



UK Engineering 2016

An Independent review led by Prof John Uff CBE, QC, FREng





Contents

- Preface to the report 2
- Executive summary of conclusions 5
 - A. Introduction and approach to review 11
 - B. Future requirements for professional engineers and technicians – evidence and submissions 19
 - C. Existing arrangements for delivery of required numbers of engineers and technicians – evidence and submissions 25
 - D. UK engineering and its governance – evidence and submissions 35
 - E. Funding matters – evidence and submissions 47
 - F. Other governance models – evidence and submissions 49
 - G. Lessons from similar initiatives – evidence and submissions 51
 - H. Conclusions proposed by consultees 55
 - I. Reply/response submissions – form consultees 57
 - J. Discussion and conclusions 61
 - K. Responses to terms of reference 75
 - L. Recommendations 81

- ANNEXES
 - Annex 1 84
 - Annex 2 91
 - Annex 3 101
 - Annex 4 103
 - Annex 5 104

Preface to the report



Prof John Uff CBE, QC, FREng
February 2017

The commissioning of this review was preceded by a lengthy period of debate between the principal players aimed at achieving a degree of reform and re-organisation with the objective of providing better service to the membership of the many Professional Engineering Institutions and to the UK public, whether as engineering clients, as prospective members of the profession or as the majority whose livelihood is affected by the performance of this major sector of the UK economy.

While I have not been privy to this debate, what has become apparent is its broad outline as well as its evident failure to achieve meaningful progress; and that this was the reason for the three leading PEIs, representing 70% of UK professional engineers, taking the decision in early 2016 to launch this Review. It is no co-incidence that the report should have been commissioned by the PEIs, which themselves play a critical part in supporting national economic growth, employment and enhancing industrial productivity, while recognising the need to pursue, like the industries they serve, a leaner, more efficient and progressive organisation. The Terms of Reference encompass a very wide range of issues but at their heart is the question how should the UK engineering profession as a whole be better and more effectively organised for what will shortly be the third century of its existence. As narrated in the introductory section, the short timescale of the Review dictated a written procedure without the luxury of either oral evidence or professionally presented cases. The numbers of bodies and of individuals invited to contribute to the Review had also to be on a limited scale. But I am satisfied that those who did contribute were representative of the full range of views and interests within the engineering community and also of the public interest. Furthermore, following precedent in the conduct of public inquiries, those bodies whose interests were most closely affected by potential

recommendations in the Report were enabled to review all the written material submitted and to comment on it; and were then shown a draft of the conclusions of the Review to which they were able to respond, both in writing and orally in a series of meetings. I can therefore conclude that the Review, while conducted on a very short programme, was carried out in an open and fair manner. I can also assure those potentially affected by the recommendations that the review has been carried out independent of any of the participants.

The Report addresses the question, asked by many, will anything happen as a result of this latest review of the engineering profession? The fact that the draft conclusions were addressed by the major players and their views taken into account is one hopeful sign. There have been earlier initiatives directed particularly at the PEIs which are reviewed in the Report. But the Report is addressed not to a few PEIs, rather to the whole of the UK's engineering profession which has indeed in its responses demonstrated a sense of community and a realisation that collective action in the interests of both the profession and the country as a whole is possible.

In conducting the Review and preparing the report I have benefitted from the administrative support of the three commissioning PEIs, substantially through their CEOs and with the guidance of their three Presidents. The nature of Institutions is such that the three Presidents at the time of commissioning the review are no longer in office at the time of the Report and I am therefore grateful to their three successors for continuing their support of the Review to its conclusion. The three CEOs remain in post as does James Taylor of the ICE who has acted as the tireless secretary to the Review, ensuring that all messages were answered and that either transparency or confidentiality, as required, was appropriately maintained.

JOHN UFF CBE QC FREng

15 ESSEX STREET
LONDON WC2R 3AU
Tel. 44 (0)20 7544 2600
juff@keatingchambers.com

24 November 2016

Gentlemen,

INDEPENDENT REVIEW OF UK PROFESSIONAL ENGINEERING

By your letter of 29th March 2016 you appointed me, on behalf of the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Institution of Engineering and Technology, to conduct an Independent Review of the profession of engineering in the UK and to prepare a Report in accordance with attached Terms of Reference, the Report to be delivered by November 2016.

As agreed with you, evidence and submissions on the Terms of Reference have been solicited from a wide range of interested individuals and bodies. Views have also been provided by the Reference Group to whom preliminary findings have been submitted for review. The preliminary findings have been considered by the Sponsor Group comprising the three Commissioning Institutions and by EngineeringUK, Engineering Council and the Royal Academy of Engineering and their views taken into account.

I now have the honour to present my Report and trust that this will be received by the whole profession as a positive step towards achieving the changes and developments needed to make the profession fit for purpose into the 21st century.

Yours sincerely

John Uff

Nick Baveystock, CEO, ICE

Stephen Tetlow, CEO, IMechE

Nigel Fine, CEO, IET

PROF JOHN UFF CBE, QC, FREng

John Uff originally trained as a civil engineer, taking a BSc at Kings College, London followed by a PhD in geotechnics. After a number of years with consultants he moved to practise at the Bar, specialising in construction and engineering matters. While maintaining links with the engineering profession, he moved into arbitration, taking cases both in UK and in most parts of the world.

In 1987 he became the founding Director of the Centre of Construction Law and Dispute Resolution at King's College, London, and was appointed to the Nash Chair of Engineering Law at the University of London in 1992. Since 2003 he has been Emeritus Professor of Engineering Law at King's College where he still teaches and supervises research.

His links with the engineering world have led to appointments in a number of Public Inquiries. In 1996 he was appointed to chair the inquiry into Yorkshire water. In 1998-2001 he was appointed to chair the inquiry into the rail accident at Southall and, sitting with Lord Cullen, the inquiry into rail safety systems following the Paddington crash. In 2009 he was appointed to a chair panel of Commissioners inquiring into the public construction industry in Trinidad and Tobago. His professional activities have also included serving as Vice President of the London Court of International Arbitration, as President of the Society of Construction Arbitrators, as Treasurer of the Honourable Society of Gray's Inn and as Master of the worshipful Company of Arbitrators.

Executive summary of conclusions

- (1) The current structure of the UK engineering profession has evolved piecemeal over many decades. Despite great changes in society and in technology, it has repeatedly proved itself resistant to change. There is a strong body of opinion that it no longer serves the best interests of the profession or its members, or engineering employers as clients in the UK or internationally or the interests of the country at large.
- (2) Only the major Professional Engineering Institutions (PEIs) together with the Royal Academy of Engineering possess the strength and influence to bring about change. These bodies should seek to implement a detailed agenda for the restructuring of the profession in accordance with the recommendations at the conclusion of this Report, and to oversee the progressive changes needed in the interests of the members, engineering employers and the country.
- (3) The existence of a large number of separate PEIs poses many problems which are well-recognised by the Institutions themselves as well as the profession as a whole. Repeated attempts to impose mergers have been rejected by the institutions. While future mergers deemed beneficial by the institutions themselves are to be welcomed, a further campaign to promote mergers seems unlikely to succeed. Many of the institutions recognise the benefits in combining certain organisational activities and they should take urgent steps to pursue these in the interests of proper financial management of their assets as well as the wider interests of the profession. Had the PEIs been in the private sector such combining, including mergers, would have happened as a matter of course.
- (4) However there is a clear need for much more fundamental combining of professional activities between the PEIs in line with the Recommendations. While the separate institutions embody many important attributes in terms of their expertise and reputation both national and international, these should be seen as assets to be exploited for the benefit of the whole profession. They should be a key part of the proposed combining of activities, which offers significant benefits both in terms of the influence of the PEIs and the interests of their members and the public. While each institution should maintain its expertise and reputation in its own specialisms, this should also be seen as part of the combined assets to be shared with the profession as a whole.
- (5) The separate PEIs must also recognise that they perpetuate divisions between branches of engineering which have little or no relevance today and which potentially prejudice the interests of the profession as a whole as well as their members. Not only does this require intended entrants to the profession to make arbitrary decisions as to future careers by choosing between specialisms, but it necessarily inhibits the movement between different specialisms which is universally seen in typical career patterns and recognised as an essential element in the continued success of UK engineering. The present arbitrary divisions created by the PEIs also place artificial restraints on courses which can be offered by universities and colleges in seeking to combine engineering with different disciplines such as law and other non-technical subjects.
- (6) Thus, as an alternative to full mergers, the existing institutions should seek to break down barriers to movement between the branches of

Executive summary of conclusions *continued*

engineering that they represent. The objective should be to establish a single “membership” of the UK engineering institutions with the right to participate in the activities of any of those institutions. This will involve financial adjustments between the PEIs but the merging of administrative activities should produce savings to offset any loss of revenue from offering “combined” membership of the institutions.

- (7) The PEIs must also pursue ways to enlarge their membership, which has been in general decline for over a decade and which forms the basis of the UK engineering community. They should promote increased levels of registration of existing members, many of which are already well qualified to achieve registration. They should also 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. The recruitment of such additional members will benefit existing members and the Institutions as well as providing real data on the true composition of the engineering community and the reported shortfall of engineers.
- (8) Coupled with additional recruitment the PEIs should undertake, through the Engineering Council, a review of all registration and membership grades with the objective of creating new grades which better suit the demands of members. While Chartered status continues to hold value there is clearly little appetite for registration at either

Incorporated or Technician level. The review of registration grades should therefore consider the replacement of the present three grades with two, namely “Chartered Engineer” and “Registered Engineer”. In addition the institutions should review their internal membership grades and consider the introduction of a new grade of engineering members, to be known as “Engineers” and intended to be available in particular to new members who have had no previous connection with the PEIs and who are engaged in significant engineering work.

- (9) The current structure of the profession outside the PEIs entails the following elements:
- (i) A body to oversee regulation of professional standards, currently the Engineering Council.
 - (ii) A body to promote engineering and the profession to the public, particularly to would-be entrants, currently EngineeringUK.
 - (iii) A body with oversight of the profession which can also represent the profession to government, currently the Royal Academy of Engineering.
- (10) The engineering profession has, throughout its existence, enjoyed the advantage of self-regulation and has, for better or worse, rejected the offer of a statutory basis for engineering activities¹. In the light of more recent statutory regulation of other professions,² the engineering profession should seek to maximise the advantages of self-regulation and particularly the flexibility that this offers, in terms of the setting and reviewing of professional standards and overseeing continuing professional education. It is of the

essence of regulation, however, that it is seen as independent of any promotional activities. The setting of standards for education and qualification must be at arm’s length from the profession and its promotion through the institutions. No relevant criticism of the Engineering Council in these terms has been voiced, the only relevant proposal being for a possible merger with the Royal Academy. While formal links with the Royal Academy may be beneficial to both bodies and there could be a sharing of facilities, a merger would prejudice the independence of the regulation process and cannot be supported.

- (11) As regards the activities of EngineeringUK, it is undeniable that their efforts to promote increased entry to the profession have not achieved notable success and that the UK is still a long way off achieving the increased numbers taking either A level Physics or NVQ3 Technical/Engineering qualifications which are required for the future of engineering. Furthermore it is clear that the promotional activities of EngineeringUK overlap with those of many other bodies including the PEIs and could be more efficiently conducted, particularly in the harnessing of volunteer activities. There is some evidence of increased take up of STEM subjects, but the multiplicity of effort makes it impossible to identify which activities should be credited with success. There is therefore a strong case for a wide ranging review of all promotional activities including those of EngineeringUK and for re-organisation of the position of EngineeringUK within the profession.
- (12) The preferred option is for the activities of EngineeringUK to be merged with the promotional work of the Royal Academy, to include also that of the PEIs, with the intention
- of rationalising all promotional activities and avoiding duplication. This proposal is, however, dependent on the Royal Academy being able to enlarge its activities to undertake such an expanded role as well as the institutions agreeing to pool their promotional activities. EngineeringUK operates as a company limited by guarantee and as such should be capable of undertaking any new roles within its wide remit or alternatively of undertaking new roles through a newly established company vehicle. One further new role for EngineeringUK should be the enlargement of its promotional activities to aid the identification and active recruitment of the three million “engineers” with no current affiliation to join or become associated with one of the existing institutions.
- (13) There have been earlier attempts to reach agreement on changes to EngineeringUK but no such agreement has been achieved. Proposed changes to its constitution and operation require a high level of support from board members, including 35 Institutions and 34 corporate members. However EngineeringUK is enabled to operate primarily through the financial support of the major institutions, which should be entitled to allocate their support where they consider most appropriate. The funding for EngineeringUK by the PEIs is presently derived from members’ registration fees and is not as such part of the institutions’ assets. The institutions must, however, owe a duty to their registrants properly to account for the funds so collected and must accordingly ensure that they are spent properly and efficiently. There is a strong case for reviewing the funding of EngineeringUK but any such review or re-organisation of funding must seek to maintain

¹ Finniston Report
² Notably of legal practitioners

Executive summary of conclusions *continued*

and increase the support which EngineeringUK additionally derives from industry.

- (14) In terms of oversight and representation of the profession, there is universal recognition of the need for the profession to speak with an authoritative voice as well as for there to be a co-ordinating role in representing the many disparate PEIs. There is wide support for the Royal Academy or a new body closely associated with the Academy to take on such a representative role. The enlargement of the Royal Academy's representative role, either directly or indirectly, should be accompanied by a strengthening of its connections with the PEIs, which should take place along with the restructuring between the institutions themselves. This will take time to evolve but the outcome should be a new form of partnership between the Royal Academy and the institutions, with renewed organisation and functions.
- (15) In addition to the enlargement of its functions, the Royal Academy should review its structure and membership, which is currently limited to Fellows from all branches of the profession including some not registered with the institutions. The merging of the promotional activities of EngineeringUK with those of the Royal Academy and the PEIs will involve a reallocation of funding and personnel, which will require detailed negotiation, planning and agreement. The preferred process for identifying optimal arrangements for merger of promotional activities would be a formal conference attended by all involved parties, at which proposals can be debated and solutions identified.
- (16) The institutions as well as the Royal Academy operate substantially under Royal Charters,

although commercial and charitable functions are in many cases carried out under different structures. Any of the activities of an institution can be carried out under the umbrella of a company, typically one limited by guarantee³ which can also operate as a charity. Once decisions are taken as to restructuring, this can be readily implemented by the creation of a suitable company structure. When the desired format is established and seen to be operating as intended, consideration can be given to more formal restructuring by the merging of activities. There may also be a desire to retain and amend Royal Charters, but the use of a company structure has the advantages of speed and greater flexibility.

- (17) As regards education and training of engineers, there is little doubt that the system which has evolved over some two centuries, with late and grudging acknowledgement of the importance of engineering, is still a long way from the system required by an advanced technology-based economy in the 21st century. The system is still hampered by much historical baggage, not least of which is the dichotomy between university courses and employment-based or apprenticeship training, a dichotomy still attended by ill-informed prejudice and snobbery, despite many of the most influential members of the profession having qualified by the latter route. It needs to be recognised that engineering requires a combination of theoretical knowledge and its practical application, coupled with many other skills.
- (18) While many partial solutions are currently being introduced towards achieving a more balanced and satisfactory system, the overall aim should be⁴ a common framework of standards to cover both apprenticeships and college-based

training. There should be an overall national system of technical education and standards with an integrated framework of routes to cover all employment-based and college-based technical education at levels 2 to 5. The Royal Academy, the PEIs and EngineeringUK must play a significant role in such a system and should ensure it applies across all branches of the profession.

- (19) The UK must retain its international reputation in its universities and world-class institutions, which can presently be measured by the

numbers of overseas students who obtain admission and whose fees make an essential contribution to their funding. Such bodies must, however, also recognise their place in the engineering profession and maintain their co-operation with the PEIs which also benefit from overseas membership. The importance of maintaining the UK's international reputation and overseas reach cannot be overstated if UK engineering is to thrive in the modern world and maintain its vital contribution to the economic and social well-being of the UK.

³ As is the case with a number of smaller institutions.

⁴ As recommended in the Sainsbury Report



A. Introduction and approach to review

Origin of Review

1. This review was initiated in a Letter of Appointment and Terms of Reference dated 29 March 2016 ([Annex 1](#)) on behalf of the Institution of Civil Engineers (ICE), the Institution of Mechanical Engineers (IMechE) and the Institution of Engineering and Technology (IET). While the appointment was by the three largest Professional Engineering Institutions (PEIs) which collectively represent some 70% of the UK professional engineering community, the establishment of the review was with the full knowledge and co-operation of the other major bodies involved in the governance of the engineering profession: the Engineering Council, EngineeringUK and the Royal Academy of Engineering. The three PEIs also consulted and kept informed the other current 32 PEIs, many of which have been actively involved in this review. The sheer impossibility of any concerted action involving nearly forty different autonomous bodies indicates that a process of selection was necessary before any effective action could be taken and it was the three leading PEIs which decided to take action in the form of this review.
2. The review was, naturally, preceded by some months if not years of deliberation concerning particularly the issue of governance of the UK engineering profession, which was universally recognised as requiring serious overhaul. This process involved discussions between all the leading bodies, discussions which were eventually focussed in a paper prepared by the ICE entitled *'The Role of the Professional Engineering Institutions in 2025'*, which became known as the Futures Paper ([Annex 2](#)). In the paper, the need for engineers and the role of the PEIs is reviewed against the

background of continuing decline in numbers of registrations throughout the PEIs, issues of public duty and the roles and functions of the PEIs including their learned society roles and international operations. The paper set out a number of "work streams" which included certain radical proposals such as the subsuming of the functions of EngineeringUK and the Engineering Council by the Royal Academy of Engineering.

3. These radical proposals had been the subject of exchanges and debate but there being no consensus nor any forum in which the issues could be formally debated and decisions made, the three PEIs resolved upon setting up this review to consider the issues, take evidence and submissions from all relevant sources and make recommendations which, while they could not bind any of the parties, would nevertheless carry the weight of opinion represented by the contributors to the review.

Terms of Reference

4. The briefing documents prepared by the PEIs included a paper ([Annex 3](#)) headed Terms of Reference, which sets out the background to the review, noting that while the profession had been declining in numbers over the long term, its governance and structure had remained largely unchanged for decades. Despite various reports over the years calling for significant change, the challenges remained largely unaddressed. It was noted that engineering underpins the UK economy to the tune of £1.2 trillion per annum and required a doubling of the number of engineering graduates and technicians over the next ten years. Despite significant investment the future supply of

A. Introduction and approach to review *continued*

engineers would not meet this demand under current arrangements. The three major PEIs together provide nearly £4 million annually to EngineeringUK to support its programmes aimed at recruiting additional numbers to the profession but the efficiency and effectiveness of those arrangements called for review. The paper then set out proposals for the review which have been incorporated in the Terms of Reference. To those original proposals the PEIs added a rider which appears in the Terms of Reference in [Annex 1](#) as follows :

“To clarify the future requirements of the UK for professionally registered engineers and technicians and review the effectiveness of existing arrangements between education and training establishments, employers and the professional engineering community in support of their delivery, with particular reference to employers as the end user i.e. provide a definitive statement of the problem which needs fixing”.

Consultees and Reference Group

- For the review, it was agreed that evidence and submissions would be solicited from a substantial but limited list of interested bodies and individuals. The bodies concerned included

all the PEIs, including the three commissioning institutions, together with other bodies and individuals nominated by each of the commissioning PEIs with additional contributors added to include persons having significant views. The total list of those who submitted contributions to the review is at [Annex 4](#).

- In addition, the commissioning PEIs proposed the establishment of a Reference Group of distinguished individuals who would be in a position to contribute significant expertise on specific questions and particularly by way of response and comment on draft proposals or recommendations. To the initial Reference Group additional names were added at the suggestion of the reviewer after consultation with the PEIs, with the objective of ensuring that all relevant aspects of the Terms of Reference were covered.

Procedure Adopted

- The timescale for the review, which envisaged completion of the report in November 2016, precluded any public or oral procedure which, in any event, would be inappropriate for a review as opposed to an enquiry. It might be borne in mind that the Finniston Enquiry, which ran from July 1977 to November 1979, included sixteen open meetings held around the country, attended by over 6,000 people. The extensive report with its far reaching recommendations was eventually rejected by the profession, which decided to adopt its own course for the future. In the present case the need for change is generally recognised and the task of this review is to identify and recommend the course most likely to be acceptable to the majority of participants

in the profession and most likely to lead to beneficial change.

- The procedure adopted was therefore to invite written evidence and submissions addressing the Terms of Reference or such issues therein as consultees preferred to address. The evidence and submissions received have been considered and collated by the reviewer, who has requested further input where required, including input from members of the Reference Group. A number of meetings, either in person or by telephone, have taken place either at the request of the reviewer or at the request of particular consultees whose views have then been incorporated into the collated report. During the course of receiving submissions, a private portal website facility was established on which all evidence and submissions from consultees were placed, to be available to all other consultees for their information and further comment as deemed appropriate.
- After receipt of the initial exchanges of evidence and submissions, the principal parties affected by the review, namely the commissioning PEIs, the Engineering Council, EngineeringUK and the Royal Academy of Engineering, were each invited to submit responsive or concluding submissions in the light of the material received from consultees and most responded. The responses were provided in early September following which Sections A to J of the report were drafted, in which the evidence and submissions received, including suggested conclusions, were collated and arranged, broadly following the topics contained in the Terms of Reference, with the evidence or submissions generally being quoted verbatim, and noting the sources as appropriate. It will be noted that certain topics recur so

that a degree of repetition under the different headings is unavoidable. Following this step, preliminary conclusions and recommendations based on the collated evidence and submissions and on other research were drawn up and initially submitted to the Reference Group for their individual comments and responses, which led to a number of additions and amendments. The revised conclusions and recommendations were then sent to the commissioning PEIs, the Royal Academy of Engineering, the Engineering Council and EngineeringUK. Meetings were conducted with each of them in which they had the opportunity to comment and to express further views, all of which were carefully taken into account. The final version of the conclusions and recommendations form the Executive Summary to this Report.

- The final sections of the report were then drafted, taking into account all the foregoing, namely Discussion of Evidence and Submissions (Section K), Responses to the Terms of Reference (Section L) and the Summary of Recommendations (Section M) which forms the Execution Plan called for in the Terms of Reference..

The problem which needs fixing

- This was the question proposed by the commissioning PEIs and forms a useful starting point before embarking on the broad topics contained in the Terms of Reference. This section can conveniently be prefaced by some general observations on the historical baggage against which the engineering profession in the UK still struggles.
- Much has been written about the decline of British industry and technology from its high-

A. Introduction and approach to review *continued*

point in the mid-19th century, the reasons for the decline and successive attempt to reverse that decline⁵. Of relevance to this Report is the fact that, despite its early and pioneering successes, Britain failed to establish a system of technical education designed to provide suitably trained engineers, in contrast to the countries which rivalled, and then in some areas surpassed, Britain's achievements, notably Germany, France and the United States. Accompanying this decline and arguably contributing to it was the undoubted fact that engineers in Britain have, at least since the 1860s if not earlier, been accorded a lower social status than in other countries and compared to other professions. The evidence supporting this conclusion is widespread. Notably, the public school system and the major universities remained dedicated to the study of traditional non-vocational subjects, while technical qualification was left substantially in the hands of the expanding engineering institutions. This is no mere historical aberration. In a recent letter to the Times from a young member of a famous British engineering family⁶, it was revealed that during his education at Eton College, famous for producing many of the country's leaders, he was taught nothing about engineering. By contrast however, and without derogating from the general proposition, the position in a leading girl's public school is quite different.⁷

13. In a House of Commons Committee Report on Engineering⁸ it was stated *"We have found engineering to be one of the UK's great strengths and were pleased to discover that UK engineering and engineers are highly regarded internationally, more so than they are at home"*. This point may be illustrated further by contrasting the fate of UK innovators with those

of other industrial nations. In the United States Henry Ford, the originator of organised motor manufacturing, remains a cult figure; whereas William Morris, who was largely responsible for creating volume motor production in Britain, is largely forgotten and universally confused with the designer of wallpaper of the same name. This is, therefore, the background to the many attempts to re-launch and re-invigorate the UK engineering profession, the most recent of which are reviewed later in this Report. Many improvements have indeed taken place, notably in the establishment of many renowned British schools of engineering; but the problem of the perceived status of engineers and engineering remains, as does the task of persuading school children to undertake the STEM studies that will allow them to enter for engineering courses.

14. To these historic problems may be added the piecemeal way in which the current structure of the profession has evolved. For more than a century the expanding engineering institutions operated independently, each with its own voice although subject to various mergers and amalgamations. Only in 1965 was the first effective joint body established, the Council of Engineering Institutions (CEI), along with the introduction of Chartered and other registered titles. This body was not without its problems and was effectively overtaken by the Finnieston report and its recommendations, which emphasised the need for a new body to represent the whole profession which was to be an "engine for change". The Finnieston recommendations were not accepted by the profession, dominated as it was by the engineering institutions themselves. Instead the Engineering Council was set up and took over from the CEI in 1982. This was hardly an

engine for change and had no mandate to act on behalf of the profession. In 1993 there were further calls for change⁹ and in 2001 a new and influential group¹⁰ secured the creation of the Engineering and Technology Board (ETB), effectively hiving off the promotional activities of the Engineering Council. Finally in 2010, largely by name-changes, the present arrangement between EngineeringUK (formerly the ETB) and the Engineering Council was set up, each funded from registration fees collected by the Institutions.

