ENGINEERING ETHICS VISION 2028



A ten-year vision for embedding ethics in the UK engineering profession: **for consultation**.



Inter-Disciplinary Ethics Applied

UNIVERSITY OF LEEDS

The vision

Our vision is for an Engineering profession that demonstrably fulfils its fundamental duty, common to all professions, to serve the public interest.

To bring this about, the profession will need to focus on:

1. **Growing and strengthening the profession:** A significant expansion of the number of engineers who are within the scope of efforts to embed ethics in the profession, whether through registration, membership of a professional engineering institution or some other measure.
2. **Ethical Competence:** Much more widespread recognition by professional engineers that ethics is a fundamental part of their work, along with a significant improvement in their ability to recognise, analyse and respond effectively to ethical issues.
3. **Responsible Innovation:** Engineers need to recognise the extent to which new technological innovations (whether they be automated vehicles or geo-engineering) impact on society. As such, the profession must recognise its duty to communicate with the public and with policy-makers, and to alert society about the risks that may come with these technologies, as well as the benefits, to help ensure that society is prepared for these technologies, and to ensure (as far as possible) that we get the benefits with minimal risks.
4. **Sustainability and climate change:** Within ten years it is imperative that the profession's members and its institutions see much more clearly the centrality of their responsibility to work sustainably, including with regard to climate change, recognising engineering's historical and ongoing contribution to both some of the problems and potential solutions.

About the vision

Why publish a ten-year vision for embedding ethics in the UK engineering profession?

Engineers are at the forefront of a wide range of activities with deep and complex ethical implications. More than ever, as rapid advances in science and technology profoundly affect the way we live our lives, the decisions that engineers make impact not only their direct clients, but also the wider public. It is therefore more important than ever that engineers recognise this fact, work together to ensure that they are well-equipped to deal with the ethical issues they face, and work responsibly, with an eye to the broader implications of their work.

Significant progress has already been made within the profession, particularly over the last fifteen years, to define the ethical values underlying engineering work, and to motivate engineers to express these values in their work. The Royal Academy of Engineering (RAEng) established its working group on professional ethics in 2003. In 2005, the RAEng and the Engineering Council jointly published their Statement of Ethical Principles. This document broke new ground by demonstrating that there is a shared set of values which define ethical engineering work in all sectors. It also presented an important challenge to the sector by asking engineers not only to act with honesty and integrity, but also to engage with public opinion, informing the public on technical matters wherever possible but also taking proper account of concerns that the public may have about their work.

Between 2005 and 2011, the RAEng and the Engineering Professors' Council (EPC) established a Teaching Engineering Ethics Group (TEEG) to identify and share practices in the teaching of Engineering Ethics across UK Higher Education. The Inter-Disciplinary Ethics Applied (IDEA) Centre at the University of Leeds has been closely involved with both of these initiatives, publishing with RAEng a set of case studies under the title Engineering Ethics in Practice, designed to help engineers understand, interpret and apply the Statement of Ethical Principles in their work, and running workshops on teaching engineering ethics through TEEG.

Progress has also been made on the regulatory side, with ethics increasingly embedded in the UK Standard for Professional Engineering Competence (UK-SPEC), with 'exercise responsibilities in an ethical manner' listed among the standards of competence in the current version, along with a focus on ethical issues such as safety, sustainability and risk. In addition, some professional engineering institutions (PEIs) now offer ethics training for engineers wishing to address ethics in their continuing professional development (CPD). Similarly, in education, engineering degrees accredited by the Engineering Council must also include coverage of the 'economic, legal, social, ethical and environmental context' (UK-SPEC) of engineering work.

