contribution do you think engineers can make to the following challenges?

	A lot	A great deal	Some	Little	None
Reducing pollution	○	○	○	○	○
Earlier cancer detection	○	○	○	○	○
Developing safer cars	○	○	○	○	○
More efficient production of food	○	○	○	○	○
Producing new types of antibiotics	○	○	○	○	○
Improving quality of life in old age	○	○	○	○	○
Making buildings more likely to survive earthquakes	○	○	○	○	○
Protecting rainforests	○	○	○	○	○
Understanding more about the universe	○	○	○	○	○
Making our economy richer	○	○	○	○	○
Keeping premature babies alive	○	○	○	○	○

Institution of MECHANICAL ENGINEERS

INSTITUTE OF IDEAS DEBATING MATTERS COMPETITION

Future of Engineering (ScotlandPre)

9.

16. Use the drop down to rank the following groups in order of their importance for shaping the future of our lives (1=Most important 9= least important)

- Teachers
- Lawyers
- Celebrities
- Engineers
- Doctors
- Politicians
- Religious leaders
- Actors
- Scientists

Future of Engineering (ScotlandPre)

10.

For the following questions state whether you support or don't support the statement

17. Do you support the view:*All vehicles should be automated*?

- Yes
- No

Future of Engineering (ScotlandPre)

11.

18. Do you support the view: *Technological progress will not solve society's environmental issues?*

- Yes
- No

Future of Engineering (ScotlandPre)

12.

19. Do you support the view: *The constant monitoring of our health does more harm than good?*

- Yes
- No

20. Do you support the view: *Engineers are born and not made?*

- Yes
- No

Future of Engineering (ScotlandPre)

13.

Thank you for your response