15. In 1976, shortly before the Finnieston Inquiry was set up, the Fellowship of Engineering was founded, on the initiative of HRH Prince Philip and a group of distinguished engineers, under the auspices of the CEI, to represent engineering as a whole. Upon the demise of the CEI in 1983, the Fellowship of Engineering was granted its own Royal Charter and in 1992 became the Royal Academy of Engineering. The Royal Academy is funded to a substantial extent by central government and acts as the government's principal engineering adviser. The Royal Academy maintains close relations with the PEIs but has no formal link or powers in relation to the institutions, to EngineeringUK or to the Engineering Council. To the extent the Royal Academy speaks on behalf of the profession, it does so subject to any of the institutions or other bodies having the right to express their own views and regularly doing so.
16. Thus it is unsurprising that one of the major institutions¹¹ considers the engineering profession to be fragmented and diverse and its leadership to be fuzzy and ill-defined. Another¹² identifies a systemic failure in the governance construct of the profession and the leadership responsibilities of the Royal Academy, the
- Engineering Council and EngineeringUK demonstrably overlapping. The response of the profession is slow and confusing with mixed voices when it does respond. The Royal Academy takes a leading role but without a mandate from the PEI membership. A former ICE President¹³ believes that the effectiveness of the profession is severely constrained by lack of role clarity. He considers there to be a need for a rationalisation of the roles and functions of the professional bodies within engineering, the current arrangements being sub-optimal, resulting in poor value for money and importantly resulting in confusion within government and society. The chairman of a major consultancy group¹⁴ further considers there to be no one voice in the PEIs which speaks for engineering. The issue has been raised on many occasions with government and this review should challenge the position on who should speak on behalf of engineering in its broadest terms.
17. Another institution¹⁵ considers the profession, collectively, as not effective in the promotion of the value and importance of engineering and therefore the place of engineers within it. Whilst there are examples of really positive achievements, overall we are not collectively succeeding and progress as a result is very slow. The Royal Academy itself considers that UK engineering does not provide the focused leadership, coherence or visibility at the highest levels to deliver what is needed by our principal stakeholders, including those in business, government and education. The current structure of UK engineering presents an almost impossible landscape for the outside world to navigate effectively. Perception is too often of apparently competing organisations, none

⁵ See particularly English culture and the decline of the industrial spirit 1850-1980, Martin J Wiener

⁶ Letter from Julian Nettlefold 24 August 2016

⁷ See paragraph 64 below

⁸ Turning ideas into reality, Report of Session 2008-09, Chaired by Phil Willis MP, p5

⁹ Engineering into the Millennium, Interim Report 1993

¹⁰ The Hawley Group

¹¹ CIBSE

¹² IMechE

¹³ Peter Hansford

¹⁴ Alan Cook, Chairman, Atkins Design Group.

¹⁵ The Energy Institute

A. Introduction and approach to review *continued*

of which can operate at a significant enough scale for effective leadership. The profession's effectiveness in influencing policy makers in Whitehall and Westminster is less than it should be for a profession of our scale and importance to the economy.

18. Many consultees saw the major problem as the apparent inability to produce sufficient trained engineers with appropriate skills for the future requirements of the profession. A major institution¹⁶ noted its concern that the UK educational system is not producing sufficient engineers with the correct skills and motivation at both technician and chartered engineer level. Some engineering graduates found it very difficult to find appropriate engineering employment and employers were concerned that graduates did not have the correct skills or work ethic for employment. There was also concern about the age profile within the profession, with many young engineers at the start of their career and many nearing retirement but with a dip in the middle.¹⁷ Passing on the experience and knowledge from those nearing retirement to the younger engineers was a challenge and risked detriment to the industry.
19. Fragmentation of the industry was also seen as a problem where, for example, the UK chemical industry was formerly dominated by several major companies through which young engineers could work their way and gather appropriate experience. The situation is now very different, the industry being fragmented and engineering teams are leaner, making it more difficult to gain engineering experience.¹⁸ In the context of change generally, it was observed that some stakeholders, including institutions, were more concerned about loss

of sovereignty over their own decision making. Other stakeholders saw the profession at best as irrelevant or at worst as potentially protectionist¹⁹.

20. As regards the contribution of the institutions, it was considered the majority continue to be inward facing, elitist and insular and thus failed to attract sufficient potential engineers. While adept at promoting engineering within its own confines, the institutions do little to engage with the wider engineering community or with society at large. Registration should be made simpler and presented as a positive benefit to enhance future careers²⁰. The current institutional landscape is confusing to anyone outside it and emerging subjects and growth areas are poorly catered for. The case for membership and registration is evidently too weak for most newly qualified professional engineers and engineering technicians and variations in processes across the institutions act as a disincentive to engage. As a result the institutions were failing to tackle either the engineering skills crisis or the diversity challenge. Key people in industry reported their frustration with the degree of complexity and overlap, with poor use of resources and with apparently competing organisations having insufficient scale for effective leadership.
21. Thus the "problem which needs fixing", which derives in some measure from its accumulated past and recent history, can be summarised as: (1) the PEIs, which are too numerous and have failed to engage with the profession; (2) fragmented and ineffective leadership of the profession; (3) failure to produce enough skilled and motivated engineers; and (4) ineffective promotion of engineers and engineering. These matters will be addressed in the context of the broad issues set out in the Terms of Reference.

16 CIBSE
17 IChemE
18 IChemE

19 IMechE
20 Society of Operations Engineers (SOE)

B. Future requirements for professional engineers and technicians – evidence and submissions

Shortage of Engineers

22. There is a disparity of views as to the future requirements, ranging from the mantra-like assumption that there has always been a serious shortage of suitably qualified engineers, to more considered views concerning particular areas of engineering. For the purpose of this section both engineers and technicians, whether or not registered with PEIs, are referred to simply as engineers for reasons which will appear.
23. It is noted that the engineering industry accounts for around 25% of UK GDP or rather more in some estimates. Research by EngineeringUK and the CEBR²¹ has identified the economic benefit to the public and the wider economy through encouraging more young people to follow an engineering career, with an estimated two additional jobs created for each skilled engineering job and a £27bn opportunity for economic growth. EngineeringUK calculates that the UK needs 182,000 persons with engineering skills per year, and that there is a current annual shortfall of 69,000²². This represents a significant increase on the predicted shortfall calculated for 2015, although the figures are generally regarded as high. Such an annual deficit of engineers and scientists will limit business growth in the UK and in consequence work and enterprise will move overseas.²³
24. However, recognising that all such predictions are based on statistical projections and calculations, Professor John Perkins, while accepting the mantra that “we need more engineers” (per *inter alia* Sir James Dyson), describes the question of calculating the shortfall as “tricky”.²⁴ Professor Perkins notes,
- as one of the most widely cited estimates, The Royal Academy’s report on Jobs and Growth which states that between 2012 and 2020 the UK economy will require 830,000 scientists, engineers and technologists, i.e. over 100,000 per year, “largely to replace those leaving engineering practice e.g. through retirement”. It can be seen that this estimate is sensitive to assumptions as to the categories of qualified individuals and also to retirement intentions which are likely to have changed following the financial crisis and reviews of pension arrangements.
25. In considering the future requirements for professional engineers in the UK, attention is also drawn²⁵ to the extensive use of outsourced and offshore engineering capability. It is noted that many UK and international companies have such arrangements in place to cater for peak demand requirements and variation in economic cycles. There is no doubt that engineering in the UK benefits from the international mobility of engineers, which also promotes skills transfer as well as safeguarding peak demand.
26. It is noted that since a relatively low percentage of prospective engineers choose to join their relevant PEI, this will invalidate any projection based on PEI membership²⁶. Particular sectors question the overall assumption of a shortfall in those entering the industry. Thus while accepting the UK needs to increase the numbers of graduates and apprentices, the data suggests that the UK education system is producing sufficient numbers of new apprentices and graduate engineers to meet the current projected demand for civil engineers.²⁷ For the marine engineering sector, while accepting that the industry will continue to require people with STEM capabilities, “we really have

²¹ Centre for Economics and Business Research

²² EngineeringUK Annual Report, 2016 and submission to review

²³ Erik Bonino, former Chairman, Shell UK

²⁴ Review of Engineering Skills for Department of BIS, Nov 2013, p10

²⁵ IStructE

²⁶ Chartered Institution of Building Services Engineers (CIBSE)

²⁷ ICE Education Foresight Report 2016

B. Future requirements for professional engineers and technicians – evidence and submissions *continued*

no idea what the requirements will be in 10 years' time"²⁸. Specific evidence collected in the chemical engineering sector indicates that demand is very cyclic²⁹. One contractor found no evidence of shortage, while others reported receiving 250 to 300 well qualified applications for between four and ten places each year. Recruitment of graduates has been described as "very promising". However, other contractors had to supplement engineering resources by use of agencies or supply chains, a position that was exacerbated by remote locations of nuclear facilities, and where competing for skills with other companies. The position has changed as a result of swings in the prices of oil and gas. At times contractors were struggling to recruit process engineers and had to look overseas, but subsequently had to release good engineers due to the downturn in the market. There was a distressing tendency for some companies to stop recruitment altogether in lean times, which stores up problems in the long term.

27. In the mining sector it is considered the present and overall supply of competent chartered professional engineers, scientists and technologists is broadly in balance with demand³⁰. By contrast, the supply of technicians competent to support higher value added businesses (Original Equipment Manufacturers as well as Small and Medium Enterprises) is not in balance with demand. There had been a failure of professional bodies to develop such competent persons which is only now being addressed. The nuclear industry³¹ appears to have greater control of its own recruitment and training, with a workforce of around 78,000 across power generation, decommissioning, R&D and defence. Newbuild projects³² are set to expand the UK nuclear workforce to around

111,000 by 2021³³ which is predicted to require some 9,000 FTE new entrants per year. The industry itself is heavily involved in promoting recruitment and training at all levels.

28. The view of the aeronautical sector is that the reported shortfall of numbers going in to engineering is overstated. While the Perkins review endorsed the continuation, extension or enhancement of existing initiatives without reviewing their effectiveness, the findings of the Wakeham review of STEM graduate employability was preferred as strongly quantitative. As an example, in a recent Aerospace MSc scheme with 500 places funded by industry, with matched funding from government, applicant numbers did not support the view that there were large numbers of unfilled vacancies in the industry waiting for these graduates.

The engineering population

29. The current registered membership of PEIs is some 230,000, a number which has been in decline for over a decade despite the best endeavours of Engineering Council, EngineeringUK and the PEIs. Some individual institutions have recorded increases in some years³⁴, a few of these being significant. Of greater note is that the total "membership" of the PEIs is over 750,000 and thus includes some 70% of membership as being non-registered for a variety of reasons. These will include students and graduates but also a greater number of persons who have professional interest in the activities of the institution but do not aspire to registration. Some of these will be overseas members, who also account for around 19% of registered members. Of all registered engineers,

the great majority (80%) are at Chartered level. The remaining percentage is accounted for by those registered at EngTech level (7%) and IEng level (13%). This is significant in that grades below Chartered would normally be expected greatly to exceed the number of Chartered engineers.

30. With regard to the numbers of registered engineers, it has been calculated that this represents only some 51% of engineers eligible for Chartered status and that the proportion of those eligible for Incorporated status drops to 5%³⁵. For reasons which appear below the proportion of those eligible for EngTech status who are registered is very small and effectively unmeasurable. The reasons why many well-qualified engineers do not become Chartered is addressed later in this report.
31. Perhaps the most surprising statistic concerning membership of the institutions is the comparison with various estimates of the total number of persons considered to be working in engineering. This number was estimated in the Malpas Report³⁶ as two million, but this has been superseded by a statistically calculated figure, based on census figures, of 4.3 million, the calculation being set out in the Universe of Engineering Report of October 2014.³⁷ Other current estimates of similar order are 4.7 million³⁸ or 5.5 million³⁹, the latter being an increase of 1.8% on the previous year's estimate.
32. These statistics give rise to a number of important issues. 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. This gives rise to the question of which body should represent the whole engineering community and how can such representation be achieved; further, how can the composition of the "missing" three or four million "engineers" be ascertained; and in relation to the latter question, how can the supposed shortage of engineers be properly addressed without any knowledge of the great majority of those who make up the engineering community?

The skills which engineers need today

33. One of the more serious criticisms of the UK engineering institutions is that they have failed to adapt with changing practices and technology. In particular, while at the time of their creation it was appropriate to specialise in one branch of engineering, this is no longer the proper preparation for a career in engineering. To put the same point another way, most practising engineers today work in areas which span the specialisms of particular PEIs and many, having qualified with one institution, find their careers developing in areas covered by different institutions or by no institution.
34. The institutions themselves recognise that the industry is moving towards an integrated approach such that there will not be a single landscape in the future of engineering, but many. While there will be more technical specialists and specialisms, there will be an increasing need to work across boundaries with new sectors playing a more active part in infrastructure design, construction operations and maintenance. Teams of engineers will be increasingly multi-disciplinary and will need

28 IMarEST

29 IChemE

30 Institute of Materials, Minerals and Mining (IOM3)

31 Submission of Sellafield

32 <http://nugeneration.com/>

33 <https://www.nsan.co.uk/nuclear-energy-skills-alliance/nea-nuclear-workforce-assessment-2015>

34 A particularly case being the Welding Institute

35 Engineering Council

36 The Universe of Engineering, report of Sir Robert Malpas, June 2000

37 Royal Academy of Engineering Report, chaired by Dame Sue Ion, at Annex 4

38 IMechE

39 EngineeringUK

B. Future requirements for professional engineers and technicians – evidence and submissions *continued*

to demonstrate creativity and communication skills as the profession moves to a collaborative approach. Engineers must be trained to work in a flexible, dynamic, and open way, taking on board the digital and virtual world to serve its increasingly diverse stakeholders.⁴⁰ The institutions must reflect these far-reaching changes.

35. Similar opinions are voiced by a leading infrastructure contractor who notes that a wide mix of skills is increasingly required on projects and that technology will continue to impact at an increasing pace, broadening the skills mix required. Collaboration is superseding cooperation. The engineering institutions, by contrast, present a siloed outlook. The industry should be heading towards one fully integrated organisation, certainly for construction, but probably for all industrial activities, which should attract all professionals. Such a body could facilitate more effective collaboration and have more influence on government, education and society. The institutions need to shake off their Victorian outlook and embrace new forms of learning and qualifications. The UK construction industry must also embrace genuine innovation and new solutions rather than its present conservative and risk averse approach which has led to it becoming the most backward in the developed world and certainly the most unproductive⁴¹.
36. Other consultees have emphasised the need to incorporate systems engineering and project management into engineering courses⁴². Likewise the multi-disciplinary approach of some universities is seen as more appropriate to allow engineers to take on multi-faceted projects such as the current Automatic Train Control Project. The institutions should be more

ready to include people who have not taken the prescribed routes and who wish to become or return to practise as an engineer. This would allow engineers who have been driven out of the profession in times of economic downturn or those who have taken a different career path on graduation to return to the engineering profession⁴³.

Areas in which UK engineering currently excels

37. UK engineers historically led the world in many areas, stemming originally from the industrial revolution in the 18th century and continuing at least to the mid 19th century. Thereafter increasing competition from European powers and from the United States steadily eclipsed the UK's lead; and in the 20th century competition from the Far East, now including China, coupled with increasing globalisation, has stripped the UK of any inherited advantages. This has led to a situation in which success in international markets for engineering and engineering services is dependent not simply on an ability to carry out the work, but on innovative skills including deployment of the latest technologies, coupled with the ability to deliver on time and to a demanding budget. It is this uniquely challenging environment in which UK engineering must survive and thrive.
38. There can be no doubt that many UK engineering enterprises can and do rise to this new level of challenge. Among contemporary and current success areas can be listed the achievements of Jaguar Land Rover in the design and marketing of innovative vehicles including the new Ingenium series of engines; the work of BA Systems and British Aerospace in

both the defence and civil areas of the aircraft industry; in the field of electronics, the design of micro-chip components at the Cambridge based ARM Holdings⁴⁴; in Satellite engineering, the work of the Surrey University spin-off company Surrey Satellite Technology Ltd; and the work of a number of innovative companies working in the fields of pharmaceutical and molecular engineering. Indeed, such a list gives some impression of where UK engineering is now centred, as opposed to the traditional heavy engineering of past decades.

39. Any account of UK engineering and its achievement would be incomplete without reference to the still universally regarded professionalism of UK-qualified engineers and the international regard in which its

institutions are generally held, perhaps more so than here in the UK. As regards the former, many UK engineers work as independent experts in their specialist fields, contributing to inquiries and legal and arbitration proceedings throughout the world, where their probity is often preferred to that of experts from other countries. As to the latter, most of the UK PEIs have a sizeable overseas membership, and many of the larger institutions have branches in other countries, in both cases to a much greater extent than any other country. This is not to say that the institutions are without need of reform. Rather, the reforms which are the subject of this Report should be seen in the light both of the public national interest and also in the context of the wider international profile of the UK engineering community.



40 ICE

41 Steve Fox, BAM Nuttall

42 Roderick Muttram, Fourth Insight Ltd

43 John Barber

44 Although the company has recently been sold to the Softbank Japanese Co

C. Existing arrangements for delivery of required numbers of engineers and technicians – evidence and submissions

Recent developments

40. This section needs to take into account a number of recent initiatives of central government⁴⁵, particularly the launch of the new apprenticeship scheme involving the setting up of the Institute for Apprenticeships and the apprenticeship levy and the recent Sainsbury report on Technical Education⁴⁶. The Sainsbury Report recommends a single, common framework of standards to cover both apprenticeships and college-based provisions, with government designing the overall national system of technical education and employer-designed standards to ensure the system works in the marketplace. The report recommends that both employment and college-based learning need to be closely integrated with a common framework of routes to encompass all forms of technical education. While key strategic decisions should be reserved for the Secretary of State, including those relating to the overall national system of technical education to ensure it remains coherent and stable over time, the Institute for Apprenticeships is seen as largely autonomous and encompassing all technical education at levels 2 to 5. The Institute should be responsible for assuring standards and deciding upon the levels of technical knowledge, practical skills and behaviours to be acquired on each route for both apprenticeships and college-based provision.
41. Other recent developments include the announcement by the Open University (OU)⁴⁷ of plans to offer “degree apprenticeships” as a cheaper alternative to regular university courses, following last year’s government initiative, involving a combination of work experience and study. This is seen as boosting the Skills Funding Agency’s current estimate of only 1,500 to 2,000 students currently intending to take up degree apprenticeships. The OU Vice-Chancellor was quoted as intending this scheme to help overcome the “slightly snobbish” attitude to apprenticeships and offering the chance to incoming students of qualifying with a degree without incurring the debt levels imposed on university entrants. A second important initiative was the announcement of a new university named the New Model in Technology and Engineering (NMiTE), to be based in Hereford and offering a new “liberal engineering” programme based on creativity, design and innovation without the traditional requirements of maths and science at A level. The new course is intended to be based on project-based learning with seminars and on-line self-study and will provide a concentrated course of 46 weeks per year with secondment to industry as part of the course.
42. Another recent initiative, to be based on traditional A level entry requirements, is the new Dyson Institute of Technology at Malmesbury, Wiltshire, which will initially award degrees through Warwick University. Students will have their tuition fees paid plus a salary of up to £16,000, and will study and work alongside Dyson engineers. As with other schemes, students will emerge free of debt and with a job at the end of the course. Other recent academic start-ups can be seen as either part of or a response to the new world of e-learning by which increasing numbers of traditional academic institutions are resorting to the internet to make their courses available on-line. The consequence is that traditional university courses and teaching methods must be seen as subject to fundamental review and to the inevitability of new courses emerging, some

⁴⁵ BIS and DfE

⁴⁶ Report published April 2016

⁴⁷ Article in The Times 5 August 2016 “Open University to train apprentices”

C. Existing arrangements for delivery of required numbers of engineers and technicians – evidence and submissions *continued*

of which will thrive and possibly replace those which have hitherto been the principal routes to qualification in engineering.

Universities and full-time courses

43. The university system is currently divided in terms of how engineering specialisations are taught. Following the existing institutions, most universities offer separate teaching for different engineering disciplines, while many of these offer a common first year with cross-disciplinary subjects and specialisation in subsequent years. Some, however, eschew specialisms and offer courses in “engineering science”, for example those at the Universities of Oxford, Cambridge, Exeter and Durham, although some of these also offer individual engineering disciplines. The last Research Excellence Framework exercise saw a move away from separate engineering departments to many entrants now being offered general engineering⁴⁸. The transition to a wider range of studies has wide support.⁴⁹
44. One of the biggest problems with recruiting engineering students is the traditional need for a strong foundation in mathematics, whether the student intends to follow an academic or vocational route. The UK lags behind its competitors in post-16 maths participation, creating a ‘maths gap’ between 16 and 18 for many students. Only about 20% of students in England study maths after GCSE, significantly lower than comparable countries: 48% of Scottish students study maths post-16, in the United States the figure is over 65% and exceeds 90% in Germany. The OECD’s recent survey of adult skills estimated that 8.5 million, roughly a quarter of England’s adult population, have the maths skills of a ten year old, able to

tackle only one-step tasks in arithmetic, sorting numbers or reading graphs. The same survey showed young people in the UK falling behind: 16 to 24 year olds in England score lower on basic skills than their grandparents’ generation. This poor performance limits the pool of people able to work in engineering both at technician level and at professional level.⁵⁰

45. Whether in response to these statistics or not, a significant change in university courses is occurring. University College London now offers civil engineering to students who have taken arts and humanities A levels. The need for humanities and creative arts is stressed⁵¹ as bringing ideas and research from the laboratory into industry, ‘because we train STEM people to think inside their singular silos and to be creative there, but not in how to relate to people outside their increasingly narrow disciplinary straitjackets.’⁵² A similar development is occurring at the University of Bath, currently ranked third in the UK for civil engineering, which welcomes students with a broader A level range. Analysis of their 2015 final year MEng cohort⁵³, found that there were performance advantages for those in groups with A level Art & Design, Geography or Design and Technology over those in the groups with Physics, Further Maths or Maths and Sciences. The inclusion of creative and human aspects is being taken further by the Association of Civil Engineering Departments. Additionally, letters to the Times⁵⁴ in response to the launch of the Hereford NMiTE revealed that similar initiatives are in place at the Universities of Chester and Lancaster.
46. Universities are not free from controversial issues. The view has been expressed⁵⁵ that the pipeline into industry has been disrupted

by government policy from 1997 seeking to increase numbers in higher education. This has created a disconnect between Higher Education (HE) providers and industry in terms of capturing employers’ requirements, willingness to satisfy those requirements and competence to satisfy them. This was especially so in research-intensive universities whose academics are armed with a particular set of skills⁵⁶. While engineering degrees are accredited by one or more PEI to demonstrate compliance with UK-SPEC competencies, it is suggested there is a burden on university departments, especially if accreditation derives from different PEIs⁵⁷, to demonstrate the value of accreditation to the PEIs, the Higher Education Institutions and to students and employers.⁵⁸

47. The view is expressed that too many universities focus on research outputs as a success measure, rather than on their primary role to produce the graduates that industry and the economy need. The overall nature of engineering employment has changed dramatically in recent years such that many employers are now multi-national and a UK professional registration is only one of many ways of assessing competence. Many employers draw on resources from around the world and operate centres of competence in many countries. Both universities and the PEIs need to recognise the new employment landscape of engineering in their outputs and requirements⁵⁹.

Vocational and employment-based training

48. The last five years has seen a major resurgence in the field of vocational education in the form of University Technical Colleges (UTCs)

largely replicating the former polytechnics and technical colleges in providing courses for 14 to 19 year olds. This initiative has benefited from the active support of former education secretary Kenneth Baker and many other individuals and bodies⁶⁰, including the Gatsby Trust. UTCs are regarded as a positive development for 14-19 year olds but still require close engagement with sponsoring employers, much as happens in Germany, to ensure graduates are ‘work ready’.⁶¹ It is emphasised, however, that virtually half the talent pool that could become engineers is overlooked: female entrants to the profession remain largely ignored and poorly represented in contrast to the position in the United States and many other countries.