Despite this progress, it is clear that much still needs to be done to strengthen the profession, to enable it to fulfil its fundamental duty to serve the public interest. John Uff's 2016 report into the engineering profession in the UK estimates that less than 15% of engineers are registered. Speaking at the National Engineering Ethics conference in 2018, John Uff emphasised the fact that the profession has no way to monitor what CPD activities (if any) the unregistered engineers are undertaking. In addition, Uff's 2016 report also stated: "while the title [Chartered Engineer] is protected there is no requirement for persons undertaking engineering work in the UK to be registered, subject to very limited exceptions." The significance and implications of these three serious concerns were highlighted by the Grenfell Tower disaster in 2017, and by Dame Judith Hackitt's report into building regulations and fire safety in 2018. Hackitt identified "a lack of skills, knowledge and experience and a lack of any formal process for assuring the skills of those engaged at every stage of the life cycle of higher risk residential buildings (HRRBs) as a major flaw in the current regulatory system", and emphasised the importance of CPD, particularly in relation to fire safety. But, as Uff emphasised, a profession cannot monitor the CPD of those engineers who are not registered. Like Uff, Hackitt also emphasised the fact that there is often no requirements for an engineer to be registered. Contrasting the UK with other countries, Hackitt's report stated: "In other parts of the world, those engaged to work on more complex buildings require a higher degree of competence and expertise – for example through certification and accreditation – than that required for work on small-scale or simple buildings." This focus on Grenfell Tower and Hackitt's 2018 report is not intended to suggest that the ethical issues highlighted here are specific to this disaster, or to this specific area of engineering. On the contrary, the Grenfell Tower is presented here as an example, to emphasise the serious consequences of these flaws in the profession and in engineering practice, but the flaws themselves (1 – the number of engineers who are not registered, 2 – the resulting difficulty in monitoring CPD, and 3 – the lack of restrictions for non-registered engineers) were raised by John Uff before the Grenfell Tower disaster, and were raised as challenges for engineering in general, not specifically for engineering in the context of high-rise and complex buildings.

In addition, in education, while all accredited degrees must include some ethics coverage, in practice the amount of coverage varies considerably, and teaching rarely includes specialist ethicist input. Engineering academics who may not have been taught ethics themselves, and who may not see it as a core subject, may therefore lack the skills and

knowledge to teach ethics with maximum effectiveness. Engineers who enter the profession without a specialist engineering degree, meanwhile, may receive no education in ethics at all, and may not cover ethical issues in their CPD.

The next ten years will also be critical in efforts to tackle man-made climate change, and it is imperative that engineers recognise their personal responsibilities in this respect. Indeed, the ethical challenges that the engineering profession will need to meet are many and various, and there are many practical steps that can be taken to improve its ability to meet them.

How the vision was developed

This ten-year vision for embedding ethics in the UK engineering profession has been developed by the IDEA Centre at the University of Leeds.

It is the IDEA Centre's vision, but its development has been strongly informed by the National Engineering Ethics conference, hosted by IDEA in 2018. This event, and the idea of developing a vision for embedding ethics in the UK engineering profession, were supported by the Engineering Council, the Royal Academy of Engineering, the Engineering Professors' Council and Engineers Without Borders UK. Nevertheless, the vision itself has been produced by IDEA, and does not necessarily reflect the views of the aforementioned institutions. We first identified a set of themes from discussions at that conference and surrounding it, for example on Twitter and through the Padlet app which was used to support the conference. We then crystallised these themes into the vision itself, and a set of suggestions for how the vision should be achieved, which are presented in the final section below.

Explanation of each heading

The public interest

The suggested goals and actions here are wide-ranging, but united by a single ultimate aim: to create a profession which is better able to fulfil its duty, common to all professions, to serve the public interest.

This duty is fundamental in defining what is ethical in the activities of the profession and its members.

That serving the public interest should be a central aim of a profession is a widely accepted tenet of professional ethics, and is also written into the Royal Charter granted to some professional bodies. That the public interest should be at the heart of efforts to reform the profession was also an idea frequently expressed at the conference, notably in the presentation by Dr Rob Lawlor, in which this aim was contrasted with the aim of improving the profession's status, which appears to drive some other efforts at reform. While improving the status of engineers may be desirable for other reasons, we believe efforts to embed ethics in the profession should have serving the public interest at their heart.

It is not always readily apparent what is in the public interest, and one element of ethical competence (see below) is the ability to think sophisticatedly about the public interest, for example disentangling conflicting options all of which may appear to be in the public interest.

Growing and strengthening the profession

The vision emphasises the importance of increasing the number of engineers who are within the boundaries of the profession.

The reason for this is simple: since only a small proportion of UK engineers are currently in this position, the majority of engineers are currently outside the scope of the profession's effort to improve and maintain their competence, or to engage them in the work of PEIs, the RAEng, etc., which include public engagement on ethical issues and efforts to make engineering work sustainable.

The centrality of this issue was recognised by Professor John Uff QC, who stated in his 2016 review of the engineering profession that the PEIs 'should… take urgent steps to bring in up to three million "engineers" who currently have no formal affiliation with the profession. The PEIs, with the support of EngineeringUK and Engineering Council, should mount a vigorous campaign to identify and inform by all possible means the "missing" engineers and to offer a form of membership at modest cost. Depending on levels of expertise, such members can then be offered opportunities to become registered.' Elsewhere, Professor Uff noted that,

'Whilst it is less surprising that Chartered engineers represent only 5% of the engineering community, it is of the greatest significance that membership of the PEIs (including non-registered members) represent only about 15% of that community.'

We believe that professional registration is the most effective way of ensuring the competence and conduct of those working in engineering

roles. This belief appears to have been common among delegates at the conference. For example, asked through a show of hands who would support compulsory registration 'at least for some roles', a clear majority indicated assent.

On the other hand, there may be other approaches, short of requiring engineers to be registered before they can practise. One such approach could be to automatically enrol engineers in a professional body at the point of graduation. Another could be to require engineers in critical roles to demonstrate that they are responsible persons. To do this, they

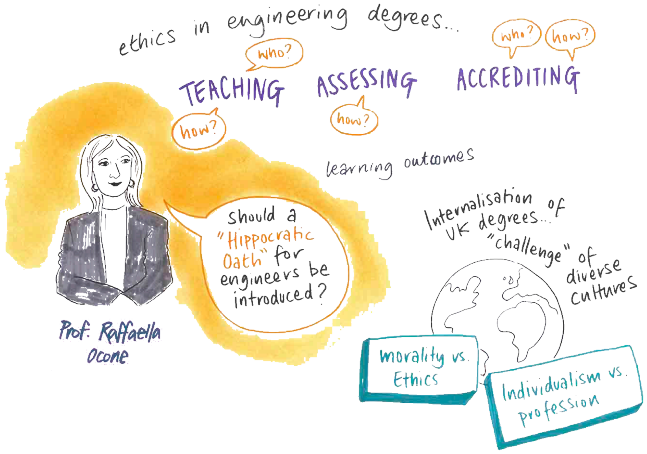
would need to have received adequate training, including in ethics. This could be monitored through a system of certification outside the direct purview of PEIs, though PEI membership could provide one route to achieving it. An interesting comparison here is the 'Senior Managers and Certification' regulatory regime which has recently been introduced in the UK banking industry.

We recognise that PEIs are already focused on increasing their membership, and that there are considerable barriers to overcome before this can be achieved. We believe, though, that success in achieving this is critical to the ethical effectiveness of the profession. This should be a focus not only for PEIs themselves but for anyone with an interest in the ethics of the profession.

Ethical competence

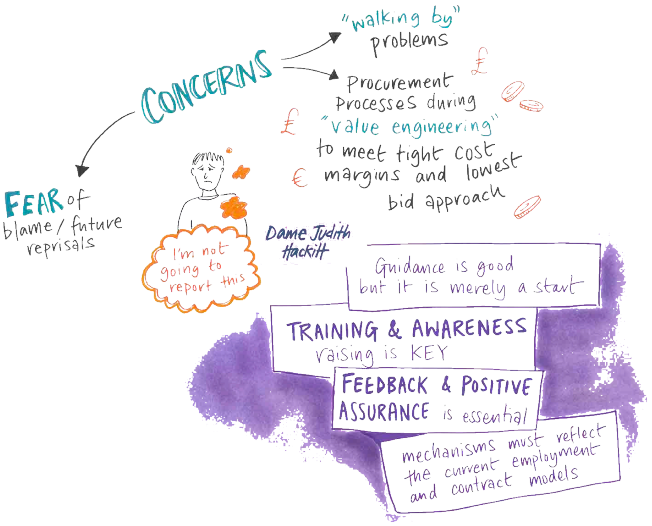
Ethical competence stands for the set of qualities which, together, enable professionals to recognise, analyse and respond effectively to ethical issues.

These qualities include knowledge and understanding of ethical principles, but also the ability to apply these flexibly in a range of situations. That the level of ethical competence in the profession still needs to be increased is an idea that was frequently expressed at the conference. For example, one commentator on the Padlet app stated that 'engineers are not well equipped to translate ethical principles into day to day problems.' In his keynote speech, Professor Chris Atkin questioned engineers' 'ethical awareness' and suggested ways in which this could be improved. In the panel on education, there was much discussion of how ethics teaching can be used to instil desirable qualities in student engineers, including ethical awareness and reasoning skills, but also the motivation that comes from seeing your work as having an ethical dimension at all.