49. Concern is also expressed that many of those now aspiring to degree-level qualifications in engineering should be pursuing an apprenticeship route rather than being taught by research-focussed academics.⁶² Numbers of PEIs are active in promoting schemes such as the Trailblazer apprenticeships scheme. However there is a perceived problem in that HE is now a business sector of its own and is susceptible to damage if aspiring engineers are directed away to other types of training in the future. Large employers are also active in promotion of the HE route: in the North West, Sellafield Ltd plays a prominent role in establishing and organising apprenticeships in a wide range of engineering disciplines, including project management and design engineering, working with local academic providers and nuclear-related industries (through the Nuclear Skills Strategy Group). The Centre of Nuclear Expertise and the National College for Nuclear have been established as an awarding body for qualifications relevant to the nuclear industry which also covers a wide range of skills.

48 Professor Dragan Savic
49 John Barber *inter alia*.

50 Review of Engineering Skills, Professor John Perkins, p 19/20
51 Professor Nick Tyler, UCL,
52 Creative Education Agenda (2015)
53 Dr Paul McCombie, May 2016 Conference.
54 Published 6 September 2016

55 Royal Aeronautical Society (RAeS)
56 See Dowling Review of Business-University Research collaborations, July 2015.
57 [https://www.engc.org.uk/engcdocuments/internet/web-site/Engineering%20Degree%20Accreditation%20\(1\).pdf](https://www.engc.org.uk/engcdocuments/internet/web-site/Engineering%20Degree%20Accreditation%20(1).pdf)
58 Dr Amanda Dowd.
59 Roderick Muttram

60 See utccolleges.org and article by Emma Duncan in the Times 13 August 2016; but see also article in the Times of 18 October 2016 reporting on problems with UTCs.
61 Energy Institute
62 RAeS

C. Existing arrangements for delivery of required numbers of engineers and technicians – evidence and submissions *continued*

50. One unintended but clear advantage of the HE route may be noted. While university student numbers are reportedly declining in response to the new student fees structure, with students graduating from 2015/2016 acquiring a serious debt burden, employment-based training offers the possibility not only of secure employment following completion of training but relief from future debt as fees are generally being met by employers. These are advantages which should become more apparent to students as they consider their future prospects.

Role of PEIs in Higher Education and training

51. PEIs generally take an active part in promoting HE in different forms. While the three commissioning PEIs each maintain a substantial programme of HE support and training initiatives, a number of other institutions have also demonstrated major commitment in the field. The Institution of Structural Engineers (IStructE) has very strong and effective relationships with the significant majority of HE providers in the UK. There is good engagement at academic level and mutual support for the Institution's research and technical publications from academics. Each university has a Student Liaison Officer to encourage student membership of the Institution, which has significantly increased its output of learning material aimed at the graduate and undergraduate audiences including an on-line course launched in 2015. The IStructE together with three other institutions operates the Joint Board of Moderators (JBM) to accredit degree programmes in civil engineering at the majority of UK universities and their international

campuses. Many senior Institution members have seats on University Industry liaison panels and many are formally appointed as Visiting Professors.

52. In 2010, responding to the lack of civil engineering apprenticeships in London, ICE supported six major civil engineering consultancies to set up the Technician Apprenticeship Consortium (TAC). TAC and ICE developed an apprenticeship, based on the BTEC Level 3 Diploma and mapped to EngTech, with ICE producing a competence qualification. ICE thus anticipated the Trailblazer apprenticeship process in England by developing an employer-responsive programme that leads to professional membership.

53. The Welding Institute has a large, international, training delivery network⁶³, an independent, industry-led, UKAS accredited personnel certification body,⁶⁴ is a member of a number of international bodies and engages in all relevant national and international standards development activities including the harmonisation of welding engineering education across Europe. The Nuclear Institute similarly carries out a range of educational activities which include conferences and seminars including STEM areas, national and local STEM outreach based on nuclear technology, sponsoring scholarships in nuclear technology, mentoring schemes, career development workshops and mapping of industry training courses. The Ministry of Defence operates through a PEI Steering Group for Defence Operations, both civil and military, with the objective to institutionalize MOD engineers and technicians, *inter alia* through a coherent and rigorous approach to Continuing Professional Development (CPD)

by the institutions. They seek to broaden the Steering Group's outlook beyond professional development to include youth STEM engagement activities, having developed its own STEM Engagement Strategy which has resulted in the formation of strategic STEM partnerships, one of which is Tomorrow's Engineers.

54. The Institute of Physics and Engineering in Medicine (IPEM) has been at the forefront of developing and supporting the education and training of engineers moving into the Clinical Engineering discipline in the National Health Service. There are some 300 Clinical Scientists practising in Clinical Engineering across the UK. The accredited training centres that are used for work-based learning under the new NHS Modernisation of Scientific Careers are primarily IPEM-recognised centres, especially for Clinical Scientists. IPEM are involved in collaborating with the NHS to ensure that work based training departments meet required standards⁶⁵. IPEM has also been instrumental in promoting engineering registration within the Clinical Engineering profession, and in obtaining recognition of the CEng title as a requirement of the new Higher Specialist Scientist Training programme for Consultant Clinical Scientists.

The role and needs of employers

55. It is helpful to identify who or what currently should be regarded as typical employers of engineers. There have been major changes over the last thirty years through the privatisation of many large industries to become regulated private companies exposed to the disciplines of capital markets. In the view of some this has resulted in a change of

emphasis away from the pursuit of technical excellence to the need to deliver reliability and profit in a commercial environment. There has been a similar but less dramatic change in consultant firms with many being taken over by large American corporations, and those remaining independent moving from partnerships to limited status⁶⁶. In many organisations, graduate training is driven by the perceived need of the employer, not the dictates of PEIs. Participation in the activities of PEIs does not assist with career progression in many employer organisations.

56. As regards the involvement of employers in engineering education, it is reported that German practice is for engineering to be taught by practising engineers, helping them to stay closely connected with industry, abreast of the latest technology, as well providing real projects and hands-on experience for students⁶⁷. While there is no such organised practice in the UK, an alternative possibility exists through the Industrial Secondment Scheme which allows university academics to spend six to twelve months in industry, with the Royal Academy of Engineering funding replacement teaching staff. Academics involved in the scheme have reportedly changed their course content and teaching as a result to become 'more aligned to the needs of industry'. The companies involved are also considered to benefit from having an expert available within their business, which has also reportedly led to developing strong ties between the university and the business concerned.⁶⁸

57. Energy & Utility Skills Ltd, an industry body representing major infrastructure companies within water, power, gas and waste recovery/

⁶³ <http://www.twitraining.com>

⁶⁴ <http://www.cswip.com>

⁶⁵ This is via a Memorandum of Understanding with the National School of Healthcare Science, part of Health Education England, within the NHS.

⁶⁶ John Banyard, FEng

⁶⁷ Energy Institute.

⁶⁸ Roderick Muttram

C. Existing arrangements for delivery of required numbers of engineers and technicians – evidence and submissions *continued*

renewable, puts forward the following issues in relation to this sector:

- The need for a different blend of skills meaning more entrants with STEM related skills, and the need to attract more young people, women and ethnic minorities into engineering roles. Support for the Government's Apprenticeship Trailblazer scheme which gives employers the opportunity to lead the development of new employer-designed apprenticeship standards. The Energy and Efficiency Independent Assessment Service (EEIAS) enables employers to design and develop programmes that focus on the skills needs.
 - Through EEIAS, new apprenticeship standards and programmes focus on professional development and career progression and promote membership and professional registration with institutions.
 - Through its work with employers and the PEIs the EEIAS has set out to ensure that level 3 and above competences meet the UK-SPEC and enable each apprentice to progress to EngTech registration.
58. The Gatsby Foundation in collaboration with the Royal Academy of Engineering offers Sainsbury Management Fellowships to enable engineers of high career potential to undertake full time MBA courses. It is considered that people with both engineering and management skills are vital to ensure that the UK retains the capability of exploiting its own good ideas, rather than to see them exploited by others. Similarly, Engineering Leadership Advanced Awards are made available to provide support for engineering undergraduates in UK universities who have the potential to become leaders in

engineering, to enable them to become the role models of future engineers.

Inspiring schools and pupils in STEM studies

59. It is universally recognised that one of the key factors in delivering higher numbers of appropriately qualified engineers is the promotion of studies in Science, Technology, Engineering and Mathematics (STEM) in schools. The principal initiative, organised by EngineeringUK and the Royal Academy of Engineering, is the schools engagement programme entitled Tomorrow's Engineers, which operates in partnership with many of the major institutions including the ICE, IET, IMechE and the Institute of Physics and with businesses, not for profit organisations and charities. The programme includes major initiatives such as the Big Bang Fair and the Young Scientists' and Engineers' Fair as well as industry visits, workshops, STEM Ambassador partnerships and careers resources, to help schools to incorporate engineering into the current curriculum.
60. The ICE recognises the scale of the challenge, which involves some 27,000 schools and ten million school students in the UK. While the ICE contributes on an enthusiastic and active volunteer basis to encourage members and employers to inspire the next generation of engineers, the relationship with the Royal Academy of Engineering⁶⁹, EngineeringUK⁷⁰ (including Tomorrow's Engineers) and STEMNET⁷¹ and other PEIs is seen as fundamental. The scheme is only meaningful if there are genuine pathways from education to employment, so that young people can find their way into the profession.

61. The Royal Academy of Engineering expresses concern that the STEM skills pipeline fails to produce the potential numbers indicated by initial entrants. There are losses of some 50% at the first assessment hurdle of GCSEs. This is followed typically by the collapse of interest among students in pursuing STEM subjects, most notably Physics and in particular with girls where only 2.5% progress to A level. The result is a serious lack of scientific literacy and a highly restricted talent pool for engineering. Given that so many children have natural engineering talent, this is a huge missed opportunity. The Royal Academy considers the problem to lie in the lack of impact achieved by the plethora of smaller scale, profession-specific initiatives which have taken place to date. Qualitative research on attitudes to engineering and STEM among a core target group has demonstrated the importance of marketing in addressing misperceptions and prompting enquiry. STEM options are, for some young people, loaded with perceptions of limitations.
62. The Royal Academy has in response developed The Engineering Talent Project (ETP), a multi-intervention programme of work with specific objectives to transform perceptions of engineering, promote the importance of engineering to the UK economy and encourage uptake of STEM and recruitment to engineering. The programme has been developed by the Royal Academy at the request of seven major engineering businesses⁷², which considered the multiplicity of independent schools' engagement activities to be ineffective. The Royal Academy was asked to lead a programme to address these issues and to market engineering effectively to young people. The ETP has attracted resources and support

from five main professional institutions – IET, IMechE, CIBSE, ICE and IChemE, including financial contributions to the project.

63. However, concerns as to the effectiveness of the present programmes are expressed in a number of quarters. The Energy Institute considers that continual changes to the education system in the UK have not addressed the problem of increasing and improving technical education. Resources, funding and teachers with technical backgrounds and experience have not increased to the levels needed to translate that support into the numbers of skilled people able to enter the workforce. CPD for teachers is poor and opportunities for real exposure to practise are limited. The Royal Aeronautical Society points to duplication and lack of co-operation – between PEIs, the Royal Academy and EngineeringUK. The effect on the numbers entering engineering was disappointing and the lack of diversity in the profession continued to be a problem. Making a lasting impression on young people in schools requires sustained activity throughout a child's primary and secondary education. Away days and fairs entertain but cannot compete with the intense and structured teaching which has evolved in response to school league tables. While the Big Bang Fair attracts some 70,000 attendees each year, this equates to about one tenth of one single year of the annual school cohort. Given the age bracket at which the Fair is aimed, the percentage of children who can actually benefit is very small. It is also apparent that the schools which attend the event are those which are already engaged in STEM promotion so that the schools without such commitment are least likely to become engaged. Further, while those who do visit show a very positive response, there is no evidence

69 <http://www.raeng.org.uk/education/engineering-talent-project>

70 <http://www.engineeringuk.com/>

71 <http://www.stemnet.org.uk/>. STEMNET and the National STEM Learning Centre are currently in merger talks

72 Jaguar Land Rover; National Grid; Atkins; Babcock International; BAE Systems; GKN; Airbus.

C. Existing arrangements for delivery of required numbers of engineers and technicians – evidence and submissions *continued*

that the same level of interest is maintained and translated into subject choices. The present level of outcomes suggests that little long-term influence is achieved and that one-off events which consume substantial resources, such as promotional fairs, should be reconsidered with the alternative of developing a more sustained influence on the curriculum as opposed to mere guidance which may or may not be adopted by hard-pressed teachers⁷³.

64. Despite the arguments of EngineeringUK to the contrary, it is apparent that the current range of activities aimed at promoting STEM subjects with 14-16 year-olds is not succeeding in achieving meaningful improvement on the disappointing statistics for numbers taking up science and maths at A level and following this up in further education. Nevertheless, it is equally clear that children have great potential enthusiasm for STEM studies and that there may be more successful ways of bringing out and developing that enthusiasm. Among numerous initiatives are a number of programmes organised by EDT, which delivers over 40,000 STEM experiences each year for young people aged 9 -21 across the UK. Their programmes include Inspire and Headstart courses at universities for 15-16 and 16-17 year old students⁷⁴ and a variety of accredited work experience courses for young people aged 11-19. Other examples can be found in a number of schools via their websites, including schools in both the state and private sectors. While the additional challenge of encouraging more women to take up STEM subjects has been beyond the scope of this review, it is convenient to cite a particular example of success which covers both aspects, at Cheltenham Ladies College, which has recorded notable success

both in the promotion of STEM and in adding significantly to the numbers of women taking up science and engineering⁷⁵. A study of their methods and those of other schools which have achieved individual successes should inform the future direction of efforts to promote STEM in schools nationally.

65. Among other criticisms of the existing system, CIBSE considers there are insufficient STEM teachers in terms of quantity and quality, especially in physics. The Institute of Physics has done much in this area but considers more must be done. There are a staggering number of schemes promoting engineering in schools and almost as many organisations and bodies involved in this task. The variety and overlap is bewildering and wasteful. The Institute of Marine Engineering, Science and Technology (IMarEST) considers that a consequence of the many PEIs is a lack of co-ordination in the approach to attracting young people into STEM subjects. There is certainly a need for better co-ordination between PEIs in attracting school children into STEM subjects and young people into the profession.
66. In the nuclear field it is considered there is little collaboration and co-ordination of effort across the PEIs leading to duplication of effort. Many schools and teachers report that they are overloaded with STEM initiatives, with too much going on in an unfocussed way. Teachers fail to understand what professional engineering is. There is an understandable tendency for local PEI groups to participate in locally organised STEM activities, but this contributes further to the rather scattergun approach. Given this lack of organisation, the ICE considers a critical element of the review will be to consider how most effectively to bring together what

appears to be wide and large scale duplication between competing bodies such as STEMNET, EngineeringUK, the Royal Academy Talent Programme, charities and CICs⁷⁶, Tomorrow's Engineers and the rest in order to inspire potential engineers in this country.

67. As a solution the Society of Operations Engineers (SOE) favours the creation of a single professional team to lead engagement with schools and universities, forming a national approach which removes competing bodies and delivers an approved standard of activity to encourage and show the opportunities in an engineering career. That a properly organised programme to inspire students can be effective is demonstrated by the IChemE's whynotchemeng campaign which has been instrumental in driving a sustained and steep increase in the number of chemical engineering students at UK universities, quadrupling

applications and almost quadrupling intake since 2001. Student intake has increased threefold in a decade with proportions of overseas students and women remaining at the same level. The increased student uptake has led to increases in existing departments and the establishment of new departments in a number of universities, including Bradford, Chester, Greenwich, Huddersfield, Hull, Lancaster and Wolverhampton. The expansion has created challenges of (a) academic staff recruitment, (b) creation of sufficient laboratory space, equipment and the other infrastructure required to maintain the practical course content which employers particularly value; and (c) sufficient provision of industry placements, visits, co-supervised projects and the like. Such challenges should become the experience in other branches of engineering, given a successfully co-ordinated programme to inspire students.



⁷³ See Education Trust at www.lccicet.com
⁷⁴ Evidence of Anna Elliott

⁷⁵ huffingtonpost.co.uk/eve-jardineyoung/women-in-engineering

⁷⁶ Community Interest Companies

D. UK engineering and its governance – evidence and submissions

The composition of the engineering community

68. The engineering “community” in the UK is divided between the institutions, most of which operate under a Royal Charter and are empowered to confer professional status on qualifying members, together with three other oversight bodies. From the 1920s there has been a joint body appointed to oversee the activities of the institutions themselves, being variously named and in 1965 becoming the Council of Engineering Institutions. This body was supplanted by the Engineering Council from 1982, after the failure of the Finniston Report to achieve its recommended changes. In 2002 the Engineering Council’s representative functions were split off to become the Engineering and Technology Board (ETB), subsequently reconstituted and renamed EngineeringUK.
69. The third overseeing body is the Royal Academy of Engineering, set up in 1976 as the Fellowship of Engineering, to represent engineering as a whole, but with membership limited to Fellows who were established senior members of the profession. In 1983 the Fellowship was granted a Royal Charter and in 1992 became the Royal Academy of Engineering. The Royal Academy is substantially funded by central government and acts as the government’s principal engineering adviser. Links with other branches of the engineering community, which are currently close, are however also informal and dependent on personal relationships with senior members of the institutions who are generally also Fellows of the Academy. There are no formal links or powers in relation either to the institutions or to EngineeringUK or the Engineering Council.

70. There are numerous *ad hoc* and semi-permanent groupings set up by the above bodies in various combinations and for various purposes. Recruitment to the profession, training programmes and the inspiring of school children are activities which engage virtually everybody in the profession. However there are many examples of activities in which the different bodies act in an autonomous way, particularly in terms of news and publicity. In addition different branches of the engineering profession have given rise to more specialist bodies or groupings outside the above categories, an example being the Construction Industry Board under which the Construction Industry Council represents aspects of construction, including some interests of the ICE and related construction professions.

The Professional Engineering Institutions

71. The UK’s PEIs are the oldest in the world, dating from the late 18th century, with the ICE being established in 1818. Throughout the 19th and 20th centuries more institutions have been set up which, by the 1920s, numbered over fifty. A series of mergers and takeovers reduced this to around thirty at the time of the Finniston Report, which was itself followed by a number of initiatives aimed at merging all the institutions into one single body. All of these endeavours failed with the sole exception of the Institution of Electrical Engineers, which merged with the Institution of Incorporated Engineers and took a new name as the Institution of Engineering and Technology. The PEIs therefore currently number 35 and range in size from a few dozen members to over 60,000.

D. UK engineering and its governance – evidence and submissions *continued*

Significantly the three largest PEIs (who have commissioned this review) represent some 70% of the total membership.

72. The original purpose of the PEIs was the dissemination of knowledge of the newly emerging technologies; but this developed as the activities and power of the institutions grew. The PEIs today fulfil multiple functions as qualifying bodies, learned societies, promoters of the profession and providers of independent advice to governments and society. By convention each institution focusses on its own distinct area of discipline, but with inevitable overlaps. For example, the ICE is seen in government, media and society as being the independent voice of infrastructure⁷⁷ although the Construction Industry Council sees its role in similar terms; the Royal Academy also plays a more strategic role in relation to government policy in engineering.
73. Many of the institutions operate on a national basis with branches throughout the UK and also on an international basis with offices and membership in many different countries. Thus, the ICE maintains the largest regional footprint of any PEI in the country, with nine regional offices and 70 regional staff, with regional education coordinators in each of the offices. The IStructE is the world's largest membership organisation dedicated solely to structural engineering and operates in several countries. The IChemE represents an international professional community with some 47% of members domiciled outside the UK across some 120 countries and with 13% of its membership in Malaysia and 9% in Australia. National Boards in these countries and in the UK, Singapore and New Zealand look after the Institution's interests locally. The South African

Institution of Chemical Engineers, SAIChE, while legally independent, operates in effect as IChemE in South Africa. IChemE accredits university courses in thirteen countries, with a minority of the accredited institutions being in the UK.

74. The learned society role is also of great importance. Some institutions consider their main and original function to be that of a learned society.⁷⁸ In addition to lectures and meetings, the institutions are, individually, the home of some of the most prestigious and influential societies and journals in the engineering world, in many cases being internationally based. These include, in the case of the ICE, the British Geotechnical Society and its international journal *Geotechnique*. The IStructE publishes a monthly world-renowned journal, *The Structural Engineer*; the IET and IChemE similarly publish regular research journals. These are all academically significant publications and rank as a major part of the research output of the UK in the engineering field.
75. PEIs have important roles in the maintenance of proper standards through registration of members and through Continuing Professional Development (CPD). The PEIs provide the reassurance that those operating in the engineering profession in UK are safe and competent.⁷⁹ The maintaining of quality standards as part of the registration function is essential for further development and is considered attractive to international members. CPD is an important development in maintaining and enhancing professional competences which PEIs should oversee and enforce.⁸⁰ However, in high hazard industries (for example, nuclear and rail) competence

management systems or licencing have emerged which are seen as likely to supersede professional registration, which can be regarded as too coarse a measure. Further, specialist skill sets required of many engineers may not cover the broader requirements for professional registration.⁸¹

76. The PEIs are the subject of many criticisms, however, and it should be recalled that one of the "problems" identified in the introduction to this Report was that the institutions dominate the profession, are seen as self-interested and failing either to engage with the community or to provide effective leadership. It is also pointed out that the institutions and their activities are still 'London centric' whereas education is highly regionalised⁸² and the distribution of engineering activity even more so. PEIs are said to be very inward-looking, focusing on survival above all else. Engineering is a team-based activity that is inherently collaborative and interdisciplinary, yet there is little institutional focus on team competences and assurance.⁸³ Another criticism is of the loss of the professional values of integrity and collaboration resulting from the drive to generate income. The promotion of the New Engineering Contract by ICE as a major source of income is one example, where such material was formerly freely available. Professionals are said to be no longer motivated to produce papers purely for academic interest⁸⁴.
77. Many PEIs are said to be wealthy, but the money invested in core mandate areas such as STEM in schools is thought to be insufficient and lacking in ambition. Sponsorship of UK students for engineering courses is also thought to be modest. PEI governance structures are said to lack business representation. As

such it is difficult for the PEIs to be engaged and relevant to the needs of employers and industry. The functional structures of the PEIs have not kept pace with today's "systems engineering" thinking and they are out of step with developments in industry, which should facilitate crossover between engineering and technical knowledge.⁸⁵ The issue of fragmentation is addressed further below.

Engineering Council

78. The Engineering Council is the regulator for the engineering profession and exercises an overseeing function both in relation to standards and professional registration. In regard to standards, prescribed levels of competence and commitment required to be met for one of three grades of registration, being Engineering Technician (EngTech), Incorporated Engineer (IEng) or Chartered Engineer (CEng). The required standards are set out in UK-SPEC, which has been drawn up in collaboration with the whole profession, which is represented on the Council. As regards registration, the 35 PEIs are each licensed by the Engineering Council to conduct interviews to assess professional competence and to award appropriate registration. The institutions collect a "registration fee" from each registered member that is used to fund the activities of both the Engineering Council and EngineeringUK.
79. The Engineering Council and its licensed members are said to be mutually dependent and work in partnership for the promotion and protection of the public interest. The Engineering Council is effectively a council of engineering institutions and will therefore

77 Peter Hansford, former President ICE

78 RAeS

79 ICE

80 CIBSE

81 Phil Davis, WS Atkins

82 Roderick Muttram

83 Debbie Carlton and Dr Gang Zhao

84 John Barber

85 Erik Bonino

D. UK engineering and its governance – evidence and submissions *continued*

support and implement the will of those institutions. The Engineering Council is incorporated by Royal Charter in which changes require a three quarters majority vote of the Board, followed by a three quarters majority vote of the Licensed Members at a general meeting, followed by a petition to the Privy Council.

80. The Engineering Council commissioned a review (Project GALILEO) in 2014 into what changes the PEIs wished to see in the regulatory function. Whilst relatively minor improvements were suggested, there was no call for regulation to be either increased or relaxed. The current Engineering Council governance mechanism was therefore deemed suited to the task of self-regulation. The need for regulation to be kept separate from promotion and other activities of professional bodies is recognised in other professions and applies equally in the case of engineering. This is supported by one PEI which considered the Engineering Council should be independent in both mind and spirit.⁸⁶ Another institution considered similarly that the Engineering Council should become a fully stand-alone organisation with responsibility for the register and that all income arising from registration should stay within the Engineering Council to support its work.⁸⁷
81. The Engineering Council's governance structure is based on weighted groups that allow each of the licensed institutions to have a proportionate voice in the self-regulation of the profession. This mechanism underpins the setting of standards and the monitoring of appropriate bodies to champion those standards through an established process of peer review.

82. Since 2001 the Engineering Council has been asked on a number of occasions by PEIs to consider extending the scope of its activities, which have been considered and declined on the basis that they would distract from the Council's focus on regulation. The principles on which the Council operates its governance model can be summarised as (i) an overriding obligation to deliver public benefit, (ii) the adoption of peer review of all levels of decision making, and (iii) a governance structure whose decision making is founded on consultation and fundamentally based on consent.

Engineering UK

83. EngineeringUK is the working name for the Engineering and Technology Board (ETB), which promotes engineering within the UK through educating and informing the public and policy makers. Its work comprises three core programmes: the State of Engineering Report, an important source of labour market information for engineering and the foundation on which the two delivery programmes for young people are based: first, Tomorrow's Engineers and secondly the Big Bang Fair and Young Scientists' & Engineers' Fair. EngineeringUK's work thus focuses on young people before they make their GCSE subject choices at the age of 14 and on their key influencers, particularly teachers.
84. Within education, EngineeringUK works with the National Centre for Universities and Business (NCUB) and has integrated the Talent 2030 engineering competition for young women with the Big Bang. NCUB has engaged fifteen universities in the Tomorrow's Engineers programme. An agreement to work together on

six key areas is in place with the National STEM Learning Centre (NSLC) and Network where NSLC leads on the link to teachers and schools and EngineeringUK leads on the employer links. NSLC now has the STEM Ambassador contract and is helping in the winding up of STEMNET. EngineeringUK states that for the £7 million investment in their activities, 400,000 young people are reached and over £10 million of media value generated. Employer activities in schools are encouraged and supported which would cost almost £11 million to deliver.

85. However, serious criticisms have been voiced as to the performance and outcomes achieved by EngineeringUK in its educational activities, which are criticised as ineffective, particularly the campaigns to inspire school children to take up STEM studies and continue into further education and career choice. The topic has been discussed above in terms of the activities of the PEIs, the Royal Academy and others but is here addressed in terms of the role of EngineeringUK. One PEI has expressed the view that EngineeringUK has largely failed to achieve its mission in terms of a meaningful impact in the supply of engineers into the profession.⁸⁸
86. EngineeringUK's flagship educational activity is the Big Bang Fair, which is designed to inspire school children at 11-14 and motivate them to take up STEM studies in their future careers at school and beyond. Allowing for the fact that EngineeringUK has only been operating since 2010, the question still arises why, despite some two decades of endeavour by EngineeringUK and its predecessor, there has been no material increase in numbers taking STEM courses. The UK remains woefully behind international competitors in recruiting potential engineers.
- The Royal Academy's concerns have already been noted⁸⁹ particularly their concern at the failure to produce sufficient numbers of potential engineering students and the general lack of scientific literacy.
87. Statistics can be cited that are suggestive of more recent increases in numbers taking STEM subjects at both GCSE and A level. However, as noted, there is a clear case for a thorough review of all promotional activities, particularly as to the effectiveness of Big Bang and similar presentational events, as opposed to those demanding participation and more long term commitment. Bearing in mind EngineeringUK's request that the PEIs provide additional funding, there is a clear need to establish the appropriate use of both the existing funding as well as any further financial support. The response of EngineeringUK emphasises the importance of maintaining its independence. While it is vital that the regulatory role of the Engineering Council should be independent of other activities within the profession, this is not the case with EngineeringUK whose activities should be directed squarely to the future development of the profession and its members.
88. As noted elsewhere, this review was preceded by discussions between the PEIs, EngineeringUK and others aimed at achieving changes to the governance of EngineeringUK. These led to no agreement and it was pointed out in EngineeringUK's submission that, following the Hawley review, a clear separation was put in place from the regulatory function of the Engineering Council, although the shared source of funding remained, underpinned by the Royal Charter of the Engineering Council. Changes to the governance of EngineeringUK require a 75% majority of members (PEIs plus

⁸⁶ CIBSE
⁸⁷ BINDT

⁸⁸ IMechE

⁸⁹ Paragraph 61

D. UK engineering and its governance – evidence and submissions *continued*

board members and 34 corporate members for EngineeringUK) in addition to approval of the Privy Council. In fact EngineeringUK as successor to the Engineering and Technology Board operates as a company limited by guarantee which has, accordingly, determined its own rules of governance, that do not require approval of the Privy Council.

Registration of Engineers

89. As has been noted, the numbers of members of PEIs who are currently registered as one of the three professional grades has been declining for over a decade. The current total number of registrants of around 230,000 is such that it can no longer be regarded as representative of the profession as a whole. This represents a failure by the PEIs both in the recruitment of members and in motivating those already qualified to become part of the professional engineering community. As to the proportions who have taken up registration, around 51% of those qualified are registered as Chartered engineers and much lower numbers in the case of other grades.⁹⁰ The question arises why many choose not to register. It is suggested that professional accreditation has no bearing on career progression in UK engineering companies and as such the motivation for accreditation is reduced⁹¹. Numbers of companies offering schemes for graduates has declined as corporate staff development and quality assurance measures have improved and displaced external input in professional development.⁹²
90. The accreditation process for CEng is different for each PEI, which is seen as creating unnecessary complexity and cost for business which becomes a barrier to dealing with the PEIs⁹³. Employers

are burdened with the need to transact with each individual institution to support the professional development and registration of their employees⁹⁴. Within some areas, professional standing can be achieved and recognised without a direct link to registration through an external licensing body and professional employees can be sourced from a variety of disciplines, and countries⁹⁵. PEIs generally have far less influence with many organisations that employ engineers than was historically the case.⁹⁶ Registration is valued in certain engineering disciplines, but there is variability across industry sectors. Civil engineers will generally become chartered to practise at a senior level; similarly with structural engineers and, to an extent, mechanical engineers; far less so in electrical engineering and telecommunications.⁹⁷ One very senior engineer reported spending fifteen years in the defence sector as Chief Engineer and then Divisional General Manager, when membership of a PEI was never raised. This included working for the Ministry of Defence on the warhead system for the Polaris Intercontinental Ballistic Missile. Only when subsequently joining a company in the railway industry was Chartered status raised.⁹⁸ Among those strongly supporting registration for all relevant personnel is one of the UK's leading international engineering testing laboratories.⁹⁹ Similarly in the materials processing and application sector, companies are said to use the number of professionally registered staff as an important metric against competitors¹⁰⁰; and a leading consulting engineer commented that their graduate development programme supported and incentivised registration at Chartered level, rather than at the lower Incorporated level.¹⁰¹

91. It appears the promotion of registration was formerly part of the remit of the ETB but was dropped on its reformation as EngineeringUK. The promotion of registration is therefore a matter for the PEIs themselves, who appear to treat the issue on an individual basis with no evidence of a combined approach. It may also be noted that the total membership of the PEIs is some three times the number of registered engineers, so that there exists a large pool of potential registrants immediately on hand who could seek registration. Where registration has particularly failed to achieve any penetration is in the recruitment of registrants at Incorporated and Technician level. The reasons for this are not clearly apparent but the numbers achieved, which should be far higher than for Chartered level, are such as to call seriously into question the value and relevance of maintaining the three grades of registration. The comment of one institution was that it is very difficult to gain interest in EngTech pathways from potential registrants as reflected in the very low numbers of registrants, with very little practical employer interest across the sector. Another comment was that fewer employers today are prepared to pay for professional institution membership¹⁰².

Royal Academy of Engineering

92. The Royal Academy presently has no formal role in the governance of the engineering profession and has no formal links or functions in relation to the PEIs, the Engineering Council or EngineeringUK. However it occupies a significant place in relation to government and has important links to all the bodies comprising the engineering community through its membership which covers the

whole community and its related areas, at senior level. The Royal Academy has been one of the supporters of this review and has the advantage of being closely linked to, but independent of, all the other participating bodies.

93. The Royal Academy is not without critics, particularly in relation to the mooted expansion of its remit. It is pointed out that the Royal Academy is a fellowship of self-selected engineers of merit, which does not confer any knowledge, skill or ability to deliver governance functions. The Royal Academy is described as a “revolving door” of mainly taxpayers’ funding which does not sit easily with independence of the registration and promotion of the profession. Equally the promotion of the profession is said to need a range of skills and approach that does not appear to fit the Royal Academy’s current skill set. The Royal Academy’s governance is suggested as neither suitable nor appropriate currently to oversee either the Engineering Council or EngineeringUK.
94. One PEI observed that there is overlap in the activities of EngineeringUK and the Royal Academy in terms of promotion of education, such that it is seen as a viable option for the role of EngineeringUK to be subsumed by the Royal Academy.¹⁰³ Another PEI considered that while the Engineering Council should remain independently funded by registrants, the Royal Academy and EngineeringUK should join forces to reduce overheads and duplication of effort and be funded by other means, possibly through a professional levy on employers¹⁰⁴.
95. While recognising the Royal Academy as the UK’s national academy for engineering,

90 See discussion under The Engineering population

91 IChemE, Institute of Measurement and Control and others

92 RAeS

93 CIBSE

94 Debbie Carlton and Dr Gang Zhao

95 IOM3

96 John Banyard FREng

97 Phil Davis, WS Atkins and see other comments of Institute of Measurement and Control, IChemE

98 Roderick Muttram

99 Neil Sandberg

100 Institute of Materials, Minerals and Mining

101 Phil Davis, WS Atkins

102 Institute of Measurement and Control

103 IMarEST

104 Institution of Royal Engineers

D. UK engineering and its governance – evidence and submissions *continued*

one PEI suggested that it would require considerable change and modernisation before consideration could be given incorporating the functions of EngineeringUK or the Engineering Council, if either could be achieved. EngineeringUK is essentially a marketing organisation, promoting engineering as a career to young people. This does not appear to fit readily with the role as the UK's national academy for engineering¹⁰⁵.

96. The Royal Academy has taken significant steps in responding to the need for the profession to act together. Following the 2009 Parliamentary report on the engineering profession, which noted the coherent and co-ordinated approach of the profession organised through the Royal Academy, and the recommendation that the Royal Academy takes forward and formalises its leadership role¹⁰⁶, the Academy set up Engineering the Future (EtF). This is an alliance of professional engineering organisations which includes PEIs together with the Engineering Council and EngineeringUK, with the aim of promoting understanding of the contribution of engineering to the economy and society and increasing the role of engineering in the development and delivery of national policy. EtF works with government in areas such as energy, national infrastructure and biomedical engineering, promotes engineering to the public and works with business and industry. EtF was most recently instrumental in producing a timely report to government on the implications of Brexit¹⁰⁷, and can therefore now be seen as an initial step by the Royal Academy towards assuming a significant leadership role within the profession.

Mergers and the public voice of engineering

97. At this point it is appropriate to address another of the problems identified in the introduction, namely what is considered to be the fragmented and ineffective leadership of the profession and its ineffective promotion of the value of engineers and engineering. It will be recalled that these problems have been addressed in recent decades by seeking to achieve mergers between individual institutions with the aim of achieving more effective leadership and of promoting the value of engineers. At least three attempts at achieving mergers failed because the institutions concerned were not persuaded that the benefits outweighed the loss of influence and prestige. However the problem remains and, short of formal mergers, there is a clear need for much closer collaboration between the PEIs, with at least three distinct objectives. The objectives are, firstly, the avoidance of wasteful duplication and division of efforts; secondly, the generally recognised need for a more authoritative body which could speak on behalf of the engineering profession; and thirdly, and perhaps most obvious, the need for the institutions to reflect the increasingly inter- and multi-disciplinary nature of engineering in education, in day to day practice and in research.¹⁰⁸
98. The opportunity for the institutions to achieve much greater efficiencies through the combining of activities is well-recognised by the institutions themselves¹⁰⁹, as well as the need to correct the fragmented and dysfunctional nature of the profession which the institutions currently present to the public¹¹⁰. There are many examples of where PEIs have come

together to collaborate on areas of common interest, thereby avoiding duplication of effort and confusion of message. This is particularly relevant given the need for greater inter-disciplinary working.¹¹¹ It is suggested there would be advantage in the establishment of a joint education liaison organisation to co-ordinate or manage the institutions' inputs to the education process and encouraging more young people into engineering.¹¹² Such improvements should embrace the concept of the public good whilst recognising the individual benefit to the membership¹¹³.

99. For the achievement of an authoritative voice on behalf of the profession, the solution does not necessarily lie in one single body: some professions operate on the basis of having several "authoritative" voices.¹¹⁴ Engineering, however, gives rise to many complex technical issues on which one authoritative voice is needed, for example in relation to the safety of structures or industrial processes, where the public surely expects informed guidance and not mere debate. A typical comment on these issues is that, while a single national PEI is unachievable, a federated model in which the institutions retain their individual identities within an overall umbrella structure has attractions. In this way, PEIs could combine to speak with a single voice on national issues. The key organisations i.e. the Royal Academy, EngineeringUK and the Engineering Council, whose roles overlap in many areas, could usefully be combined into a single entity, which would have an enhanced authority and an improved public recognition¹¹⁵. Some have seen the need for an authoritative voice as requiring a new body to be created; while others have seen the Royal Academy itself as the

natural source for such authority. It is relevant that the government increasingly turns for technical advice to the Royal Academy rather than any individual PEI. This is not a matter of surprise given their number and the nature of contemporary engineering issues which are increasingly inter-disciplinary, sometimes involving areas not covered by any of the existing institutions.

Engineers and their status

100. An important objective in any reorganisation of the profession is the improvement of the public perception of engineering and engineers, seen by many as a factor in the continued failure to inspire sufficient numbers to take up careers in engineering. A typical comment was that engineers are not valued by society in the way they are in Germany and the United States, for example, which means that engineers do not hold equivalent status to other qualified professionals such as doctors or lawyers. The lack of engineers in positions of influence in society is mirrored by a lack of understanding of the importance of engineering and the role engineers play, compounded by our inability to communicate that engineering is exciting¹¹⁶.
101. Such discussions lead inevitably to the question "What is an Engineer?" If the answer is restricted to engineers who are registered with a PEI, then this cuts the number to only 30% of the total membership of the PEIs themselves, or about 5% of the total population of those who regard themselves as working in engineering. Everyone is familiar with technicians who work at various levels of ability and complexity who choose to label themselves as "Engineers", ranging from those who design and construct

105 SOE

106 See paragraph 10

107 Engineering A Future Outside The EU, October 2016,

108 Dr Amanda Dowd

109 Peter Hansford, former president ICE, CIBSE and others

110 Institute of Measurement and Control

111 Chartered Institution of Highways and Transportation (CIHT)

112 Roderick Muttram

113 Institute of Physics and Engineering in Medicine (IPEM)

114 Including the legal and medical professions

115 Energy Institute supported by CIBSE and Institute of Measurement and Control

116 Energy Institute and to similar effect CIBSE, Institute of Measurement and Control

D. UK engineering and its governance – evidence and submissions *continued*

engineering works to those who repair and service those works. Some take the view that this debases the term; but the reality is that there is no available or viable definition of what constitutes an engineer and where any demarcation line should be drawn. The same conclusion could be drawn about other professions, including some which continue to enjoy public regard, such as lawyers. The only sensible distinction to be drawn is between those who choose to join a recognised PEI and those who do not. This puts a strong onus both on the institutions to provide the means for those presently outside the profession to join, and on those who consider themselves engineers to join the profession, in each case to their mutual advantage.

102. As discussed above, the efforts of the former ETB and the PEIs to persuade engineers outside the institutions to join at Technician or Incorporated Engineer grade have substantially failed and should now be reviewed as to their usefulness. Given the extensive remarks on the limited value placed on corporate membership and registration, it cannot be surprising that very few of those qualified to register at Technician or Incorporated level are motivated to proceed, particularly as this involves not insubstantial fees and other commitments. Given the tiny numbers currently registered at either EngTech or IEng level, there is a strong case to abolish these titles and to create new grades which are more attractive to would-be entrants with fee levels and entrance requirements designed to attract a good proportion of the three to four million people working in engineering with whom the profession currently has no contact. As well as enhancing the membership of the institutions,

such increased membership would provide real data on the numbers of engineers available from which more reliable predictions can be made.

103. Enhanced membership of the institutions coupled with better organisation and more clearly identified leadership of the profession should lead to enhancement of the status of engineers, particularly if this is accompanied by a much wider and more general regard for STEM studies in schools and increased recruitment to the profession in future. As part of efforts to seek increased membership, the PEIs must be more open to potential members and should seek to liberalise their entry requirements to attract those who have not chosen a prescribed route but who may wish to seek Chartered status. This should include welcoming candidates who have not studied maths and physics at A level or do not have engineering as their first degree.¹¹⁷
104. Changing the public perception of engineering and enhancing the status of engineers to align with that of engineers in Europe, the United States and elsewhere will not be achieved by internal action of the engineering community itself but must enlist the support of government and the media. With regard to government, the topic was addressed in the Parliamentary report already cited¹¹⁸, which quoted evidence given to the committee by Lord Broers¹¹⁹. He noted the strange convention that chief technical advisers to government departments were designated “Chief Scientist” or “Chief Scientific Adviser”, notwithstanding that the advice given was generally on engineering matters and the individual so appointed was in most cases an engineer.¹²⁰ Lord Broers called for the posts to be renamed as “Chief

Engineer” etc. It is understood the matter was raised at Cabinet Office level but no action was deemed appropriate. This initiative should be revived with the full force of the engineering community behind it, with other similar examples of mis-description, by which engineers and engineering are made to take second place to science, being exposed and corrected.

105. With regard to the media it is a common experience to find that reporters and reviewers of engineering matters in both the press and in radio and television are lacking in

the background and qualifications needed to present a proper account, including an appreciation of the importance of UK engineering innovations and achievement. This applies particularly to the BBC which has a long-standing tradition (in common with other UK institutions) of employing individuals with liberal arts backgrounds in positions of power and influence. The campaign to change such entrenched attitudes will be long and difficult but needs to be pursued with sustained vigour by the whole engineering community.



¹¹⁷ John Barber

¹¹⁸ Report of Session 2008-09, Chaired by Phil Willis MP, see Footnote 4

¹¹⁹ Past President, Royal Academy of Engineering

¹²⁰ Of many such individuals may be noted Professor John Perkins FEng, Chief Scientist at the former Department for Business Innovation and Skills; and Sir David Davies FEng, Chief Scientific Adviser, MOD and Past President of the Royal Academy of Engineering

E. Funding matters – evidence and submissions

106. EngineeringUK receives funding from the registration fees set by EngineeringUK's Board and paid, as provided by the Engineering Council's Royal Charter, by the individual registrants. Payment of the registration fee is a requirement of the licence granted by Engineering Council to each PEI under which the PEIs carry out assessment and professional registration of candidates. From these fees, EngineeringUK makes a grant of £2.5 million to the Engineering Council to fund their operations¹²¹. ICE, as one of the three largest funders, provides EngineeringUK with over £1.1million annually, of which 40% is paid over to Engineering Council, including 7% in respect of the Legacy Pension Fund. The 60% retained by EngineeringUK funds the Big Bang event, Tomorrows Engineers and the annual report *"The State of Engineering."*
107. Other PEIs contribute on a similar basis, although at least one is said to charge an additional membership fee if a member is professionally registered. Contributions are thus in proportion to registered numbers, and not to the total membership, which in overall terms is three times the registered membership. ICE points out that PEIs with a low proportion of registrants pay less in proportion but receive all the benefits of EngineeringUK's activities. Some members therefore argue that they are subsidising other branches of the profession.
108. Similar concerns are voiced by other PEIs, including the difficulty of justifying the Engineering Council being funded by EngineeringUK, whose function is to promote engineering to the next generation. Although a worthy objective, the public benefit is not advanced by these arrangements and there is a strong argument for decoupling the funding

of EngineeringUK from registration fees¹²². However, it is to be noted that the funding collected by the PEIs is not "their" money but the registered members' money: If there was a well-defined task and timescale the broad profession would be likely to support a larger fee¹²³. Concern is expressed that too few registrant members understand the mechanism that sees their registration dues paid to EngineeringUK with only a portion passed on to the Engineering Council to operate the registration scheme. IStructE considers there to be a link between its growing numbers of non-registrant members, its increasing percentage of internationally based members and a registration fee that primarily supports UK engineering education promotion. While recognising that EngineeringUK has been very successful in securing outside financial investment for its outreach programmes, there should be a review by EngineeringUK, the Engineering Council and the Royal Academy as to how they will deliver services and whether their current governance arrangements are suitably cost-effective, efficient and appropriate.

¹²¹ EngineeringUK

¹²² Institution of Royal Engineers
¹²³ CIBSE

F. Other governance models – evidence and submissions

109. There are many different governance models which can be selected from different UK professions and from engineering bodies in other jurisdictions. In regard to the latter many, particularly from Commonwealth countries, are based on the UK Institutional model but in most cases seemingly having improved on the current UK model. Thus many consultees instanced the Hong Kong Institution of Engineering (HKIE) which includes the various disciplines under one central body¹²⁴. If this model were to be adopted, independent PEIs would sit under one central body, operate independently, but share back office and other functions as appropriate. The central body should be a new, independent and authoritative body¹²⁵. Other countries having a single professional body of engineers with “chapters” for the various engineering disciplines include Australia, New Zealand and Ireland, although this in itself is unlikely to provide a more effective ‘voice’ to government and society¹²⁶.
110. In the view of the Royal Academy, while the diversity of engineering and the history of the profession have led to the current situation, professions with a single or smaller number of representative bodies have a distinct advantage. There have been successful mergers, but only when there is a compelling mutual case. The Royal Academy considers it to be difficult and undemocratic to force mergers, particularly when many smaller institutions are successful in their own right and meet the needs of their constituencies. The Construction Industry Council could be cited as an example of merger of related interests; but their effectiveness in bringing together the views of the PEIs involved in the construction industry is doubted.¹²⁷
111. One UK institution, while agreeing with the principle of collaboration to increase effectiveness and efficiency, noted that its level of collaboration with other overseas-based institutions was increasing and considered that international, discipline-specific collaboration was more likely to increase.¹²⁸ Another institution noted similarly that it had a number of co-operation agreements in place with member bodies in the United States, Canada, France, Japan and Hong Kong and had seen interest from overseas engineers in gaining membership of the UK institution to gain registration with the Engineering Council. However some individual members of the former Institution of Electrical Engineers have expressed the view that the expansion to become the IET has made it less relevant to them by becoming more generalist, while not increasing its sphere of influence. To advise on engineering issues requires highly specialised knowledge in the particular field, rather than a generalist approach. This had led some members to support the establishment in the UK of the more specialised US-based Institute of Electrical and Electronics Engineers.¹²⁹
112. It is relevant to note the legal structure by which the majority of institutions and other bodies within the engineering community are set up, which is by Royal Charter, granted after appropriate application and scrutiny by the Privy Council Office. The grant of a Royal Charter can be regarded as the ‘Gold Standard’ in respect of the work of regulatory and other organisations and the status thus granted can be seen as a recognition of the professional standing of the body, while also establishing it as an incorporated organisation with limited liability of its members. The Royal

¹²⁴ Similar to the airline industry where independent operators are members of a large alliance.

¹²⁵ CIBSE

¹²⁶ Peter Hansford

¹²⁷ Peter Hansford

¹²⁸ BINDT

¹²⁹ Roderick Muttram, Professor Charles Turner and others.

F. Other governance models – evidence and submissions *continued*

Charter of the Engineering Council contains the important right to confer and use the title “Chartered Engineer”, which title together with appropriate post-nominal letters is thus authorised by the State.¹³⁰ However, while the title is protected there is no requirement for persons undertaking engineering work in the UK to be registered, subject to very limited exceptions¹³¹.

113. The major criticism of a Royal Charter is that it is relatively inflexible and difficult to amend. All the bodies comprising the engineering community, with the exception of the Engineering Council, could equally operate as a company limited by guarantee, of which the governing memorandum and articles of

association may be altered at will, subject to approval by the members and notification to Companies House. In either case the body so formed may operate wholly or partially as a charity within the requirement of charity law, which applies equally to a limited company or a company established by Royal Charter. A company limited by guarantee can make rules and requirements equivalent to those of a body established by Royal Charter. A company is therefore a suitable vehicle for any temporary governance arrangement as part of a future reform programme; and also for achieving an expansion of the activities of any body which would otherwise be restricted by a Royal Charter.

G. Lessons from similar initiatives – evidence and submissions

114. It should not be supposed that similar initiatives from which lessons are to be learned are limited to the past few years or even decades. It has been noted that UK engineering reached a zenith around the year of the Great Exhibition, 1851, after which there can be seen to be a slow but inexorable decline in both engineering and science, although with notable peaks in both¹³². The situation was apparent to the government which set up, in May 1870, a Royal Commission on Scientific Instruction and the Advancement of Science, chaired by William Cavendish, Seventh Duke of Devonshire. The impetus behind the “Devonshire Commission” was concern among industrialists and manufacturers that Germany, which had recently overhauled its education system and established specialist technical universities, was gaining a significant economic advantage over Britain.

115. The reports, published between 1872 and 1875, documented the inadequacy of scientific education in the UK and the elementary level of scientific instruction available in even the most advanced schools. Facilities for science research were almost non-existent. The unusual feature of this Commission is that some of its recommendations were acted on within a relatively short time, including the setting up of the Cavendish science laboratories in Cambridge, largely funded by the Duke himself, a man of considerable scientific education and ability. Other measures included the introduction of properly funded science professorships. But the bolder proposals for curriculum reform were never implemented, and the report thus became the first of many far-reaching reform proposals not to achieve their objectives.¹³³ The lesson to be learned from this early experience is that the

existing educational system in the UK is highly entrenched and not easily dislodged by logic or evidence.