While ethics coverage is now a compulsory part of engineering education at HE level – a significant achievement – the view of many conference delegates was that the quality of this coverage may be variable. In particular, much ethics teaching is done by engineering academics who may not have studied ethics themselves, may not see it as a core subject, and generally may not be well equipped to teach ethics with optimal effectiveness. We suggest that the increased involvement of specialist ethicists – as teachers, as consultants, and as part of the team which reviews curricula for accreditation – is the most effective way of bringing about improvements in this area.

As well as being able to tackle ethical issues as individuals, it is essential that professional engineers feel able and willing to speak out on ethical issues within their organisations. For this to be the case it takes more than individual qualities of competence and confidence. It also requires that organisations have the kind of culture that responds positively to challenge. It also requires institutions to support professional engineers in taking action.



As one delegate put it in a post in the Padlet app:
'Of equal importance I consider to be how to enable engineers (through codes of ethics, through training) to pursue what is ethical, given they are part of organizational/workplace structures with inherent imbalance of power, in light of the risk of retaliation. Empirical studies showed how much the personal and professional life suffers in the case of whistleblowers in the engineering sectors. Thus university education, professional associations, codes of ethics should focus attention also on how to prepare /enable engineers to challenge and change unethical structures they are part of. As it is, the focus is solely on how to "instil" the correct ethical judgement and develop ethical character, putting into brackets that professional engineers are part of wider, more powerful structures, and that even if they indeed recognize what is the right thing to do, they might not be able to act according to their character and their judgment.'

One particular issue that highlights the problem mentioned above is the issue of engineers failing to raise concerns even when they know that problems exist. By its very nature, this has never been the sole cause of an engineering disaster. However, it has been a contributing factor in countless cases, including for example the Grenfell Tower tragedy and Deep Water Horizon oil spill. Dame Judith Hackitt discussed this in relation to Grenfell Tower at the conference, stating that many engineers who were interviewed admitted that they knew that problems existed, but were either unable or unwilling to come forward with their concerns until it was too late.

On the other hand, it should be acknowledged that other sectors of engineering appear to have more effective ethical cultures, and aerospace

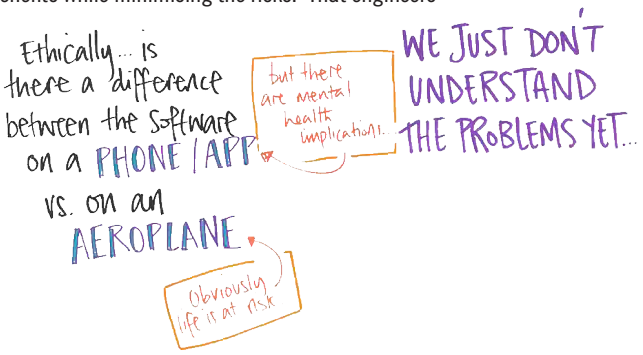
and nuclear were both praised in this way by some delegates at the conference. The aim here, then, should be to spread good practice from areas where it already exists to areas where it does not.

Responsible innovation

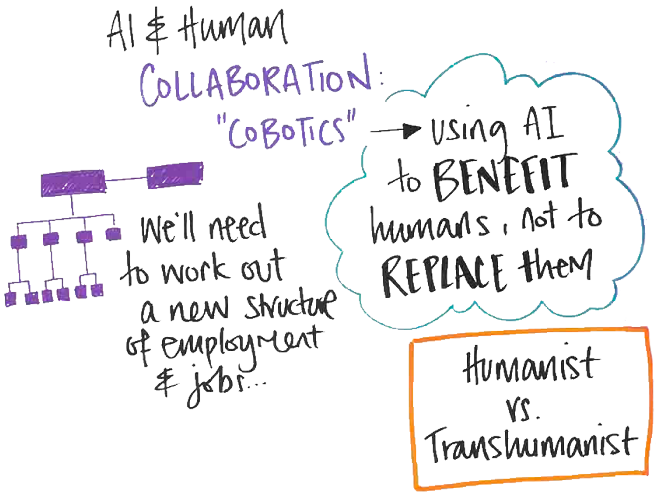
There are numerous areas of innovation which pose ethical issues for society. Some of these that were discussed in depth at the conference included AI and automation, big data, cyber-security, and human augmentation/transhumanism.

All of these areas have advanced quickly in recent years and are likely to continue to advance quickly over at least the next ten years.