116. As education in both science and engineering did gradually become more widely established, with schools of engineering being set up in several universities in the latter part of the 19th century¹³⁴ and a greater number of technical colleges and polytechnics, the engineering institutions, which remained the repository of specialist knowledge, began to focus on the need to reform the organisation of the profession. It has been commented that there have been a number of attempts over the past fifty years to develop a working governance structure for the engineering profession and particularly to achieve a single overarching body which would speak for the profession. These attempts have included proposals for merger to optimise the use of resources, with the constituent parts maintaining their own specialised areas and engineering disciplines. No such structure has yet been met with sufficient support from the institutions, however.¹³⁵
117. Between 1977 and 1980 the Finiston Inquiry examined all aspects of the engineering profession including the issue of professional regulation, which had hitherto been dealt with by individual institutions. The Finiston report recommended a statutory register of qualified engineers, operated by a new Statutory Engineering Authority, replacing the existing Council of Engineering Institutions. The report emphasised the need for the new body as an “Engine for Change”. The proposals did not command the support of the PEIs and, after extensive debate, an alternative body, the Engineering Council, was established to take over both the regulatory functions of the

¹³⁰ Keith Lawrey

¹³¹ Work at Nuclear sites is regulated under the Nuclear Installations Act 1965, the Energy Act 2013 and the Health and Safety at Work Act 1974. Work at certain reservoirs is regulated under the Reservoirs Act 1975.

¹³² See FN 5

¹³³ Professor Lisa Jardine, BBC talk, 2010

¹³⁴ The earliest school of engineering in UK was that set up in Kings College London in 1838

¹³⁵ Engineering Council

G. Lessons from similar initiatives – evidence and submissions *continued*

CEI and the task of promoting the engineering profession under a new Royal Charter. The lesson to be learned from the Finniston Report is that little is to be achieved without the support of the PEIs which have, for well over a century, represented the membership of the profession.

118. A further review in 1993¹³⁶ resulted in changes to the Engineering Council but these were to be short-lived. Between 1999 and 2001 a group led by Dr Robert Hawley promoted further major changes on the basis that the Engineering Council had failed to promote engineering or to engage with the wider engineering community. In the result these functions were taken over by the newly established Engineering & Technology Board (ETB) with the Engineering Council being given a fresh Royal Charter and confined to regulation of the profession in the UK and its representation internationally. In 2010 the ETB was reorganised and renamed EngineeringUK. Given the level of criticism already noted of the achievements of EngineeringUK to date, it may be concluded that the devising and setting up of an appropriate model for the promotion of engineering, and particularly the inspiring of school children to embark on the studies needed for entry to the profession, remains unfinished business.
119. In the period leading up to this review a number of notable reports have been produced. In 2013, Professor John Perkins, Chief Scientist to the former Department of Business Innovation and Skills (BIS), produced a Review of Engineering Skills. The report makes recommendations for promoting engineering to young people, for improved teaching of STEM subjects and for the promotion of both vocational education including apprenticeships and university courses,

in each case with enhanced participation and contributions from industry. It draws attention to the poor record of attracting women and to the gradual leakage of potential engineering talent during the process of qualification, as well as illustrating the loss of numbers which occurs progressively from GCSE stage through to professional registration by a striking visual presentation based on a leaking pipeline (see Annex 5).

120. In 2014 Dame Sue Ion chaired a further review for the Royal Academy's Universe of Engineering, entitled *A Call for Action*. This report, carried out by a panel of senior members of the engineering community, drew conclusions similar to those of the earlier Universe of Engineering report of 1993 namely: that the central role of engineering in society is not evident to the public; that the universe of engineering is much larger than has been appreciated and ranges across the whole economy; and that the professional engineering community needs to evolve to meet the needs of those currently beyond its reach. Attention was drawn to the need to address the three or four million people working in engineering with no connection to the institutions, which has been reviewed above. The lessons to be learned from the Perkins Report and from the Universe of Engineering Report is that the task of effectively promoting engineering in the UK so as to enhance the future supply of qualified engineers is immense and will require the concentrated actions and energy of the whole engineering community. A rather more upbeat message is conveyed by a third report, of Sir William Wakeham, published in April 2016, on STEM degree provision and graduate employability. This report concludes that,

while there is much variation across sectors, engineering in general fares favourably in terms of employability and salaries. The report also notes the need for adaptability and personal resilience and that graduates must be prepared for a lifetime of learning, a lesson which applies equally to the PEIs as to their future members.

121. In November 2015 the Minister for Skills, on behalf of Departments of Education and Business, Innovation and Skills, set up an Independent Panel on Technical Education, chaired by Lord Sainsbury, to advise ministers on actions to improve the quality of technical education in England and Wales and, in particular, to simplify the current system to ensure the provision of the skills most needed for the 21st century. The panel reported in April 2016. The Foreword to the report notes that it is over a hundred years since the first report was produced which highlighted the failures of technical education in the UK, and that since the Second World War there have been very many attempts to reform the system. These have all been unsuccessful because they tinkered with technical education, and failed to learn from successful systems in other countries. The report concludes that while government has to design the overall framework, industry experts must lay down the knowledge, skills, and methods of assessment for each qualification.
122. The report calls for a system of clear educational routes that career advisers can easily explain, with flexible bridging and transfer provisions, together with the new apprenticeship levy, with industry taking ownership of the content and standards of technical education, and for government to ensure the availability of high-quality teaching and access to industry-standard facilities and equipment with adequate funding.
123. While it is too early to judge the outcome of any of these recent reports, they each reveal a consistent pattern in calling for more recruits at all stages to be inspired or persuaded to undertake STEM studies; in calling for greater numbers to be encouraged to embark on courses, either at university or technical college, and in either case with or without additional employment-based training; and in calling for more of those emerging with qualifications to seek, through further vocational training, registration with one of the PEIs to become a fully-fledged member of the profession. The conclusion must be that, despite the plethora of reports and recommendations, the engineering industry remains short of the recruits that it needs at all levels and that the recruitment that has regularly been called for and encouraged at many levels is not yet happening.

¹³⁶ Engineering into the Millennium, Interim Report 1993

H. Conclusions proposed by consultees

124. Many of the contributors have provided their own conclusions and recommendations which are here briefly reviewed. In terms of closer co-operation between PEIs, it was noted that individual institutions often wished to see activities badged with their own brand identity rather than operate under a generic brand such as Tomorrows Engineers. There is a plethora of organisations operating outside the professional engineering community framework promoting niche aspects of curriculum support, which adds confusion. The engineering community needs a vision of what is to be achieved and of how to organise its resources to realise that vision.¹³⁷
125. Many contributors supported the proposal for a single, strong, effective, but consultative overarching body to lead the engineering profession.¹³⁸ Such a body should exist alongside the PEIs, tasked to deliver all relevant cross-profession functions that currently sit in different ways in a number of independent bodies. The Royal Academy should itself be a core part of any such reorganisation and play an active role in shaping and delivering the solution. There should be a clearly-drawn mission that is universally endorsed across the profession, a well-defined relationship with the PEIs, and an ability to draw on the strengths, resources and networks of the whole profession.¹³⁹ While agreeing on the need for a single body with the responsibility, authority and mandate to lead the profession, one PEI considered that a new body was needed, rather than the Royal Academy.¹⁴⁰ Others, however, saw the Royal Academy as a necessary partner in any such reorganisation of roles.
126. Other conclusions emphasised the importance of addressing the national skills shortfall and the need to build resilience into the profession,
- driven by a clear line of leadership and governance.¹⁴¹ Employers needed to be at the heart of education to reach the next generation of engineers. Any governance changes should focus on greater employer and education engagement and not a hierarchical approach based on individual members or fellows.¹⁴² In addition, there was a case to review the different levels of registration. IEng and EngTech registration numbers remain very low and the registration system could be seen as too hierarchical, over-designed and no longer fit for purpose.¹⁴³
127. While accreditation of degree courses was still one of the strengths of the profession, accreditation can be seen as an irritant to universities seeking to promote courses that cross disciplinary or sectoral boundaries. While the accreditation of engineering degrees through the Engineering Council is an important factor in undergraduate choice, the role of the professional bodies in regard to future graduate employability has been highlighted in recent reviews on higher education graduate outcomes. The issues raised warrant careful review and indicate the need for greatly simplified processes that avoid unnecessary duplication.¹⁴⁴

¹³⁷ IStructE

¹³⁸ RAeS

¹³⁹ Royal Academy of Engineering

¹⁴⁰ CIBSE

¹⁴¹ Ministry of Defence

¹⁴² EngineeringUK

¹⁴³ Royal Academy of Engineering

¹⁴⁴ Royal Academy of Engineering

I. Reply/response submissions from consultees

128. When the full complement of submissions had been received from both nominated and volunteer contributors, the principal parties, including the commissioning PEIs, were invited to review and provide responses to the submissions, which had all been logged on the review private portal. The following paragraphs summarise the responses received.

Institution of Engineering and Technology

129. The IET identifies three key areas for review namely: pipeline of future engineers, increased professional registration and a more effective governance structure for the profession. As to securing recruits to the profession, while there was a proliferation of initiatives and programmes, the recommendations of the Perkins Report were to be noted in seeking additional support from the engineering community and government alike for the Tomorrow's Engineers Programme. There was a need for an entity with influence to secure such additional support and generally for the promotion of STEM subjects and engineering as a career.

130. To promote increased registration the IET has introduced programmes to encourage earlier registration both at graduate and technician level and intends to monitor the results which should lead to earlier registration. PEIs must be more inclusive and welcome applicants from related disciplines with innovation, creativity and problem solving at their core and ensure that the process of registration is more flexible and works with changing lifestyles while maintaining standards. Increased registration can be achieved through working with corporate partners and with SMEs. IET would welcome additional registration from within the 2.7 million

declared engineers identified by the Universe of Engineering Report.

131. For more effective governance, there is a need for a coherent single voice to harness collective efforts including those of the PEIs. IET concludes that the Royal Academy has significant technical authority and should take the lead in co-ordinating the provision of expert engineering input to government, with the resources of the PEIs. EngineeringUK and the Engineering Council should be consolidated under a reformed Engineering Council in order to produce two rather than three co-ordinating organisations; but it is recognised that collaboration across the PEIs themselves remains an imperative for success. EngineeringUK's objectives are the promotion for public benefit of engineering in all its applications and the advancement of education in engineering and technology. The IET sees consolidation under the Engineering Council as the preferred solution under a modern and transparent governance structure.

Engineering Council

132. The Engineering Council emphasises the need to ensure that society can have confidence and trust in engineering. This requires the maintenance of internationally recognised standards of competence to ensure that the public is provided with trustworthy and reliable products and services and with ethical and sustainable development. This is the purpose of the regulatory functions which must be maintained free of conflicting interests. Responsibility for promoting engineering and professional registration lies with others.

133. While engineering continues to suffer skills shortages, there was a need to distinguish between skills shortage in terms of difficulty

I. Reply/response submissions form consultees *continued*

in recruiting sufficient skilled individuals, and a skills gap, where staff lacked full proficiency, the problem in engineering being in relation to the former. With regard to the continued decline in numbers of registrants this was partially due to the switch in entrance requirements to Masters level, which resulted in a significant increase in the average age of registration. This, coupled with an increased in the retirement age, should in the long term lead to an increase in registered numbers.

134. If, as suggested by a number of contributors, a federated structure were to be adopted for the profession, the Engineering Council would need to continue to operate its separate functions and regulation should be maintained as an independent activity. The current structure of the Engineering Council was appropriate to reflect and serve the public interest and is not considered to require review.

EngineeringUK

135. EngineeringUK emphasises the need for a joined up approach to engineering engagement targeted at young people with employers at its heart, which should build on the joint working of PEIs and employers, echoing the recommendations of the Perkins report. It is considered essential to maintain the system of ring-fenced funding. Any review should include employers who contribute much of the funds derived from registration.
136. The question of governance of EngineeringUK is a matter for its members, which includes all 35 PEIs as well as corporate members and trustees nominated by bodies outside the charity. While there are calls for merger, there is no evidence to support such a change. The role of EngineeringUK includes the promotion of engineering and engineering careers,

focusing on the Big Bang Fair and Tomorrows Engineers. EngineeringUK produces the Annual Report into the state of engineering in the UK and co-ordinates a unified voice for engineering to the public. What is needed is closer co-operation between bodies involved in STEM promotion.

137. The three largest PEIs should increase their funding and support for the Big Bang Fair and Tomorrows Engineers programmes by involving their members as well as non-members who might be drawn into membership through a commitment to education. EngineeringUK's expenditure, principally on the Big Bang Fair, can be seen to be highly efficient by comparison to other public engagement events.
138. EngineeringUK supported reform proposals contained in a report of the Royal Academy of September 2012 which highlighted the common interests of the professional engineering community. These were: to speak with one voice on engineering issues; to promote an understanding of the critical contribution that engineering makes to national and global issues; and to promote the profession coherently, consistently and effectively to young people. A professional engineering forum was proposed to include all PEIs, EngineeringUK, the Engineering Council and the Royal Academy, which would meet in plenary session at least once a year to facilitate a more structured approach and the interchange of views with greater sharing of leadership of projects and programmes among PEIs.

Royal Academy of Engineering

139. The Royal Academy considers that current initiatives for the future requirements for UK engineers and technicians are not nearly as effective as required. The Royal Academy has developed the Engineering Talent Project

(ETP) which addressed barriers holding back recruitment, culture and practice in industry, understanding 21st century engineering and its poor image and the improvement of schools' engagement activities. The Tomorrow's Engineers Programme needs to become the *de facto* engineering engagement mechanism in schools.

140. The Royal Academy recognises the problem of poor levels of registration at all levels resulting in less than 5% of those working in engineering roles being registered. This was a reflection of the inter-disciplinary nature of engineering which universities had been slow to accept. While PEIs tend to focus on conventional routes to engineering, new emerging areas needed to be recognised and the Royal Academy would support a significant review by PEIs to ensure their relevance to practising engineers.
141. The Engineering Council and EngineeringUK represented widespread duplication and overlap. There were strong calls for a new representative voice for the profession which the Royal Academy supported. As to the proposed merger of both organisations with the Royal Academy, the regulatory function should be kept separate from promotion of the profession. The Royal Academy did not support the creation of an entirely new authoritative body. However, an appropriate governance mechanism could be created which would allow the engineering promotion function of EngineeringUK to be overseen by an independent board with the existing Royal Academy education programme being consolidated within it and PEIs having a stronger incentive to do the same.
142. Progress has been made in collaboration across the professional engineering community: more PEIs are sharing accommodation and collaborating

in educational projects. However, more collaborative effort was needed and progress depended on simplifying the landscape, improving co-operation and removing duplication. Attention should be devoted to promoting arrangements between employers and the professional engineering community and making them more effective.

143. The Royal Academy recognised differing opinions on the effectiveness of existing arrangements for the promotion of science and engineering in schools. While the Engineering Council produced evidence of improved public awareness and attitudes, this had not led to significant increases in recruitment in higher or further education in engineering or engineering apprenticeships. A simplified landscape would make it easier to focus professional resources, remove duplication and achieve more focused effort.
144. The Royal Academy acknowledged criticism of the process of accreditation and concerns that the academic qualification system did not sit easily with the promotion of registration. The PEIs needed to look carefully at their values and at changes necessary to meet the needs of the professional engineering community including value for money of registrants' subscriptions. The major concerns were: the level of overlap, duplication and confusion arising from the number of engineering organisations; and the need to create a simplified structure for the profession with a stronger and more visible leadership structure. The solution was not for one organisation to run everything, but significant governance changes were required. Care was needed to ensure that those with a stake in the professional engineering community were properly represented; but change was essential to improve performance and increase relevance.

J. Discussion and conclusions

145. It is appropriate to begin, following the Terms of Reference, with the problems which need fixing, which should be the main focus of this Report. This is covered in the Introduction above where, after reviewing the submissions received, it is concluded that the problems in summary are (1) the Professional Engineering Institutions, which are too numerous and have failed to engage with the profession; (2) fragmented and ineffective leadership of the profession; (3) failure to produce enough skilled and motivated engineers; and (4) ineffective promotion of engineers and engineering. To these principal concerns, however, should be added many specific or subsidiary problems which have been raised in the submissions received.

146. Further problems include the contended failure of the institutions to engage and provide leadership, which includes the problem of the low and generally declining levels of registration within the PEIs and the broader question of the appropriate governance arrangements for the profession in the 21st century. In terms of fragmented leadership, questions arise as to what form of leadership is appropriate and which body should or can provide such leadership. The generally accepted failure to produce enough engineers leads to the issue of education and the apparent failure of both the engineering community and our education system to motivate children to take up engineering as a career and for this purpose to study appropriate STEM subject at school. It also gives rise to the question how to deal with the wide disparity of views as to the numbers in fact required and variations across different sectors. Behind any consideration of numbers is the "elephant in the room", namely the statistically assessed but potentially

huge numbers of people reported as working in engineering who are not affiliated with any of the existing institutions and of whom little is known. In terms of the promotion of engineers and engineering, specific problems include the perceived status of engineers in the UK in comparison with other countries. All of these issues need to be the subject of recommendations and of an execution plan to implement those recommendations.

Professional Engineering Institutions

147. The Professional Engineering Institutions (PEIs) represent the core of the engineering profession and can be seen as one of the originators of the institutional tradition throughout the world. Each of the PEIs has, in turn, been created by their members who considered their particular branch of the profession not to be adequately represented by existing institutions. This led to the creation of over fifty such bodies which have, over time, become more rationalised through mergers and take-overs into the present number of 35. The Institution of Civil Engineers was responsible for the founding of engineering as a civil as opposed to a military discipline, and in so doing created the original learned society traditions of exchanging knowledge and expertise which have been replicated in all the UK institutions and throughout the world. The PEIs indeed remain the repository of a large proportion of the engineering expertise within this country. However, comparison shows that some countries have managed to adopt an institutional system which many now regard as preferable or at least having advantages over that of the UK.

J. Discussion and conclusions *continued*

148. The PEIs have become one of the main features of this review and, in formulating any recommendations, it should be remembered that Adam Smith in *The Wealth of Nations*¹⁴⁵ was opposed to guilds and other institutions which he believed restricted the movement of workers from one trade to another. If such barriers were removed, the “invisible hand” of the market would lead each to specialise in the trade they were best suited for, improving quality and encouraging innovation. While Smith did not have professional institutions in view, his observations remain valid to the extent that the institutions must carefully balance the benefits they seek to create against the effect of restrictions in stifling free movement and innovation. Individually the institutions undertake, largely through voluntary activities of members, a huge amount of work in support of the profession, particularly in the fields of education and training¹⁴⁶. They undertake these activities, however, largely on an individual basis.
149. The professional institutions in their present form give rise to many of the problems which have been perceived over past decades, substantially in terms of their disparate and seemingly competing structures, and particularly in their restricted range of subject matter which can be considered to have the effect of compartmentalising engineering according to the specialities of each institution. While this may have advantage in terms of generating specialists expertise, it has disadvantages in aligning and encouraging both training courses and subsequent careers towards a particular subject area, when the consistent message from engineers in current practice is of the need to adopt a multi-disciplinary approach, to be prepared to embrace both new methods and techniques within their own discipline and new and novel technologies and industries which will typically be encountered within the span of a single career. While each of the PEIs represents primarily if not exclusively its own branch of engineering, the near universal view is that PEIs should respond to the increasing need for engineers to operate in an inter-disciplinary environment, adopting a systems engineering approach. Rather than advocate changes within the PEIs, the clear message is that they should be adopting some form of combined operation so that members will have access to other branches and specialisms within the wider spectrum of engineering.
150. Another problem with the present operation of the existing 35 PEIs is that they represent a high level of duplication both of administrative and professional functions, to the extent that were they to be subject to normal commercial forces and pressures, many of their functions would be pooled or merged and their numbers undoubtedly reduced by takeovers and mergers. Being controlled by boards of trustees with a comparatively rigid organisational structure, the PEIs have over many years maintained their existing structures and organisation such that they are now perceived as self-preserving and inward-looking, and as failing either to engage with the wider engineering community or to provide effective leadership. These problems similarly suggest a remedy in terms of combined operation both at administrative levels and at governance levels so that, if individual PEIs are to maintain their present specialisms, they should do so in a manner which is demonstrably efficient and cost-effective.
151. It has been observed that the numbers of registered members of most of the PEIs is low and generally declining, although there are limited exceptions where individual PEIs have significantly increased both their membership and registered numbers. The fact that some PEIs succeed where others are failing is not a reflection on the management or leadership of those PEIs whose numbers continue to decline, but confirmation that in general there is a problem affecting most PEIs in making themselves relevant to prospective members, a task made more difficult by the almost universal absence of any form of statutory regulation as applies to other professions such as law and medicine. Engineers need to be persuaded of the relevance and benefit of joining an institution and of registration. The fact that most PEIs represent a comparatively narrow range of activities leads naturally to a perception that, whatever the true state of affairs, they are out of touch with modern developments in technology. This can only make the task of attracting new members and new registrants even more difficult. Again the possibility of adopting some form of combined operation between the existing PEIs should make membership more attractive to those who wish to have access to a broader range of skills.
152. The institutions have, both individually and collectively, been very much aware of the level of criticism both from within and from outside the PEIs themselves. Attempts to create a form of combined operation date back to the 1920s and became the subject of a major government inquiry in the 1970s¹⁴⁷. These initiatives, however, led only to the setting up of new bodies to oversee regulation and promotion of the engineering profession, with the existing PEIs retaining their independence and freedom of operation within the agreed system of self-regulation. It was in these circumstances that, during the last three decades, there have been separate proposals for the merging or combining of the PEIs to form a single Engineering Institution, on the last occasion involving detailed proposals for merger between the major institutions. The fact that all these proposals were eventually rejected by the trustees of the institutions concerned¹⁴⁸ does not detract from the important fact that each of the institutions concerned has been persuaded of the need for combining their activities and that the arguments for doing so remain and have grown stronger in the decade following the latest attempts at merger.
153. Given the extensive debate which has already taken place on mergers, it is unnecessary to rehearse the arguments further¹⁴⁹. However, three further matters should be borne in mind in approaching the merger argument again, which are also relevant to other issues considered in this Report. Firstly, the contention that the institutions individually or collectively fail to provide effective leadership. Many have called for the Royal Academy of Engineering to become the voice of the profession, which to a large extent is the reality at present in that the government is said to look first to the Royal Academy for advice on engineering matters. However, the Royal Academy does not represent the bulk of the profession, being confined to senior and in many cases retired members. The combining of the PEIs, in whatever form might eventually emerge, will be a powerful lobby representing the effective membership of the engineering profession, which will be entitled to a voice on behalf of the membership alongside the voice of the Royal Academy. Secondly, many of the PEIs are heavily involved in educational

¹⁴⁵ Published 1776

¹⁴⁶ See paragraphs 51-54 for examples

¹⁴⁷ The Finiston inquiry

¹⁴⁸ With the single exception of the Institution of Electrical Engineers which agreed a merger with the Institution of Incorporated Engineers to form the Institution of Engineering and Technology

¹⁴⁹ But see *The Rebirth of Engineering*, Michael Letellier, Training Publications Ltd., 2003.

J. Discussion and conclusions *continued*

and promotional activities which presently operate separately for each PEI with limited co-ordination. As recommended elsewhere in this Report, the work of the PEIs must be co-ordinated both within the institutions and within the activities of other bodies¹⁵⁰. Such co-ordination will be aided by and should form part of the combining of activities of the PEIs.

154. The third matter which needs to be borne in mind is that the decisions to reject merger proposals by individual PEIs was reached in most cases on the basis of self-interest and preservation of the existing structure and independence of those institutions. It needs to be emphasised that, while there are very substantial advantages for individual PEIs in the merger of interests and functions, the most important interests that the institutions must take into account are those of the engineering profession as a whole and the national interest. Whether or not individual institutions accept that they owe a public duty in the management of their affairs, as bodies which operate wholly or mainly subject to charity law there can be no doubt that they owe such a duty. It should be sufficient, however, that some form of merger is in the interests of the profession as a whole and the members.
155. If it is accepted that the solution to the problems discussed is a form of merger of the interests and activities of the separate PEIs, it remains to be considered how this might be brought about. The possible steps involved in a merger are discussed in the Futures paper (Annex 2) and include a wide range of matters from pooling of training courses and library services to the sharing of headquarters premises and common membership. A contemporary example where a combined approach is

essential is in the development of Building Information Modelling (BIM) where the emerging technology knows no boundaries or national frontiers. Other new and far-reaching technologies will demand the same approach. In each case, co-operation will require the removal of existing barriers which should lead to reduced costs and freeing up of facilities. To initiate the process it will be necessary for a core number of PEIs to agree in principle that they will embark on a process of merger of activities and interests. Provided there is such an agreement in principle, it is unnecessary for there to be agreement on where the process should end or when it would be regarded as complete. It is clear, however, that there should be a commitment to the eventual merging of membership such that a member of one institution should be able to enjoy the facilities and opportunities of all. It is also of the essence that the participating institutions maintain their original and separate identities, subject to any bilateral mergers that might be agreed in parallel with the general merger process.