Engineers are at the heart of technical innovation, uniquely placed to understand the issues, to inform the public about them, to listen to public concerns and to work with others to put in place measures to maximise the benefits while minimising the risks. That engineers



need to act responsibly in leading innovation, not only making ethical decisions but also engaging with and taking account of public opinion, is not a new idea. It is in line with the principle of Leadership and Communication from the RAEng and the Engineering Council's Statement of Ethical Principles, and there is no doubt that much good has been done by those bodies, as well as PEIs, in this area.



At the conference, too, the level of discussion of the ethical issues raised by those areas of innovation listed above was impressive and illuminating. However, it remains the case that the public as a whole is underinformed about the ethical issues raised by many of these new technologies. Engineers are not the only group with a responsibility to inform the public, but they must surely play a central role.

Truly responsible innovation requires the involvement and buy-in of the engineers who are making decisions, day-to-day, that affect the outcomes of new technology and its use. It also requires that those engineers, supported by PEIs, see it as part of their job to work with other disciplines and actors to inform and improve the quality of the public debate.

Sustainability and climate change

Sustainability is of course a central ethical concern for engineers, because their work both impacts profoundly on the environment, and can be at the centre of efforts to mitigate this impact.

Sara Parkin OBE

In particular, engineers are involved in many if not all of the areas of activity which contribute most to climate change, and are also uniquely placed to develop those technologies which are a necessary part of the solution.

IF YOU'RE NOT WORKING FOR A SUSTAINABLE FUTURE FOR ALL LIFE ON EARTH... WHAT ARE YOU WORKING FOR??

For the profession to act effectively on this issue requires that engineers develop a consensus that they have a professional responsibility to take account of climate change in their work. As thought-leaders in the profession, the RAEng and PEIs must lead the way here. As one conference delegate stated, 'The RAEng and other PEI's [sic] should be clear on their position about engineering practices that hurt our atmosphere and our health (e.g. shale fracking and all new fossil fuel extraction methods).

It is hard to see Industry being steered away from profit-making ventures without very strict regulations on their behaviour.'

Climate change is and should be a central concern for engineers, but it is of course not the only environmental issue that we face. Another example of a sustainability issue on which engineers have the potential to lead the way is plastic pollution, including single-use and non-recyclable plastics.

TIME & EXPERIENCE allows professionals to gain a more ETHICAL INSIGHT

(as a young professional, it's easy to assume that ethics is "someone else's problem")

THE "TEACHING OF ETHICS"

Table of goals, enablers and barriers

In this final section of the document we present a set of subsidiary goals which will help deliver the vision, measures which different stakeholder groups might take to achieve these goals, and potential barriers which might stand in the way of their achievement.

As with the vision itself, these draw to a great extent on the views that were expressed during the conference, though we present them here as our own view, without claiming that they are widely endorsed within the profession as a whole (something that would require extensive consultation to establish). Our aim here is to provoke debate but also action within the profession. The enablers in particular are closer to the level of practical action than the other ideas expressed in this document, but still leave considerable leeway to the bodies and organisations involved in deciding how to implement them, or to offer alternative ways of achieving the same aims.

"STOP FOR ECOLOGY"...

BUT "SHOP FOR ECONOMY"...

Fewer people consuming less stuff...

Focusing activity towards achieving the vision

The tables below set out enablers (which include activities, attitudes, modes of working etc.) and barriers to the achievement of the vision. The aim of these is to give more specific challenges and areas of focus for the various stakeholder groups whose commitment will be essential to the successful embedding of ethics in the profession over the next ten years and beyond.

There is a table setting out enablers for each stakeholder group (tables 2-6) and two tables which apply to all stakeholder groups:
- Overall purpose of the vision (table 1)
- Barriers to achieving the vision (table 7)

While each stakeholder group has a specific table, members of each stakeholder group may be interested in the other tables too.

Some of the most effective and committed agents of change in the engineering sector are those sector-wide bodies that have a campaigning, lobbying or otherwise influencing role (e.g. Engineers Without Borders UK; Engineering UK; Engineering Employers Federation (EEF)). As these bodies have different areas of focus, we have not included a table which seeks to capture them all. Instead, we encourage their representatives to consider all of the enablers below, perhaps focusing on those that are most relevant to their area of activity.

Table 1: Overall purpose of the vision

<table>
<tr><th colspan="6">An Engineering profession that demonstrably fulfils its fundamental purpose of serving the public interest.</th></tr>
<tr><td rowspan="2">Growing and strengthening the profession: A significant expansion of the number of engineers who are within the scope of efforts to embed ethics in the profession.</td><td colspan="3">Ethical Competence: Much more widespread recognition by professional engineers that ethics is a fundamental part of their work, along with a significant improvement in their ability to recognise, analyse and respond effectively to ethical issues.</td><td colspan="2">Responsible Innovation: Engineers need to recognise the extent to which new technological innovations (for example, automated vehicles or geo-engineering) impact on society. As such, the profession must recognise its duty to communicate with the public and with policy-makers, and to alert society about the risks that may come with these technologies, as well as the benefits, to help ensure that society is prepared for these technologies, and to ensure (as far as possible) that we get the benefits with minimal risks.</td><td rowspan="2">Sustainability and climate change: Within ten years it is imperative that the profession's members see much more clearly the centrality of their responsibility to work sustainably, including with regard to climate change, recognising engineering's historical and ongoing contribution to both some of the problems and potential solutions.</td></tr>
<tr><td>Through education and CPD, prepare engineers to serve the public interest.</td><td>Promoting concern about ethical issues.</td><td>Empowering professional engineers to raise concerns.</td><td>Recognising ethical issues, contributing to public awareness and understanding, and articulating fruitful responses in time for these to be implemented.</td><td>Giving ethical issues due weight, alongside technical and commercial issues, when making decisions.</td></tr>
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Table 2: Oversight bodies (e.g. Engineering Council, Royal Academy of Engineering)

ELEMENTS OF THE VISION	ENABLERS
Growing and strengthening the profession	A review of options for greatly increasing the number of engineers who are fully-fledged professionals. Ensuring that work which is critical in terms of its impact on the public can only be done by an engineer who has been certified as technically and ethically competent. Options could include: - Arguing for the creation of reserved roles or activities in critical areas, for which registration is mandatory - Making professional registration automatic at graduation from an accredited course - Seeking the creation of an accreditation scheme outside the purview of PEIs
Ethical Competence: Through education and CPD, prepare engineers to serve the public interest	Demanding high standards of ethics provision in curricula. Including ethicists on accreditation boards. Emphasise that registration and CPD are primarily about serving the public interest, and that this should take priority over the career benefits they provide to individual engineers and the status benefits they provide for the profession.
Ethical Competence: Promoting concern about ethical issues.	Seeking consultation on the creation of an 'oath' or ceremony for those entering the profession, similar to the Canadian 'iron ring' ceremony.
Ethical Competence: Empowering professional engineers to raise concerns.	Continuing to review guidance and support for whistleblowers in the engineering profession. Carrying out and publishing research into whistleblowing cases and their outcomes.
Responsible Innovation: Recognising ethical issues, contributing to public awareness and understanding, and articulating fruitful responses in time for these to be implemented.	Coordinating thought leadership discussions to articulate responses to ethical issues on behalf of the profession, leading public engagement.
Responsible Innovation: Giving ethical issues due weight, alongside technical and commercial issues, when making decisions.	Working with PEIs to identify and share best practice on helping engineers to learn from their mistakes.
Sustainability and climate change	Developing on behalf of the profession a clear position statement on the responsibilities of engineers regarding climate change.

Table 3: Professional Engineering Institutions (PEIs)

ELEMENTS OF THE VISION	ENABLERS
Growing and strengthening the profession	Reinforcing the focus on membership as a means to protect and serve the public as well as a value proposition for members.
Ethical Competence: Through education and CPD, prepare engineers to serve the public interest.	CPD, codes of practice and guidance that recognise the diversity of engineering roles, and the propensity for engineers to work outside of traditional areas of practice. Innovative online ethics training that engages learners, is genuinely interactive and incorporates peer-to-peer discussion where possible. Emphasise that registration and CPD are primarily about serving the public interest, and that this should take priority over the career benefits they provide to individual engineers and the status benefits they provide for the profession. Communicating with educators to link CPD content to qualification curricula. Measuring the effectiveness of CPD.
Ethical Competence: Promoting concern about ethical issues.	Through training, advice and guidance, encouraging members to see the common underlying values which define ethical conduct, whether in personal or professional life.
Ethical Competence: Empowering professional engineers to raise concerns.	Providing advice, guidance and support for engineers who wish to raise concerns outside of their employing organisation. Publishing whistleblowing cases where possible. Working with employers to share best practice on whistleblowing.
Responsible Innovation: Recognising ethical issues, contributing to public awareness and understanding, and articulating fruitful responses in time for these to be implemented.	Working with industry bodies on thought leadership activities, e.g. putting out guidelines and official statements.
Responsible Innovation: Giving ethical issues due weight, alongside technical and commercial issues, when making decisions.	Helping engineers with ethical issues within more finely-grained practice areas. This could include advice and guidance, and training in ethical reasoning. Working with industry bodies to identify and share best practice on helping engineers to learn from their mistakes.
Sustainability and climate change	Through advice, guidance and position statements, helping their members to apply high level principles regarding the environment and climate change in their area of practice.