156. For the purpose of these proposals it will be necessary to establish a new joint body, initially composed of representatives of the institutions agreeing to join the process of merger of interests, with provision for additional future members as other institutions decide to join. The joint body could conveniently be set up as a company limited by guarantee with members and a board representative of those joining, which can also operate as a charity. The composition of the board can conveniently be based on the pattern established by the Engineering Council. The body will need to be provided with such resources as are needed for the tasks its members agree to undertake and

will similarly need to be provided with funding by the establishing PEIs, which should readily be recouped from the savings resulting from pooling of activities. The future course of the joint body, including the adoption of a formal title¹⁵¹ will depend on the success of its mergers and how far the participating PEIs are willing to pursue its aims, as well as support from other joining institutions.

157. It is not envisaged that every currently independent professional institution will seek to join the new body. While all should be free to join, there may be other potential groupings of PEIs with different areas of interest. For example there may be a group whose interests are largely international and who therefore wish either to remain independent or to explore an international confederation of activities and interests. Equally there will be new institutions formed in the future which should have the choice of maintaining their independence or joining a combined group.

Leadership and the voice of the profession

158. The need for more effective "leadership" of the engineering profession is a recurrent theme, which is entirely understandable in the light of the large number of PEIs, most of which use the media to publicise their individual opinions and views particularly when an engineering matter arises in the press. Some PEIs also issue their own publications on particular engineering issues, sometimes in the form of a "State of the Nation" report. However, pronouncements from individual PEIs are not always consistent and it is not a matter of surprise that the government tends increasingly to rely on the Royal Academy

when advice is required, particularly where relevant to government policy.

159. There is a general recognition that, of the different bodies forming the engineering community, The Royal Academy of Engineering is to be regarded as the voice of the profession, as the UK national academy. The Royal Academy is, however, under a disadvantage in terms of its ability to represent the membership of the engineering profession. As already noted, its members are distinguished but self-elected engineers, many of whom are retired and, while possessed of undoubted high levels of expertise, cannot be seen as representing the profession as a whole. The Royal Academy presently has no formal links with any of the Institutions or with EngineeringUK other than by providing nominated board members. Its key links are with government departments concerned with engineering issues and with the profession through its Fellows, many of whom occupy senior roles in the institutions, in Engineering Council and EngineeringUK. Despite its shortcomings in terms of representation, The Royal Academy has taken a significant lead in the creation of Engineering the Future which, without setting up any rigid or formal structure, has been effective in collating and delivering information at high level on behalf of the whole profession. It is important, however, that in order to be a credible voice on behalf of the profession, The Royal Academy should pursue all means of establishing more formal links with the institutions with the objective of becoming more representative of the profession as a whole.
160. There is no compelling reason why a profession should endeavour to limit itself to speaking with one voice: the legal profession is fundamentally divided into two separate branches, each of

¹⁵⁰ Particularly EngineeringUK and the Royal Academy of Engineering

¹⁵¹ Such as the Confederation of Engineering Institutions

J. Discussion and conclusions *continued*

which can speak with authority within its own sphere of activities; the medical profession also continues to speak with many more voices on its wide range of specialisms. There are indeed many engineering issues which present different aspects on which more than one view will properly be held. Examples are many and include the relative merits of renewable energy and nuclear power and issues concerning cyber security. The essential requirement for both institutions and individual experts is that their views are properly informed and independent.

161. There are, however, issues on which it is important that action is taken and messages are delivered representing the view of the whole profession. These include the issues concerning the status and promotion of the engineering profession which, as noted, were effectively delivered to the 2009 Parliamentary Inquiry through the Royal Academy.¹⁵² Issues concerning training and qualification of new entrants to the profession, endeavours to recruit more engineering students and the appropriate means of inspiring school children to take up the studies needed to gain entrance to engineering courses are also issues on which a clear message on behalf of the profession should be heard. The Royal Academy is closely engaged in all these matters and it is appropriate that they should express views on behalf of the profession at a strategic level and to government. But these and many more such issues are also of concern to the membership of the institutions, whose views are likely to be aired through their many separate PEIs. In such cases the proposed joint body representing PEIs offers the opportunity for those institutions to speak with a combined and authoritative voice, representative of the membership of the

profession, or a substantial part of it. There is no reason to suppose that the combined voice of the membership will conflict with that of the Royal Academy and they will be the more effective when each complements the other.

Producing enough skilled engineers

162. It is notable that there is a wide disparity in different estimates of the numbers of engineers needed in the future, the various estimates being based on widely different statistical approaches. Perhaps the most reliable is that based on the anticipated retirement rate of senior practitioners whose numbers will need to be replaced as others are promoted to take over from retirees. However, submissions to the review have revealed an equally wide range of views on the anticipated numbers needed in different branches of engineering, ranging from a need for significant numbers in some areas to others which are considered to be adequately served. Some more detailed evidence¹⁵³ revealed what may well be a more general situation, namely that required numbers fluctuate significantly with levels of orders and contracts. Submissions also revealed that qualified and experienced manpower needs were often met by overseas recruiting.
163. The question of manpower needs is also complicated by the fact, as revealed in a number of earlier reports but not further addressed, that there are some three to four million people operating in the field of engineering but having no affiliation with any of the institutions. This potentially affects several assumptions about the engineering community including those concerning numbers

of qualified or experienced people available for recruitment in any particular field. While little is known of the composition of the "missing" body of people, many of them must represent potential recruits for registration at least at Engineering Technician level. This conclusion can be confirmed by applying a simple rule of thumb that dictates a ratio of approximately six technicians to each chartered engineer. Given the registered number of UK Chartered Engineers at around 180,000 and the total numbers actually registered at Engineering Technician or Incorporated Engineer level at around 45,000, the potential number registerable as Engineering Technicians or above must be of the order of one million or more.

164. There is thus a clear imperative for the existing PEIs to take steps to recruit as many as possible of the "missing" engineers into the institutions in order to regularise their professional status and to encourage them to enhance their levels of qualification as well as well as renewing existing skills. This will also provide the opportunity to gather some knowledge of the "missing" numbers to assist in more accurately estimating the shortfall in numbers of engineers required. Surprisingly there appear to be a dearth of current programmes or campaigns aimed at recruiting potential registrants, from either within the membership of the institutions¹⁵⁴ or (no doubt with more difficulty) from without the institutions. It seems this task is regarded as falling to the institutions themselves, but both EngineeringUK and the Engineering Council should be tasked to consider enlargement of their activities to include the identification and recruitment of potential registrants, from which all these bodies will potentially benefit

in terms of influence and income. As a matter of priority, all PEIs should renew their efforts to motivate existing and new members to apply for registration at an appropriate level.

165. It has been suggested earlier that, given the low numbers currently registered at either EngTech or IEng level, there is a strong case to abolish these titles and to create new grades which are more attractive to would-be entrants, particularly from the "missing" three to four million not currently registered in any form. As is well known, many of these advertise themselves as "Engineers" and many are carrying out work which should certainly entitle them to such a title. But there is likely to be limited attraction to exchanging their self-appointed title to become "Technician Engineers". It is therefore proposed that, while retaining the grade of Chartered Engineer, which is well established and respected, the grades of Incorporated and Technician Engineer should be replaced by a combined new grade to be called simply "Registered Engineer". The Institutions should additionally review their internal membership grades. These include in most cases separate grades of Associate, Member and Fellow, which institutions may wish to retain. However, in the light of the proposals for eventual combined membership of the institutions, the joint representative body to be established should be tasked, as part of its remit, with the introduction of a new grade of Engineering Members, which may be known simply as "Engineers" and intended to be available to those having no previous connection with the institutions, who may wish to join without engaging with the membership rules of that institution.

¹⁵² See Footnote 8

¹⁵³ From IChemE

¹⁵⁴ Exceptionally the IET does have such a programme

J. Discussion and conclusions *continued*

Inspiring the next generation of engineers

166. The essential issue to be addressed in terms of manpower shortages is the success or otherwise of the many current schemes aimed at inspiring school children to take up STEM subjects with a view to pursuing a career in engineering. There can be no doubt of the importance of these endeavours, much of which is performed on the ground by volunteers. The funding comes from many sources, but principally from the PEIs and the Royal Academy, augmented by substantial funding from industry. The many strands of these endeavours are reviewed above and present a somewhat confusing picture of different and potentially competing activities which risks both duplication in some cases and unintended omission in others. The scale of the task is shown by the ICE's quoted figures of 27,000 schools and ten million school children.
167. There are a number of issues which arise and which call for discussion and recommendations. First, there is a well-recognised and obvious need for more effective management and organisation of the many different activities including visits to schools, visits by schools, workshops and industry experience, work by STEM ambassadors and many other such events. These activities are organised and run by many different bodies and there can be no doubt as to the need for one single body to take on the role of co-ordination and overall management and organisation of these different activities. None of the individual PEIs is in a position to undertake such a task and the choice must be between EngineeringUK and the Royal Academy. Given that it is proposed that these two bodies should in effect combine or merge

their promotional activities, the undertaking of the necessary organisation should be part of that merger, depending on availability of resources. It is vital that the participating PEIs as well as contributing industries are included in any re-organisation. The task of managing these activities will be immense, considering the numbers of bodies currently operating on a largely independent basis; but the benefits of achieving co-ordination will be similarly immense.

168. As part of the review and re-organisation, attention should be given to the resources available to individual schools, particularly in terms of the staff available to teach STEM subjects and those able to deliver informed advice. There are many comments to the effect that teaching abilities are frequently lacking in vital areas of science and mathematics and, even where expertise is available, teachers at primary level may be required to devote their time and energy to general subjects rather than to their specialist areas of science and mathematics. By contrast some schools are relatively well-endowed and local organisers should see it as part of their task to arrange for support between schools using whatever resources are available to the full, including support from local colleges and universities.
169. There is serious debate as to the effectiveness of the fairs and festivals which are organised for school visits, events which consume a major part of the available funding of EngineeringUK. There has been some evidence in recent years of an increased take up of STEM subjects, but there is no evidence linking any such increase specifically to fairs and festivals. The multiplicity of promotional activities is such that it is not possible to draw any conclusion as to the

effectiveness of events such as the Big Bang Fair or whether other activities should be credited with the success. In any event, most of the current promotional activities have been under way for the last decade, during which there has been little evidence of a sustained increase in numbers of students achieving the qualifications to undertake engineering courses. The conclusion must be that the current fairs and festivals should be a major part of the review of all promotional activities. In undertaking such a review, care must be taken to preserve the current level of industry support secured by EngineeringUK, much of which may be linked to specific promotional activities.

Training of Engineers

170. Once students have decided upon an engineering qualification they face a wide range of options, both as to the course of study and, equally significant, as to the means by which they will undertake studies. For the former, the courses available follow, in approximate terms, the different specialisms of the PEIs but with a significant and growing number of teaching institutions offering more general courses which can properly be regarded as more representative of the range of different skills which an engineer is likely to encounter in the course of a career, some of which will even be unknown at the time of first qualification. The progression towards wider fields of study is to be welcomed, provided that facilities for specialised studies are also maintained. Similarly the opening up of university engineering courses to those who have taken arts or non-mathematical studies is to be welcomed, although the full benefit of this new approach will take time to assess. This new trend must
- not be seen as detracting in any way from the importance of STEM studies in schools.
171. Participation by industry, government and the engineering community in the education process will continue to fulfil a vital role including the promotion of exchanges between industry and teaching and research staff, to the mutual benefit of both sides. Such a system is well developed in other countries and their methods need to be studied and replicated in the UK. Some PEIs have outstanding records in supporting academic staff and students and the best should be an inspiration to others.
172. As to the means of obtaining an engineering qualification, students face a significant dilemma as to whether to apply for a university place or whether to pursue employment-based training. Given the importance of this decision it is surprising that there was no emphasis on the advice available to students to assist their choice. Such advice should be readily accessible, up to date and reliable. Many will be concerned as to the relative advantages of each route, although students will be able to assess for themselves the advantage of having fees paid by an employer as opposed to taking on the substantial debt burden most will face if university is the choice. Employment-based training offers much more flexibility in terms of the courses available, which may be aimed at achieving EngTech registration, undertaken at Technical College; or the apprenticeship may include a degree course with studies replicating a full-time degree but interspersed with practical training so that the student, on completing the course, is "employment-ready".
173. In terms of the outcome it is clear that alternative routes to equivalent qualifications

J. Discussion and conclusions *continued*

should arrive at exactly the same academic level. With this objective in mind, the recommendations of the recent Sainsbury Report for a single common framework of standards to cover both apprenticeships and college-based courses are to be welcomed, as are proposals for a national system of technical education with a common framework of routes to encompass all forms of technical education and training. The educational activities of the PEIs should be directed to supporting those recommendations. Similarly, recent government initiatives in launching the new Apprenticeship Trailblazer scheme, the apprenticeship levy and the Institute for Apprenticeships are significant steps forward. The Institute will encompass all technical education at levels 2 to 5 and assist in regularising the organisation of employment-based education. It is notable how many senior and distinguished contributors to this review have added that their own careers began with an apprenticeship. The efforts of successive governments over the past two decades have tended to downplay the importance of employment-based training and efforts are now needed to redress this balance.

Funding provided by the PEIs

174. The Terms of Reference include two items concerning funding by the PEIs, referring in particular to the three commissioning PEIs, who are the major contributors to the running costs of the Engineering Council and EngineeringUK. The funds in question are not part of the assets of the institutions but derive from registration fees collected by them and passed on initially to EngineeringUK, whose Board in fact determines the level of registration fees which are collected from each of the PEIs in proportion to their

registered numbers. Approximately one third of the total amount is remitted to Engineering Council as its sole source of funding, while EngineeringUK raises significant additional funds from industry for its activities.

175. The question raised is whether the PEIs should continue to fund these bodies and their activities or whether such funding or support should be withdrawn. There are two levels of potential criticism: first as to whether the activities being funded are effective or whether they are duplicated; and second, whether the amounts are properly and rationally assessed. As to the first point, the effectiveness of the activities of both the Engineering Council and EngineeringUK are dealt with earlier and in regard to the former there has been no suggestion that they are not effective. The Engineering Council delegates most of the detailed work concerning registration to the PEIs but there has been no suggestion that this arrangement should be changed or reviewed. Conversely the effectiveness of the activities of EngineeringUK is a live issue as to which a number of recommendations are made. If there is to be a reallocation of its funding to other activities, there is as yet no indication that the overall cost might be reduced. In the immediate future, given that a large proportion of its expenditure is on staff costs, no case is made that those staff levels should be reduced. EngineeringUK has in fact called for enhanced funding from the PEIs. However this cannot be considered until decisions are made on the activities to which funding should be directed.
176. In terms of the assessment of funds raised by the PEIs, this is simply a per capita registration fee fixed by EngineeringUK and collected by PEIs according to their registered membership.

As pointed out previously there are a number of unsatisfactory or contradictory features about this arrangement. First, the activities of EngineeringUK have little to do with registration and it is illogical that the level of fees should be fixed by EngineeringUK anyway. It is also pointed out that to base funding solely on registration fees means that PEIs with higher levels of registration will be subsidising those with lower levels which, apart from being unfair, rewards those who do not promote registration.

177. The conclusion must be that the method by which funding is collected should be reviewed taking all the above points into account. A fairer system would be to assess funding for Engineering Council and EngineeringUK separately, with the former being based on numbers registered. Funding of EngineeringUK should depend on a range of criteria including total membership numbers of each PEI and also taking account of their individual contributions to promotional activities. This should also be part of the new arrangements to be agreed in the course of combining the activities of EngineeringUK with the promotional work of the Royal Academy.

Promotion of engineers and engineering

178. The final topic for discussion, as part of the drive to increase the supply of qualified engineers, is the need for and means of promoting engineering as a career and the status of those who are motivated to enter the profession. While engineering as a career stands well in terms of employment prospects and salaries¹⁵⁵ and provides a great variety of opportunities for

careers to branch out into other areas and to develop new specialisms, engineering in the UK is generally perceived as holding a lower social standing than other professions which require equivalent or lesser training and expertise, and in contrast to the position in most other parts of the world. It is no answer to say that engineers today benefit from the celebrity of their 19th century forebears and their great engineering achievements. Today's engineers live in a different world, although belonging to the same Institutions.

179. Comment has already been made on the role of the media and the preponderance of liberal arts graduates in positions of power and influence. If a solution is to be found, it must be in terms of the gradual and progressive changing of attitudes and the promotion of positive messages about engineering achievements. There is no media shortage of stories about engineering problems or failures, nor of programmes celebrating British engineering achievements of the past. The media, however, needs to be informed and educated about positive engineering achievements of the present day.
180. It will also benefit the wider standing of the profession if more progress is made towards changing attitudes among school children in the 11-14 age range and particularly including an increasing proportion of females in the cohort of children motivated to take STEM subjects. In regard to the contribution of women, the UK remains woefully behind all our competitors. Given that other professions in the UK and elsewhere are finding that well-qualified female applicants are beginning to outnumber males,¹⁵⁶ the continuing shortfall of female applicants for engineering courses would form

¹⁵⁵ The Wakeham Report

¹⁵⁶ Particularly in medicine, for example

J. Discussion and conclusions continued

a suitable subject for an industry-wide review. The experience of a small number of institutions in achieving a significantly higher female input should be the starting point for such a review.

181. In the medium term it is to be hoped that the recommendations of this review, if fully implemented, will lead to a better public perception of engineering and engineers through establishing a clearer voice for the profession, better organised institutions and a more efficient and effective system for motivating and educating those who will become the engineers of tomorrow.

Will anything change?

182. This is the question which is understandably asked by many when presented with requests to contribute to yet another review of the engineering profession. One of the tasks in the Terms of Reference is to identify lessons learned from similar initiatives including “why they failed to gain traction”. The lesson seems to be that “similar initiatives” are expected to fail.
183. Some of the recommendations in this report are administrative and aimed at the proper management of matters which presently lack efficient organisation, particularly the co-ordination of different aspects of STEM promotion to school children. The means by which this is to be achieved is a matter for those undertaking the organising task and there is substantial support for that task being undertaken. The success of the task and the increased efficiency which results is a matter for the skill of the organisers. This task is linked, however, to the proposed merger of the promotional activities of EngineeringUK with those of the Royal Academy of Engineering and

the PEIs and others. This is a step understood to be supported by the Royal Academy and the PEIs who fund EngineeringUK; but the proposed merger will require the co-operation of those involved, particularly EngineeringUK itself, which will also need to reach agreement with the PEIs as to its continued funding. The potential complexity of the arrangements proposed is not to be underestimated; but this should be balanced by the fact that the efficient and well-managed promotion of STEM studies to the next generation is vital to the future well-being of the engineering profession.

184. The recommendations involving the Royal Academy involve an enlargement of its activities, which will need to be accepted by its trustees. Subject to this, however, there is no legal or structural impediment to the proposed enlargement, which could conveniently be achieved through the vehicle of a separate company structure. Once organised and seen to be operational, consideration can be given, if thought appropriate, to amending the Royal Academy’s Royal Charter to incorporate its enlarged activities.
185. The proposals in this report for seeking out and “gathering in” the large but unknown number of people working in engineering are new: the missing numbers have been identified in several earlier reports without any proposal as to what should be done. It is now clear the numbers involved affect several important issues, such as the obvious lack of large numbers of Technician and Incorporated grade engineers within the institutions as well as the uncertainty surrounding the numbers of qualified engineers needed in particular sectors in the future. The PEIs together with EngineeringUK and the Engineering Council have every interest in

recruiting as many as possible of these missing potential members; and there must be every expectation that their efforts will succeed to an extent. If the PEIs become overwhelmed with new members that will surely be a problem they will be capable of solving. The likelihood, however, is that the new members will appear slowly and it will take time for the message to spread effectively, so allowing time to make any necessary adjustments to accommodate them.

186. The major proposal of this Report, which will be regarded as most controversial and least likely to happen, is the recommendation for the creation of a joint body of the PEIs to bring about the progressive merger of activities. It must not be overlooked that the eventual aim is not the mere bringing together of administrative activities but the merging of membership so that joining one institution leads to membership of all. That this is a major step hardly needs repeating. However, it must be remembered that this will be the fourth time such a recommendation has appeared in a report, the latest having been in the period 2001 to 2003 when the “Hawley” recommendations were in course of being adopted by many PEIs including the three PEIs who have taken the lead in commissioning this review. In the course of leading the proposed “re-birth of engineering” Dr Hawley wrote that this involved a “*fundamental redefinition of what engineering is. And from that redefinition will come – it is already happening – a reappraisal of its importance, its characteristics, and its attractiveness as a career. The days of bemoaning the profession’s lack of status or the failure of the public to give engineering credit for all it does are coming to an end*”¹⁵⁷.
187. Those who are naturally inclined to resist

change should recall wide public support given to the Hawley proposals which included, in the case of the ICE the following comments, all published in 2003¹⁵⁸: “*Council had no doubt that this is a fantastic opportunity*”¹⁵⁹; the ICE Senior Vice President who was to lead the steering group¹⁶⁰ was “*behind the plan in principle*”; the members’ satisfaction survey was clear, that the biggest issue for members was increasing the profile and status of engineers; ICE Council agreed that a single institution offered the engineering profession a better opportunity to raise its profile and would give far greater influence with government and policy makers; another ICE Vice President¹⁶² added that “*The government is absolutely fed up with the number of professional institutions it has to deal with. We have an obligation to pursue this*”.

188. The Hawley proposals were not adopted by any of the institutions and no mergers were agreed with one relatively modest exception.¹ This report does not recommend renewal of the campaign for formal mergers between institutions but proposes a much more modest beginning in the form of a joint body tasked to seek agreement on the combining of particular activities, with some form of merger as the eventual objective, conditional on the institutions agreeing to continue the process to that point. If it is thought that the new joint body is an unwarranted innovation, it should be recalled (as more fully reviewed in Dr Hawley’s paper) that such a joint body was first established in 1923 as the Engineering Joint Council, which ceased operating in 1937. This was followed in 1962 by the Engineering Institutions’ Joint Council, which became in 1965 the Council of Engineering Institutions that for

¹⁵⁷ Ingenia, 9 August 2001

¹⁵⁸ Published in *New Civil Engineer*, June 2003

¹⁵⁹ Former ICE Director General Tom Foulkes

¹⁶⁰ Douglas Oakervee

¹⁶¹ Professor John Burland

¹⁶² The Institution of Engineering and Technology

J. Discussion and conclusions *continued*

the first time organised registration across all the institutions, a task now undertaken by the Engineering Council as the industry's regulator.

189. It can thus be seen that in 1923 and again in 1962 the institutions did agree to set up a joint body expressly for the purpose of establishing common interests, sight of which was lost when the issue of joint regulation emerged in 1965. This issue indeed became the main focus of the Finiston Inquiry in 1975 with its recommendations for statutory registration, which were rejected by the institutions themselves. The need to establish

common interests between the institutions was revived principally by the Hawley initiative in 1999 in the form of direct merger proposals in 2002. It can thus be seen that the idea of merging interests of different institutions has been current for over ninety years and, while attempts at full merger failed in 2003, the attractions and advantages of merger remain, as can be seen in many contribution to this review which repeat and echo the comments of senior ICE officials noted above. The argument remains and it is to be hoped that a more gradual and measured approach can succeed this time.

K. Responses to terms of reference

190. Responses are set out below to the individual items in the Terms of Reference, taking into account the evidence and submissions received and the discussion and conclusions above. These have been rearranged for convenience:

(1) To provide a definitive statement of the problem which needs fixing.

190. The problem which needs fixing is discussed in the sections above. In summary they are that (i) the professional institutions are too numerous and have failed to engage with the profession; (ii) fragmented and ineffective leadership of the profession; (iii) failure to produce enough skilled and motivated engineers; and (iv) ineffective promotion of engineers and engineering. To these matters should be added the problems of low levels of registration with PEIs and the broader question of appropriate governance arrangements for the profession. The failure to produce enough engineers raises issues concerning education and the apparent failure to motivate school children to take up studies leading to engineering as a career; also the question of how to deal with the wide disparity of views as to future numbers of engineers needed. A problem of huge but uncertain dimension is the reported numbers working in engineering with no affiliation to any of the existing institutions. This is coupled with the perennial need to enhance the status of engineers in the UK, certainly in comparison to other countries¹⁶³.

(2) To clarify the future requirements of the UK for professionally registered engineers and technicians.

192. The future requirements for professionally registered engineers and technicians are dealt with in Section B above¹⁶⁴. The evidence presented to

this review has indicated a wide range of views including statistical projections leading to widely differing conclusions. At the lowest level there must be a requirement for sufficient recruits to replace engineers reaching retirement but beyond that it seems that demand will depend upon levels of economic activity, which will vary across different branches of the profession and with fluctuating demands dependent upon orders and contracts. However with modern means of communication and travel, resources from and within other countries can be and are being called upon to compensate for unprogrammed shortfalls.