Table 4: Firms

ELEMENTS OF THE VISION	ENABLERS
Growing and strengthening the profession	Demonstrating that professional status is valued. Requiring employees, particularly those whose work critically impacts on the public, to be professionally registered.
Ethical Competence: Through education and CPD, prepare engineers to serve the public interest.	Involving engineers at all levels of experience in ethical discussions, ethics training and ethical decision-making. Engineers at later career stages have more experience to draw on but are less likely to have undergone any ethics training. Engineers at different career stages can learn from each other. Sharing best practice in in-house CPD, both face-to-face and online, with other firms. Committing to allow employees money and time for CPD.
Ethical Competence: Promoting concern about ethical issues.	Promoting open cultures of decision review within their industry. Seeking to learn from previous successes and mistakes. Being clear about boundaries of responsibility for individuals, in line with their responsibility to act within competence as set out in the Statement of Ethical Principles.
Ethical Competence: Empowering professional engineers to raise concerns.	Active encouragement and support for engineers to speak their minds on ethical issues. Actively seeking challenge from people throughout the firm. Being clear about reporting lines within firms and instituting clear whistleblowing procedures.
Responsible Innovation: Recognising ethical issues, contributing to public awareness and understanding, and articulating fruitful responses in time for these to be implemented.	Committing to seeing ethics, not as a PR exercise or a market differentiator, but as a fundamental element of all engineering work. Engaging with PEIs and other bodies to enable industry-wide engagement with ethical issues.
Responsible Innovation: Giving ethical issues due weight, alongside technical and commercial issues, when making decisions.	Creating a respectful and supportive environment for robust debate amongst peers about ethical issues relating to their work. Forming ethics groups within firms. Using these to build ethical review and challenge into the project life cycle, and also as a source of informal advice and discussion of ethical issues. Instituting robust peer-review processes for decisions with ethical repercussions including but not limited to procurement decisions.
Sustainability and climate change	Embedding sustainability concerns throughout the decision-making practice of the firm, including in design decisions, strategic decisions, investment decisions, etc. Participating, and encouraging clients to participate, in voluntary sustainability standards.

Table 5: Educators

ELEMENTS OF THE VISION	ENABLERS
Growing and strengthening the profession	Greater engagement with 1) ethicists and 2) engineering practitioners to improve the sophistication and effectiveness of ethics teaching. Creating a network to achieve this on a national scale.
Ethical Competence: Through education and CPD, prepare engineers to serve the public interest	Approaches to assessment that assess engineers' ethical awareness, reasoning skills and responsiveness to situations, e.g. 'situational judgement tests', in which students are tested on their responses to unfolding situations. Where case studies are used, using them in a sophisticated way, encouraging reflection and linked to 'big picture' understanding – extracting the underlying principles. Also incorporating perspective-taking exercises to broaden engineers' understanding of ethical issues.
Ethical Competence: Promoting concern about ethical issues.	Ethics teaching that emphasises the continuity between personal and professional ethics, and the common values underlying all ethical issues.
Ethical Competence: Empowering professional engineers to raise concerns.	Addressing psychology as well as ethics, to prepare engineers to navigate the structures of power and authority in which they will operate within firms.
Responsible Innovation: Recognising ethical issues, contributing to public awareness and understanding, and articulating fruitful responses in time for these to be implemented.	Engaging with practising engineers to identify novel ethical challenges, and with ethicists to effectively analyse these.
Responsible Innovation: Giving ethical issues due weight, alongside technical and commercial issues, when making decisions.	Using the classroom to create a space for open debate and challenge amongst peers. Ethics embedded throughout the curriculum, both in HEIs and technical colleges. But not just as a tick in a box; encouraging active reflection on issues as they arise. Using the classroom to create a space for debate among peers, emphasising the importance of articulating and defending views in a collegial atmosphere of open debate.
Sustainability and climate change	Embedding materials on sustainability, including climate change, throughout curricula.