193. The question, however, presupposes that future requirements can be measured solely in terms of professionally registered engineers and technicians, which could be misleading given a number of authoritative reports of people working in engineering who are either unregistered or who have no connection with any of the existing institutions, those in the latter category numbering probably in the order of three million or more. Little can be said about the true level of shortages of persons with engineering expertise without some knowledge of this missing group and it is clear that urgent steps must be taken to gain more knowledge of them and to establish contact with a view to bringing them into the engineering community.

(3) To review the effectiveness of existing arrangements between education and training establishments, employers and the professional engineering community in supporting their delivery, with particular reference to employers as the end user.

194. The effectiveness of existing arrangements for education and training raises important questions as to both the effectiveness of existing

¹⁶³ These issues are dealt with further at paragraphs 11 to 21 and 145 to 146.

¹⁶⁴ Particularly paragraphs 22 to 28 and 162 to 165.

K. Responses to terms of reference *continued*

training arrangements and the preceding stage of motivating and inspiring children at pre-GCSE stage to take up STEM subjects. With regard to the latter there are serious issues as to the management and co-ordination of many different strands and activities being run by a wide variety of bodies, ranging from EngineeringUK and the Royal Academy together with many of the PEIs at one level, to many locally based organisations including employers at other levels¹⁶⁵.

195. As regards education and training establishments there remains a serious divide between university-based courses and employment-based training which requires more management and organisation, the objective being the creation of a single common framework of standard to cover both approaches and a common framework of routes to encompass all forms of technical education¹⁶⁶. In terms of university departments, many embody the best of world-class British engineering and are deserving of the strong and continued support of the engineering community and government. While problems have been identified¹⁶⁷ there are also a number of significant current developments including a strong move away from too great a concentration on traditional specialism within engineering and a number of initiatives aimed at recruiting engineers from those who have not undertaken traditional STEM A levels, which will await further results¹⁶⁸.
196. In terms of employment-based training there are again strong initiatives put in place to boost the availability of such training places which have attracted good levels of support from employers and the professional institutions

alike¹. The effectiveness of these arrangements will take time to be manifested but the objective of all training programmes must be to produce engineers who have received both academic and vocational training so as to be "employment ready"¹⁷⁰.

- (4) To review the governance of the profession and its relevance to the future, in relation to the needs of the memberships, employers, academia, governments and society with regard to future relevance and value for money, specifically the roles of:**
- (a) The Royal Academy of Engineering;**
 - (b) Engineering Council;**
 - (c) EngineeringUK;**
 - (d) The engineering institutions.**

197. The Royal Academy of Engineering, while remaining an outwardly exclusive body of senior Fellows, has undergone substantial change and expansion since its formation as the Fellowship of Engineering in the 1970s to become established as the UK's national engineering academy. At the same time the Royal Academy undertakes an overseeing role in regard to many different aspects of the engineering community, particularly in the promotion of engineering and the engineering profession at all levels and in representing the profession to government. In terms of the need for the engineering profession to speak with one voice, there has been strong support for that voice to be the Royal Academy or a body or group closely associated with the Academy. This, in reality, is the current position which the Royal Academy occupies, through less structured groupings such as Engineering the Future. The problem which exists, however, is the level of

duplication between activities of the Royal Academy, particularly in terms of promotion to would-be entrants to the profession, and the activities of the PEIs and particularly EngineeringUK¹⁷¹.

198. The Engineering Council, since its establishment in 1982, has continued to oversee the self-regulation of the engineering profession through establishing standards and levels of competence which have been drawn up in collaboration with the whole profession through a well-balanced and representative Engineering Council. The importance of retaining self-regulation is not to be underestimated and the relative freedom from adverse comment of the Engineering Council is a welcome sign of its stability.
199. EngineeringUK has had a more mixed gestation and its current role and functions are largely self-generated after the reorganisation of the Engineering and Technology Board. It is evident that there is a large measure of overlap between the promotional activities of EngineeringUK and the related activities of the Royal Academy and of the PEIs which calls for reorganisation and appropriate management¹⁷².
200. With regard to the PEIs there has been a growing need for rationalisation and reorganisation which has been addressed on a number of occasions since the 1920s, so far with very little progress being made. The institutions themselves well recognise the problems created by their perceived failures to move with the times and the proliferation of numbers such that they are perceived as fragmented and ineffective when the profession is viewed as a whole. This report reviews detailed comments on the role of the institutions and discusses
- measures to promote solutions and achieve greater effectiveness¹⁷³. The conclusion is that the institutions must urgently begin the process of merging their interests and activities and breaking down barriers between different institutions with a view to the eventual merging of memberships such that anyone joining one institution should be able to enjoy the facilities and opportunities of all, while individual institutions, subject to any mergers that may be agreed, continue to maintain their individual identity and expertise.
201. The above paragraphs have sought to address the relevance, now and in the future, of the bodies making up the engineering community, having regard to their membership including employers, academia, government and society. In terms of future relevance it is clear that there must be a coming together of bodies representing the same interests with a view to reducing the level of confusion perceived by many as to who represents the engineering profession. There is also a strong need for the same process in the interests of efficiency, effectiveness and value for money. This applies, as already noted, to the many different strands of activity in terms of promotion of engineering at all levels and particularly to school children contemplating taking up STEM subjects. It applies equally to clear and obvious levels of duplication between different engineering institutions where, irrespective of any movement towards merger, many common activities across the institutions could be more economically pooled to achieve greater efficiency. It is unlikely that professional subscriptions will be reduced; but the money raised will be better and more efficiently spent.

¹⁶⁵ See paragraphs 166 to 169 and 59 to 67.

¹⁶⁶ See paragraphs 40 to 42 and 170 to 173.

¹⁶⁷ See paragraphs 46 to 47.

¹⁶⁸ See paragraph 45.

¹⁶⁹ See paragraphs 51 to 57 and 170 to 173.

¹⁷⁰ See paragraph 48.

¹⁷¹ See paragraphs 92 to 95 and 158 to 161.

¹⁷² See paragraphs 84 to 88 and 166 to 169.

¹⁷³ See paragraphs 71 to 78 and 147 to 157.

K. Responses to terms of reference *continued*

- (5) To review other models, without any constraint, considering all options, but producing recommendations that are deliverable in practice and quickly.**
202. Other models of governance for the engineering institutions have been discussed, principally the single institutional structure adopted in Australia and in Hong Kong. However, there was no universal demand to adopt such a structure and it must be remembered that strongly argued proposals for mergers leading to such a structure have been rejected by the institutions themselves. In terms of models, it is to be noted that many of the UK institutions and bodies choose to adopt a Royal Charter which has the advantage of establishing a corporate structure without use of company law. However, such charters are invariably accompanied by complex governance models which promote continuity but inhibit change. A much easier model to adopt is a simple company limited by guarantee in which the rules of governance are extremely flexible and can be tailored to suit particular needs. Such is the case with some institutions and, notably, with EngineeringUK as successor to the Engineering and Technology Board.
203. The need for recommendations involving changes that can be delivered in practice and quickly dictates that the bodies involved in any restructuring are capable of reacting quickly, which is not usually the case with bodies either governed by a Royal Charter or having adopted complex governance structures. It must be said that most of the recommendations contained in this report will take many months to organise and years to implement. One recommendation, however, can be put in place quickly and with limited immediate consequence: the setting up of a joint body between the PEIs, or a core collection of those institutions, to begin the process of integration and removal of barriers. The body could consist simply of a joint committee. If serious changes are to be achieved, it will need to become a body in its own right which may conveniently be set up as a company limited by guarantee with its own chosen governance structure.
- (6) To express an opinion on the current structure, effectiveness, number and range of organisations that the Institutions currently fund.**
204. The number of organisations that the institutions currently fund is two, namely the Engineering Council and EngineeringUK. This report contains extensive observations and comment on both organisations¹⁷⁴. The Engineering Council is considered generally effective and not in need of revision. EngineeringUK, however, gives rise to serious questions as to its effectiveness and the duplication that exists between its activities and those of other institutions which urgently require review and re-organisation.
- (7) Where their activities are duplicated, to recommend which organisations the three PEIs should continue to support and from which funding and/or support should be withdrawn.**
205. In terms of the continuance or withdrawal of financial support it is to be noted that this currently arises as a result of the arrangement put in place by the Boards of Engineering Council and EngineeringUK, on both of which the PEIs, as the funders, are fully represented. However, while the funding of the Engineering Council based on a registration fee is logical and supportable, the funding of EngineeringUK is not, given that its activities have no direct connection with registration. It is not recommended that the funding be withdrawn from EngineeringUK, but that funding arrangements be reviewed and that this should be part of the overall review of the functions and activities of EngineeringUK alongside those of other bodies involved with promotion.
- (8) To identify lessons learned from similar initiatives (e.g. the Finniston report), taking into consideration the effectiveness of these reports and why they largely failed to gain traction.**
206. In terms of the lesson to be learned from similar initiatives, it is clear that the PEIs, or the major institutions in combination, possess the power and indeed the will to steer the profession in their own chosen direction and that any inquiry or recommendation which does not seek to harness the view of those institutions is unlikely to achieve traction. This was certainly the case with the Finniston Inquiry. The Hawley initiative sought to bring about change from within the engineering community and did achieve the separation of the regulation function and the setting up of a separate body to promote science, engineering and technology, now operating as EngineeringUK. The Hawley review also generated a very significant level of support within the institutions for merger towards the creation of a single institution of engineers which, however, was ultimately rejected by the institutions themselves as going beyond what could be seen to be in their interests.
- (9) To examine requirements necessary to achieve improved governance, propose a realistic but challenging timetable for implementation; identify strategies to be adopted to fulfil the goals and barriers which might prevent success, and identify strategies to overcome those barriers and**
- (10) To identify risks and associated mitigating strategies; and opportunities which might facilitate success and strategies to capitalise on them.**
207. In terms of requirements for improved governance, strategies to be adopted and barriers to be overcome as well as risks and strategies, these divide into two broad recommendations concerning EngineeringUK and the Institutions themselves. In terms of EngineeringUK it is recommended that its activities including funding be the subject of a major and thorough review in terms of the arguments and opinions set forth in the report. The decisions to be taken are substantially in the hands of the PEIs who provide the majority of funding together with the Royal Academy which potentially has a significant role to play in any reorganisation and rearrangement of activities concerning promotion and other activities of EngineeringUK. The review envisaged will involve many different bodies and for this purpose a suitable vehicle would be a conference at which all interested parties have the opportunity to present their properly considered opinions and proposals. With appropriate organisation this should lead to conclusions which can be implemented within a reasonably short timescale. The barriers to achieving such a solution may be a lack of will and constructive participation. But those involved must acknowledge that the present

¹⁷⁴ See paragraphs 79 to 83 and 84 to 88 and 166 to 169.

K. Responses to terms of reference *continued*

and indeed the future of the profession are essentially involved in such an enterprise and that a consensus will emerge as to the appropriate way forward.

208. The second area of implementation concerns the projected merger of activities within the PEIs with a view to overall and eventual merger. This can be implemented with the agreement and co-operation of a small but significant group of PEIs following the course already described. Once embarked upon and once suitable structures are put in place for the more economic conduct of particular activities, it is anticipated that other PEIs would see advantage in joining and enhancing the chance of an overall merger eventually being achieved. There

is, however, no imperative for an overall merger, given that some PEIs will perceive different areas of interest and may wish to pursue other forms of combination, particularly in terms of overseas operations. It has already been noted that any body which combines the activities of different PEIs would also have the ability to speak on behalf of those PEIs and to constitute a significant voice on behalf of the profession.

(11) To recommend an execution plan.

209. An execution plan embodying the above proposals is set forth in the Recommendations in Section M below.

L. Recommendations

- (1) PEIs should acknowledge duties not only to their members but also to the engineering profession and to the UK public in the management of their affairs.
- (2) PEIs should set up a joint body to promote mergers of their separate activities with a view to eventual combining of membership such that anyone joining one institution would be entitled to enjoy the facilities and opportunities of all.
- (3) The joint body should promote and oversee the combining of administrative and professional functions and the gradual removal of barriers between PEIs with a view also to reducing costs.
- (4) A core number of PEIs should agree to initiate the process of merger with others to follow at their option.
- (5) Participating PEIs should preserve their separate identities and technical specialisms, subject to any bilateral mergers that might be agreed in parallel with the overall merger process.
- (6) The Royal Academy of Engineering as the UK national academy should continue to speak as the voice of the profession.
- (7) The Royal Academy should develop formal links with the institutions so as to become more representative of the profession as a whole.
- (8) The PEIs, EngineeringUK and Engineering Council should be tasked to identify and recruit potential registrants from the estimated three million people working in engineering with no association with the institutions.
- (9) The PEIs should seek to motivate all existing and new members to apply for registration at an appropriate level.
- (10) PEIs and the Engineering Council should, while retaining the grade of Chartered Engineer, review other grades of registration and membership.
- (11) EngineeringUK and the Royal Academy should form a new combined professional team to lead all activities of engagement with schools and the promotion of STEM learning.
- (12) The separate activities of the PEIs and other professional and industry groups concerned with promotion of STEM learning should be brought within the same overall organisation with a view to avoiding duplication of effort as well as gaps in coverage.
- (13) The Royal Academy and EngineeringUK should together carry out a full review and reorganisation of all such promotional activities to assess their effectiveness and to establish proper levels of co-ordination between PEIs, the Royal Academy and other bodies involved, while preserving and enhancing contributions from industry.
- (14) The review should examine critically the effectiveness of fairs and festivals organised for school visits including reviewing the cost and benefit of such activities with a view to allocating resources to those activities shown to be successful in achieving lasting effects on would-be STEM students.
- (15) The review should examine the resources available to individual schools for teaching STEM subjects and delivering informed advice. Co-operation between schools, local colleges and universities and industries should be encouraged and where necessary established.
- (16) Funding of the Engineering Council should continue to be based on registration fees to be collected by the PEIs. The levels of fees should

L. Recommendations *continued*

be a matter of agreement between the PEIs and the Engineering Council.

- (17) There should be a review of the funding of EngineeringUK, which should in future be based on the levels of activities agreed between EngineeringUK, the PEIs and the Royal Academy. Future funding levels should be part of the revised arrangements to be agreed in the course of combining the activities of EngineeringUK with the promotional work of the Royal Academy.
- (18) For the education and training of future generations of engineers and technologists, the engineering profession should encourage adoption of the recommendations of the 2016 Sainsbury Report on Technical Education while also supporting the development and

enhancement of world-class engineering expertise in UK Universities.

- (19) There should be a renewed campaign to raise the level of awareness and technical competence of persons reporting on engineering matters in the press and media. Government should be pressed to recognise the importance of projecting the correct image of engineering as a major economic activity *inter alia* through the designation of senior engineering advisers to government.
- (20) Only the major Professional Engineering Institutions together with the Royal Academy of Engineering possess the strength and influence to bring about these changes. These bodies should seek to implement a detailed agenda for carrying out the Recommendations.





To: John Uff QC
Keating Chambers
15 Essex Street
London
WC2R 3AA

From: Institution of Civil Engineers (“ICE”)
1 Great George Street
London
SW1P 3AA

and

Institution of Engineering and Technology (“IET”)
Savoy Place
London
WC2E 0BL

and

The Institution of Mechanical Engineers (“IMechE”)
One Birdcage Walk
London
SW1H 9JJ

29th March 2016

Letter of Appointment

Dear John

This is to confirm your appointment by the ICE, IMechE and IET (together, “The 3 PEIs”) to conduct a review of the profession of engineering [in the United Kingdom] and prepare a written report on that subject (“the Report”).

1. Appointment

Your appointment will be with immediate effect and up to 31 December 2016, unless otherwise terminated earlier, at the discretion of you or The 3 PEIs, upon one week’s written notice. The 3 PEIs may invite you to serve longer depending on mutual agreement.

2. Time commitment

We have asked you to assess your own time commitment and by accepting this appointment, you will be confirming that you are able to commit sufficient time to meet the expectations of your role. You shall notify The 3 PEIs in writing promptly if you are no longer able to commit sufficient time to meet the expectations of your role.

3. Role and milestones

The role is set out in the Terms of Reference attached at Annex A to this letter dated 29th March 2016.

You shall prepare the Report in accordance with milestones set out in Annex B to this letter.

You shall take instructions from CEO, ICE.

4. Fees

In consideration of you preparing the Report, The 3 PEIs will reimburse you for all properly documented reasonable expenses and incidentals you incur in performing the appointment, provide a secretariat and other professional and administrative support as reasonably required and by prior agreement. No other fees are payable for the preparation and delivery of the Report. You will be named as the author of the Report.

You will be responsible for the payment of any income tax, insurance contributions or any other taxes or duties arising as a result of the preparation and delivery of the Report or otherwise under this agreement. For the avoidance of doubt, neither you nor any person you may engage in connection with the Report will be an employee of any of The 3 PEIs in connection with preparing the Report.

5. Conflicts of Interest

It is accepted and acknowledged that you have other business interests. In the event that you become aware of any potential or actual conflicts of interest, you shall promptly disclose them to the 3 PEIs.

6. Confidentiality

All information acquired in the course of your appointment is confidential to The 3 PEIs and the Review Reference Group established by The 3 PEIs (“RRG”) and you will not release it, either during your appointment or following termination (by whatever means), to third parties without prior clearance in writing from the CEOs of The 3 PEIs.

On any termination of this agreement you will return all documents, records (on any media) and other property belonging to any of The 3 PEIs to whichever of The 3 PEIs supplied it and you will not retain any copies in any form.

7. Review process

There should be regular reviews of progress with the RRG and the CEOs of The 3 PEIs. If there are any matters which cause you concern about your role you should discuss them

8. Intellectual property

You will promptly communicate in confidence to the CEOs of The 3 PEIs all ideas generated, work done, results produced and inventions made in the preparation of the Report (“Results”). You will not, without the prior written consent of The 3 PEIs, use or disclose to any other person or organisation either during or after the termination of this agreement any confidential information of The 3 PEIs that may come into your possession. For this purpose all Results shall be treated as the confidential information of The 3 PEIs.

You undertake that all copyright, design right, rights to apply for patents, patents and other intellectual property in the Results and the Report shall belong to The 3 PEIs. In consideration of the reimbursement of your reasonable expenses under this agreement [and being named as author of the Report], you agree on demand to assign forthwith to The 3 PEIs all intellectual property in the Results and the Report at any time after their coming into existence. At The 3 PEIs’ request and expense (but without further payment to you) you will use all reasonable endeavours to enable The 3 PEIs at their discretion to make formal application anywhere in the world to obtain and maintain intellectual property rights.

9. Miscellaneous

This agreement is personal to you and may not be assigned by you. This agreement does not give you authority to act as agent for any of The 3 PEIs.

Notices under this agreement shall be in writing and sent to a party’s address as set out at the beginning of this agreement. Notices may be given, and shall be deemed received:

- by hand: on delivery;
- by first class post: two working days after posting.

This agreement is made under English law and the parties submit to the exclusive jurisdiction of the English courts.

I would be grateful if you would sign, date and return the enclosed copy of this letter to me as soon as possible to confirm your acceptance of it.

Yours sincerely



Stephen Tetlow

On behalf of the 3 PEIs

Type on copy

Understood and accepted

Signed:

Date:

Annex A:

29th March 2016

Terms of Reference for John Uff QC to Conduct an Independent Review of UK Professional Engineering.

Annex B

Milestones

29 March 2016

ANNEX A

TERMS OF REFERENCE

FOR AN INDEPENDENT REVIEW OF UK PROFESSIONAL ENGINEERING MARCH

2016

To clarify the future requirements of the UK for professionally registered engineers and technicians and review the effectiveness of existing arrangements between education and training establishments, employers and the professional engineering community in supporting their delivery, with particular reference to employers as the end user. *ie provide a definitive statement of the problem which needs fixing.*

The review should consider the following as part of the enabling solutions:

- (a) To review the governance of the profession and its fitness for the future of the profession, specifically the roles of the RAEng, the Engineering Council, Engineering UK and the Engineering Institutions (“The Profession”), in relation to the needs of the memberships, employers, academia, governments and society with regard to future relevance and value for money.
- (b) To review other models, without any constraint of current dogmas or mantras, considering all options, but producing recommendations that are deliverable in practice and quickly.
- (c) To express an opinion on the current structure, effectiveness, number and range of organisations that the Engineering Institutions currently fund; and where their activities are duplicated.
- (d) To recommend which organisations the (three) PEIs should continue to support and from which funding and/or support should be withdrawn.
- (e) To identify relevant lessons learned from similar initiatives (e.g. the Monty Finniston report et al.), taking into consideration the effectiveness of these reports and why they largely failed to gain traction.
- (f) To examine requirements necessary to achieve improved governance, propose a realistic but challenging timetable for implementation; identify strategies to be adopted to fulfil the goals

- (g) To identify risks and associated mitigating strategies; and opportunities which might facilitate success and strategies to capitalise on them.
- (h) To recommend an execution plan.

A Sponsor Group will be formed comprising the CEOs of the 3 PEIs with CEO ICE acting as the lead point of contact. The purpose of the Sponsor Group will be to provide advice and act as a conduit to the Trustee Boards of the Engineering Institutions.

A Review Reference Group will be formed comprising key individuals from a variety of relevant backgrounds capable of providing independent advice, council and advocacy. The composition of the Group will be by mutual agreement between the Sponsor Group and Mr Uff QC.

29 March 2016

ANNEX B

MILESTONES

FOR AN INDEPENDENT REVIEW OF UK PROFESSIONAL ENGINEERING MARCH

2016

1. 1 June - Interim report to Sponsor Group – Confirmation of Scope.
2. 1 September – Draft Report to Sponsor Group – Preliminary Findings
3. 15 November – Final Report

The role of the professional engineering institutions in 2025 (Futures Paper)

If you don't like change you're going to like irrelevance even less...

General Eric Shinseki

Introduction

This is not a paper making the case for a professional engineering community. Nor is it a paper about mergers: the detailed workings of individual institutions are quite properly the business of their own trustees. While institutions naturally operate in the interests of their membership, they are charities, with charters that require them to operate for public benefit. This can be forgotten. **It is a paper that considers whether the current Professional Engineering Institutions (PEI) model provide the best, most effective and most efficient service for our members and for society.** There is a danger in the debate that we become confused by conflating the two. In this Paper we set out practical examples of collaboration that already exist between PEIs and suggest what good might look like for a 21st Century PEI.

The need for engineers

The need for engineers is well established. EngineeringUK produces an annual report setting out the likely requirement for engineers in UK. All of the indicators suggest that the demand for engineers will increase, that the engineering profession will flourish, and that technical developments will continue at least at the pace of the last decade. Numerous reports set out the challenges that society will face over the next 50 years: water and fuel poverty; the need to decarbonise our world; population growth; increasing urbanisation; and many others. Engineers will be at the heart of addressing these challenges. So the real issue is not the need, but the supply.

The need for PEIs

So the case for engineers is made, but assuming that PEIs are somehow essential to modern society, industry or membership is merely to set ourselves up for a fall. We have to be relevant. Outsiders looking in tend to see PEIs as very similar entities delivering the same service to their memberships. The reality is much more complex: PEIs vary in size, reach and outputs. Some cater for a predominantly UK based, small, technically narrow group of members; others are much bigger, broader and deliver technical support to their membership, advice to governments and opinion formers, and support R&D programmes. One size does not fit all and, as the professional engineering community we recognise this fact.

There are very real threats to PEIs: the millennial generation does not think in the same way as the baby boomers; their values and reward mechanisms are different. Over the last 18 months there have been a series of papers, discussions and observations as to the value of the PEIs¹. There has also been much academic thinking. Coerver and Byers² cover the need for change in trade and professional associations making a number of deductions.

- Time: people are busier;
- Value expectations: People question fees in a way they didn't before;
- Market structure: it has consolidated and specialized at the same time;
- Generational Differences: there are a multitude of groups (veterans, Silents, Boomers, GenX, Millennials) but all are our members, and all have radically different in expectations and influence;

¹ Universe of Engineering, Edge Report, Letters to the Times etc.

² "Race for Relevance" by Coerver and Byers (ISBN 978-0-99034-335-0).

- Competition: there are lots of others out there, nothing is a given;
- Technology: it is very different, changing faster than ever, and we find it hard to keep up.