Table 6: Individual engineers and future engineers

ELEMENTS OF THE VISION	ENABLERS
Growing and strengthening the profession	Registering as a professional engineer, and thereby committing to professionalism as a vocation with the public interest at its heart. Emphasising the importance of professionalism within your organisation.
Ethical Competence: Through education and CPD, prepare engineers to serve the public interest.	Taking responsibility for your own professional formation and CPD, and that of colleagues. Prioritising CPD activities that enable you to serve the public interest.
Ethical Competence: Promoting concern about ethical issues.	Resisting compartmentalisation of ethical vs 'non-ethical' areas of life. Knowing and complying with the code of conduct. Working with colleagues to encourage 'ethics talk' within your company.
Ethical Competence: Empowering professional engineers to raise concerns.	Willingness to challenge and 'call out' colleagues, and an openness to being challenged yourself.
Responsible Innovation: Recognising ethical issues, contributing to public awareness and understanding, and articulating fruitful responses in time for these to be implemented.	Actively engaging with the professional body and fellow professionals. Joining in the debate on ethical issues and sharing your experiences as a way to illuminate these.
Responsible Innovation: Giving ethical issues due weight, alongside technical and commercial issues, when making decisions.	Seeing ethics not as a 'bolt-on', or even a 'soft skill', but as a set of robust considerations whose importance and validity is not less than that of technical and commercial considerations.
Sustainability and climate change	Educating yourself about sustainability issues including climate change and how the engineering industry contributes to them. Lobbying for cleaner, more sustainable practice within your industry.

Table 7: Barriers to achieving the vision

ELEMENTS OF THE VISION	BARRIERS
Growing and strengthening the profession	Barriers to growth and strengthening of the profession may include cultural factors, e.g. that newly qualified engineers may be less likely to see the value of belonging to a PEI. Another factor may be the increasing number of engineers in highly specialised roles which do not require, or are not perceived to require, a broad-based professional education and CPD. Another factor may be that companies do not see professional registration or PEI membership as essential prerequisites for employment.
Ethical Competence: Through education and CPD, prepare engineers to serve the public interest.	While compulsory ethics in university curricula is a significant advance here, the level of coverage, and quality of teaching, appears still to be somewhat inconsistent. A significant barrier here is the potential for engineering academics to struggle with subject matter that is outside their comfort zone. The lack of coverage outside HE is another potential barrier.
Ethical Competence: Promoting concern about ethical issues.	Barriers to attaining this goal may be partly cultural. Many engineers are still acclimatised to seeing their work as 'purely technical', and to compartmentalising their lives, so that their personal values and ethics are seen as occupying a separate space from the technical aspects of their work. A tendency to badge ethics as a separate 'soft skill' to be learned alongside technical skills may have exacerbated this problem. Another barrier here may be engineers' tendency to see themselves as having duties primarily to their employers, rather than to the public.
Ethical Competence: Empowering professional engineers to raise concerns.	Barriers here include those present in any sector: excessive or misconstrued loyalty to one's employer and one's colleagues, the desire on the part of firms to avoid negative publicity, the potential for retaliation against those who call out bad behaviour. There can also be cultural barriers which prevent less formal challenge and critique, making it less likely that this will be either expressed, or received, constructively.
Responsible Innovation: Recognising ethical issues, contributing to public awareness and understanding, and articulating fruitful responses in time for these to be implemented.	The natural tendency of engineering firms to maintain secrecy for competitive advantage can be a barrier here, particularly when firms see ethics itself as something to compete on. Fully understanding complex ethical issues depends on the sharing of experiences, and efforts to earn the public's trust are most effective at a sectoral level.
Responsible Innovation: Giving ethical issues due weight, alongside technical and commercial issues, when making decisions.	Ethical questions are not like technical engineering questions. It may not be that everyone can, or even ought to be able to, agree on an answer. Where individuals are not used to dealing with such issues, this can lead to them not being tackled effectively, as though they are 'merely a matter of opinion' and therefore not susceptible to rigorous analysis and debate.
Sustainability and climate change	The barriers to effective action on sustainability are multiple and varied. In the engineering profession, there may be a lack of recognition of engineering's unique position as both an enabler and a potential creator of solutions to climate change.

The vision consultation forms for organisations and individuals to complete can be downloaded from the vision website:
www.leeds.ac.uk/engethics2028.

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