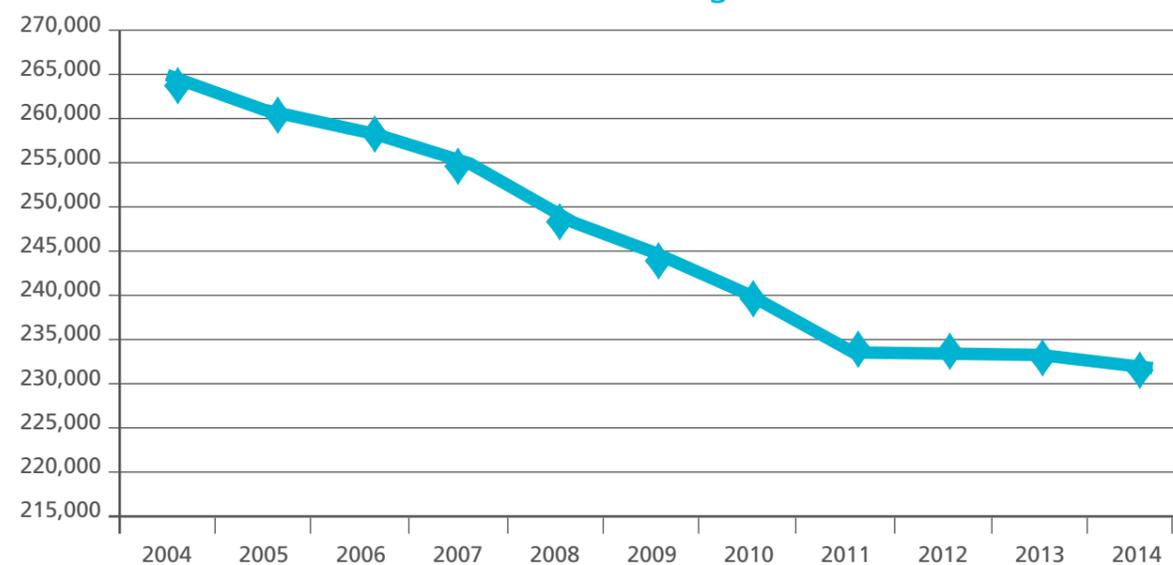
They recommend that institutions overhaul governance and committee operations and specifically stop tinkering, stop the charade, stop *the next big thing*. They note the need to empower the CEO and enhance staff expertise, to rigorously redefine the member market, to rationalize programs and services, and to build robust technology frameworks.

If we are honest with ourselves our experience shows that we are often content with the status quo. We could, and should, set a timetable and challenge ourselves. We should set out the benefits that accrue from membership, the value that PEIs provide to the engineering (and wider) community, and that we are modern, progressive and innovative organisations that have, and continue to, adapt to the needs of modern professional engineers. There is a general agreement that PEIs could benefit from closer cooperation, merging of services, and pooling of resources. But when a particular proposal is investigated it usually proves exceptionally difficult to gain agreement. There are exceptions, but not many³. Thus the issue for PEIs is about how we attract, retain and support the engineering profession, as well as providing wider society with reassurance that professionally qualified engineers are competent, safe and operating in line with best engineering practice. In essence how do we convince society of the value not just of the engineer, but also of the PEI?

Declining numbers

The reality is that, while engineering in the UK is on the cusp of a renaissance, almost without exception, membership of PEIs has fallen over the last decade and PEIs have seemed impotent in seeking to reverse the decline. That says something about how *PEIs* are perceived, not about the industry and societal need for engineers. So we should ask ourselves whether, as a PEI community, we make our case well. Is industry an active supporter of PEIs, is it ambivalent, or does it accept our existence because our membership (and their employees) value their professional membership and the status that goes with it. We should not kid ourselves: our active membership will tell us, and keep telling us, that we meet their need. But the active membership is very small: often below 10% of the total. We should be persuading the 90% not basking in the comments of the 10%.

PEI registrant numbers 2004 – 2014



³ IOM3: demonstrating that a cooperative spirit leading to pooling of resources need not be difficult to achieve. The essence of IOM3's success in bringing about six mergers in the last ten years is centred upon a straightforward business approach, removing egos and delivering benefit. Such an approach tends to work where a combined membership can identify a core strategic synergy for the partnership. IOM3 found it did not work when the outcome was a conglomerate.

Public safety: a duty to protect

The issue of *public safety* is at the heart of the PEI offer to society: PEIs are *de facto* charged with a duty to protect society. In awarding a professional qualification to an individual a PEI is attesting that that individual is competent and safe to operate as an engineer. Society will, probably, always require this reassurance. There are a number of mechanisms by which this can be delivered: UK PEIs work on professional registration on the basis of competence. Other nations maintain registers of licensed engineers. And still others deem employment grade as a statement of safety. We believe the system of engineering competence demanded of candidates presenting themselves for professional qualification remains the best system for producing engineers. But it will be important to ensure that the subjects examined at *review* remain in line with best modern practice. This is an issue for all PEIs to consider. Professional reviewers take time to generate: they need training; experience; and understanding. As engineering professionals operate in an increasingly multidisciplinary environment so it will become even more important that reviewers understand the complexities of other disciplines, of common tools (such as digital design, delivery, cyber security, and maintenance mechanisms) and changing processes of softer skills such as management, leadership and procurement practice. There may be scope to standardise such reviewer training.

A further part of the PEIs' duty to protect our membership is inextricably linked to the derivation, accreditation, maintenance and application of engineering technical codes and standards. Inevitably, different nations operate to different standards. PEIs have a duty to ensure that the technical codes to which our membership operates are robust, effective and protect the public. But almost more importantly PEIs have a duty to evolve standards and codes that are robust and effective yet up to date and fit for today's and tomorrow's purpose, not yesterday's. That means a multidisciplinary approach to reflect modern industrial practice. Then we need to explain and communicate clearly what the standards mean, why they matter and how society benefits.

Society: a duty to inform and represent

It is likely that PEIs will continue to be required to inform public debate. But this is a confused space: many bodies seek to set out their own views and opinions. Trade associations lobby for their membership, PEIs set out policy positions, industry lobbies for business. And all have shades of the similar messages. It is the duty of PEIs to represent the view of their membership: not to lobby for their members' interests; rather to bring together a considered view drawing on the profession's expertise, to set out the engineering and technical implications of policy decisions.

Different PEIs inform in different ways. Some maintain large policy and research teams deliberately to support informed decision making. Others, usually by virtue of their size, do not. But decision makers, whether public or private, rely on the independent analysis of complex technical solutions that PEIs provide. They expect impartial, politically, economically and socially informed technical advice. What they find confusing is the nuance between individual institutions in the advice they provide. Much good work has been undertaken in the last 5 years by *Engineering the Future* and the Royal Academy of Engineering. But PEIs could be cleverer in working together to produce single reports covering a range of engineering advice on particular programmes. There are real opportunities over the next 10 years: the UK energy market; HS2; transport systems; and the like. Or we could continue as PEIs to produce excellent, single engineering discipline, advice that, while trumpeting our individual institutional brand and generating column inches that our members enjoy, force opinion makers into fusing all of our reports into one. Better a common approach?

Whichever approach we adopt, PEIs need to provide clear advice. That advice should be couched in terms that are understood by, and resonate with, the wider public. Too often engineers drop into technical detail, excessive explanation of process and thereby lose what is a naturally sympathetic audience. There is significant work to do to achieve a common message; and even more work to do to establish when we *can* provide a common message, and when we *cannot*.

Learned societies: a duty to disseminate

At their heart all PEIs are learned societies. Knowledge is at the core of our Charters. And the body of learning and knowledge held within the PEIs is unmatched by any other organisation across the globe precisely because our knowledge is based on the minds and wisdom of our current and previous membership. But in a world in which information is available on a 24/7, daily changing basis, the importance of *knowledge* is of greater and greater significance. All PEIs produce brilliant, incisive and inspirational lectures, events and publications. We should ask ourselves whether we disseminate this knowledge as well as we could. Whether we address the needs of all professional engineers, or just a small part of our own membership. Does a practising engineer living in the Midlands want to attend a lecture covering their particular discipline; or, as they become more experienced, do they want to discuss a broader range of topics. Do we as PEIs address this need, or do we concentrate on the purely technical? And *should* we address the non-technical: or is this for others such as CBI, chambers of commerce or IOD?

Could we collaborate on the provision of training courses? Could we pool libraries and library services? In sum should we be looking at how we can work together to create agile, linked, interactive knowledge hubs to serve all stakeholders, meeting the needs of their CPD, drawing on our established industrial partnerships (and not just with engineering companies). Would this provide a better service to our membership, and how might we do this? Should we in fact be investigating a global Professional engineer knowledge hub into which we all input?

Knowledge hub(s) should seek to share channels of communication (and content). We should use social media and other communication mechanisms, not just focusing on emerging digital technology. And we should design our process to ensure it supports our members in disseminating good practice within their own organisations. But we should ensure that anything we design is seen from the user's perspective, not from ours. Simple, easy and logical access and availability is key.

International operations

There are 36 PEIs licensed by the Engineering Council. As at 31 December 2013 there were 222,603 final stage registrants on the register, of which 40,841 (18.4%) reside overseas. The balance of non-UK to UK members varies between the PEIs. Some, such as IChemE, have relatively high numbers of non-UK members, others are predominantly UK focused. Regardless of registration, the growth opportunity for PEI's probably lies outside the UK. Young people fully understand the benefit of a network to facilitate international career opportunity and our present offering is attractive. This window of opportunity will not be open indefinitely.

Experience shows that PEIs that operate overseas tend to establish the need on their own, conduct market research on their own, set up on their own, and manage operations on their own. Some PEIs collaborate with HM Government, some draw on their support, some operate wholly separately. Experience shows many of the challenges associated with international market entry are common: persuading non-UK potential members of the benefits of membership; establishing relationships with national bodies; ageing protocols; and establishing legal entities thereby enabling PEIs to operate as businesses. But coordination and collaboration is more by chance than planning, and yet, as in UK, the benefits of collaboration are evident.

The next generation: a duty to attract

Arguably the PEIs activity in seeking to attract the next generation of engineers to the profession is one where we should highlight the work we have, jointly, delivered for the benefit of society. The creation of EngineeringUK, the *Big Bang*, the *Tomorrows' Engineers* programme and EngTechNow are all achievements of which the PEIs should rightly be proud. These programmes are funded almost totally by our members, are delivered by them, and are taken seriously by governments and industry. We should not beat ourselves up too much.

But we cannot be complacent. These programmes have yet to deliver the step change we need. We have spent millions of pounds on education, schools and college programmes, and advising government. But the change in applications is slow. Our ability to attract women into the profession, and to retain them after 34, is variable. And this despite endless projects, discussions, campaigns and exhortations. This is an area that we should address on a more collaborative basis. Members of every PEI visit schools and colleges. While PEIs may believe they do so as representatives of their institution, the reality is that individuals visit schools with the blessing of their employer, often as part of an employer recruitment drive, and, usually, with an uncoordinated set of messages that are undermined when another engineer visits the same school two days later with a different message. We should be very clear what we have, and have not, achieved. *Tomorrows' Engineers*, STEMNET, EngineeringUK, the myriad of charities all compete against each other for reputation, for funding and for market position. The result has not been a step change in the number of registrants.

We should build on and extend *Tomorrow's Engineers*, especially to less advantaged schools and communities. We should squash the idea that science and engineering are in competition (perhaps linking TE week to what is now British Science Week?). The time has come to be more imaginative: the Army, arguably one of the most successful recruitment organisations in the country, uses a single team drawn from all parts of the Service. We could do the same: creating an engineering schools and university team with full time staff and managed centrally. We should also consider why we maintain RAEng, Engineering UK and the Engineering Council as separate bodies, with separate governance, management and support arrangements. They operate so closely, in the same space, with the same bodies that there is an irrefutable logic to bring them all within the RAEng. The Engineering Council might need a firewall arrangement to ensure we cannot be accused of undermining standards. Registrants (and taxpayers) pay the bills!

We should investigate the ability, or desirability, of PEIs hosting or facilitating an engineer careers service. If we are to attract the best minds of the next generation we need to market the benefits of a career in engineering. All PEIs set aside a space on their own websites to market their own disciplines. Perhaps we might look at how we operate collectively to bring that information together so that children and parents might better be able to understand and use it. Above all we must be seen to be inclusive, across the profession, recognising that engineering is more than just the 'traditional' branches. *This requires us to see ourselves as others see us, not as we see ourselves.*

The future: a duty to research

PEIs have not traditionally engaged in detailed research. We report research, we publish others work. We host debate. But we compete, often unwittingly, with each other. We do not coordinate policy work well (with some exceptions). We often produce slightly conflicting reports on broadly the same topics that confuse the audience of non-experts we are seeking to inform. In his role as Chief Construction Advisor Paul Morrell often complained that one of his greatest challenges was to listen to the huge number of organisations that all claimed to be the voice of the construction industry: and this is just one small sector of the engineering profession! As PEIs we should lead and inspire debate. We should consider joint working groups on innovative working, on procurement practices, on cyber security and digital delivery. We should seek to support RAEng in creating agreed pan-profession research priorities. And our learned Societies should support a coordinated research programme with common research priorities. And we desperately need a common futures group to help drive research priorities and thought leadership.

Resources: a duty to be efficient

Finally PEIs should recognise that we are expensive to operate. All 36 PEIs pay for Chief Executives and staff. All maintain estates and property. All manage the subscriptions, qualification and CPD of their memberships to varying degrees. All have IT systems that link in some way to the Engineering Council. All procure similar professional services whether legal, commercial, charitable or insurance. But from experience these similar, but individual, needs are sometimes treated as essential prerequisites for a PEI to operate effectively. Yet

experience shows that services can be delivered collectively. We routinely come to arrangements amongst ourselves for short term cover to manage absence, illness, or temporary displacement from our homes. Why do we seem unable to provide employers with PEI interfaces and processes that have a common likeness? Why could we not use the same forms for standard process work? Can we not coordinate visits so that one presenter or recruiter could operate on behalf of multiple PEIs relevant to that employer, university or college? There has been much talk but little action. IMechE has produced some insightful thinking set out in Annex B. We might at least look at whether there is merit in grouping together hubs of services (if only buying the same investment or legal services thereby gaining greater economy and wider service).

Recommendations

So what might good look like? Perhaps an institutional system practising engineers are enthusiastic to engage with; a simple reference point for employers, employees and society; a simple source of advice for non-engineers; clear professional leadership of the Profession; clear, unequivocal and informed opinion; and a Society that understands and values the engineering profession. A detailed table of recommendations are attached setting out three levels of cooperation: light, medium and heavy touch. These will take time and commitment. But there are things we can do now if we are serious about presenting a unified face to society. It is therefore recommended that consideration be given to:

- a. **Workstream 1:** RAEng subsuming the functions of Engineering UK *in toto*. Report March 2016.
- b. **Workstream 2:** RAEng subsuming the function of the Engineering Council. Report March 2016.
- c. **Workstream 3:** The creation of a single, professional team to lead engagement with schools and universities to which employers and employees turn for guidance. Report June 2016.
- d. **Workstream 4:** PEI *policy* work on education, attracting the next generation and shaping schools thinking, to include a national career service, being managed *in toto* by RAEng. Report June 2016.
- e. **Workstream 5:** PEIs investigating the setting up of a national network of regionally based offices to operate as the voice of engineering in UK. Report December 2016.
- f. **Workstream 6:** PEIs creating a common back office for HR, payroll, IT & MIS, legal services, a common member management system linked to EngC, and a common subscription collection system. Report December 2016.
- g. **Workstream 7:** The creation of shared training for reviewers to help them understand the complexities of other disciplines, of common tools (such as digital design, delivery, cyber security, and maintenance mechanisms) and changing processes of softer skills such as management, leadership and procurement practice. Report December 2016.

Annexes:

- A. Assumptions and Stakeholders.
- B. Practical Collaboration Examples.
- C. Collaboration Options.

ANNEX A

Assumption

- Society will require reassurance that those operating in the engineering profession are safe and competent to do so.
- Decision makers will need dispassionate, socially, economically and politically informed technical advice to enable them to make the best decisions for society.
- The pace of technological development will continue to accelerate.
- Engineering professionals will move jobs, employers and locations more frequently. They will require support to ensure they remain in touch with best practice.
- Engineering ideas and practice will increasingly be driven by global experience rather than purely national businesses. But SMEs that are quick to adapt and learn will demonstrate industry leadership.
- The engineering industry is likely to continue to move towards integrated delivery solutions.
- The future of engineering will not be one landscape but many. There will be more technical specialisms but with increasing need to work across boundaries.
- Basic technical competency will not be enough. Multi-disciplinary teams will work together in an increasingly specialised and technical way.
- Engineering needs to demonstrate creativity and communication in order to resolve real world problems.
- Social skills will be vital as the profession moves from an isolated approach to a collaborative one. Self-forming communities and networks will pop up to allow engineers to work in a flexible, dynamic, and open way.
- Interaction and service delivery will become much more digital, much more virtual, to serve stakeholders who are geographically, sectorally and culturally diverse

Stakeholders

We believe that PEIs have a range of stakeholders:

- Our membership
- Young people and potential members
- Practising engineers
- Professionally qualified and non-professionally qualified engineers
- Those who operate alongside the engineering profession
- Employers
- Decision makers and opinion formers
- Users of engineering products

ANNEX B

Practical examples

1. International operations

IChemE has adopted a specifically global focus since the early 2000s viewing the chemical engineering profession as “boundaryless”. Major employers are global; members’ career patterns are global; and the research and technical challenges obviously respect no national boundaries. IChemE has therefore welcomed members without restriction as to geography, with common standards and globally distributed membership processes throughout.

Approximately half the membership lives outside the UK and this proportion is certain to continue to grow, with the major areas of focus including Australasia, South East Asia, South Africa, India, and The Gulf as well as operations in North America. Key success factors include:

- Avoidance of a “Brits abroad” approach, in particular avoiding the assumption characteristic of our American cousins that a solution that works “at home” will necessarily be the right solution elsewhere.
- Establishment of national Boards in those countries where we have substantial membership, with a clear line of accountability to our global governing Council but substantial local autonomy.
- Focusing our Council business on matters affecting the profession worldwide and increasingly reflecting the distribution of our global membership in the makeup of Council itself – where necessary using co-options for this purpose. This includes the appointment of Presidents from diverse places – we have had several Australian presidents, an Indian and a Dutch president, for example
- Respect for local cultures and local circumstances: an example here would be our interest in ethics and whistleblowing, where our trustees have been keen to recognise that the protection afforded to “whistle-blowers” elsewhere may not be at a level comparable to Europe and North America, so that we need to be very careful in imposing obligations on members in countries where this may place them at personal risk.
- Senior IChemE Fellows act as “Senior Ambassadors” providing information and sometimes hosting events locally. This reduces risk when developing membership and other activities in the countries concerned.

2. Tomorrow’s Engineers

Tomorrow’s Engineers is a project coordinated by the EngineeringUK and involving all 36 UK-based PEIs, Engineering Council, STEMNET and The Royal Academy of Engineering. The aim of the project is that every child will understand the variety, excitement and opportunity presented by a career in engineering, with an equal number of girls and boys aspiring to become an engineer.

Four PEIs are represented directly on the TE Board (ICE, IMechE, IET and IED) with IED also having responsibility for representing and coordinating input and communication with the other 32 PEIs. A growing number of industrial partners are also engaged with the project, including some of the largest employers of engineers within the UK.

The project works by encouraging stakeholders to collaborate on the central message of communicating the excitement and appeal of a career in engineering to children aged between 11 and 14. This is done in a number of ways, from encouraging current communications as delivered by the partners to be badged with the ‘Tomorrow’s Engineers’ banner; to coordination of funding mechanisms and larger projects.

The message is delivered via a TE website, which includes branding, toolkits, guidance and resources for students and teachers and the development of a UK-wide database of schools which includes all information relating to that school in terms of contact with PEIs, companies and other relevant bodies which help to

ANNEX B

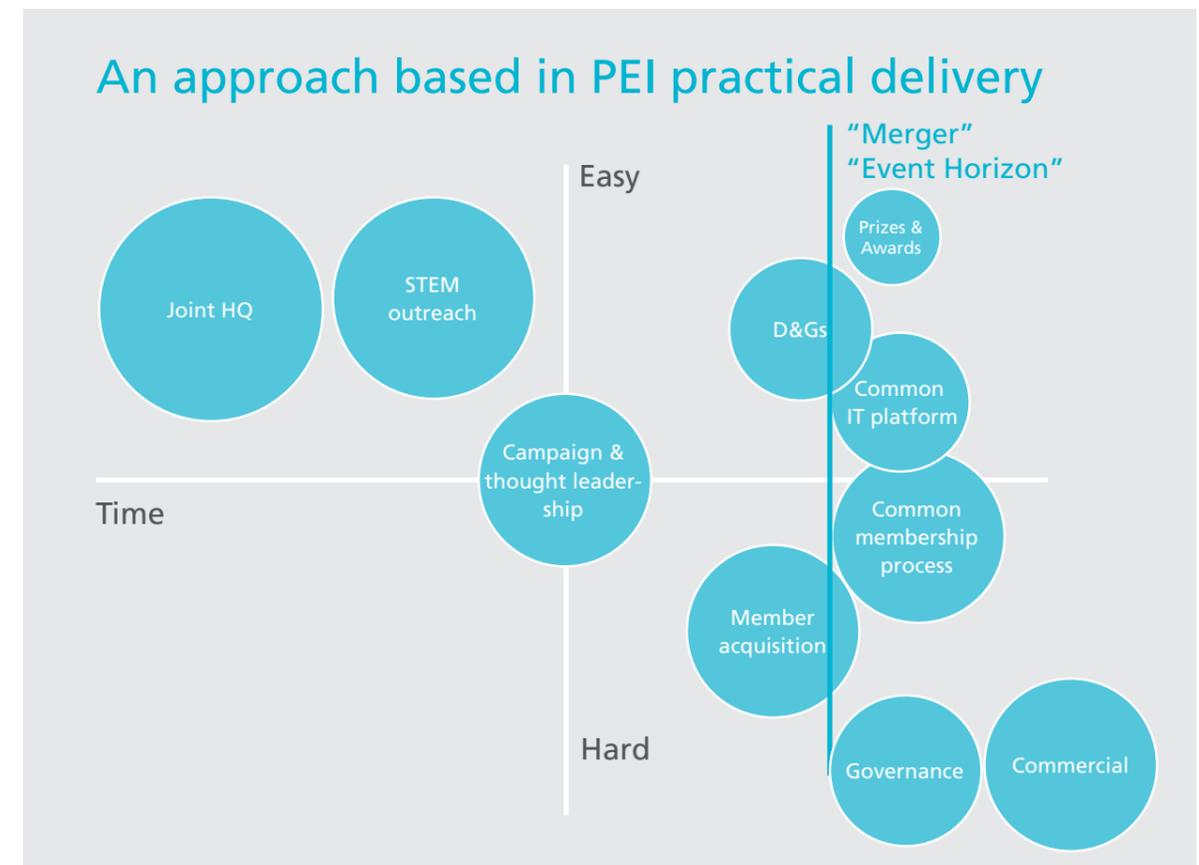
achieve the aim of the TE programme. This database is key in ensuring that the contacts made with schools are valid, relevant and focussed and in helping to identify those schools which have little or no contact with relevant programmes so that future projects can be targeted at those schools.

The project has identified that around 30% of all secondary schools currently have some contact with PEIs, companies or other bodies with regards to STEM experiences and that number will in time increase, with the introduction of Engineers Support Managers around the UK to help promote the scheme and connect local engineering industry with schools in their area.

Lessons learnt

- A project such as this takes time to develop, refine and coordinate in addition to attracting all the right partners to become involved
- A good ‘product’ is essential to attract partners
- Clear messages, goals and pathways need to be established to ensure the programme develops as intended
- There is never going to be 100% sign up to such a programme

3. IMechE Analysis of where collaboration is easy and difficult



ANNEX C: OPTIONS FOR PEI COLLABORATION: LIGHT, MEDIUM AND HEAVY.

Duty to Protect	Duty to Inform and Represent	Duty to Research	Duty to Disseminate	Duty to Attract	Duty to be Efficient
Option: Light					
<ul style="list-style-type: none"> Coordinated reviewer training, concurrent times and locations. Joint working groups on standards, PAS, and CPD. 	<ul style="list-style-type: none"> PEIs form joint panels to address key engineering issues. Annual Report on state of UK engineering. Coordinated regional engagement programme. Coordinated response to media enquiries. Coordinated response to government calls for information. 	<ul style="list-style-type: none"> Joint working groups on innovative working. Joint working groups on procurement practices. PEC agreed pan-profession research priorities. 	<ul style="list-style-type: none"> Coordinated regional activities. Joint events by default. 	<ul style="list-style-type: none"> PEIs agree to align all schools engagement activities with <i>Tomorrows engineers</i>. EngTechNow rolled out pan PEIs. Coordinated recruitment campaign. Common UTC engagement operation. 	<ul style="list-style-type: none"> Coordinated websites Common application process and paperwork. Shared IT and MIS services. Coordinated international operations.
Option: Medium					
<ul style="list-style-type: none"> Coordinated accreditation process for industry and academia. 	<ul style="list-style-type: none"> PEIs create formal alliances to address sectoral issues. Common response to media enquiries. Common response to Governmental calls for information. 	<ul style="list-style-type: none"> Coordinated research programme with common research priorities 	<ul style="list-style-type: none"> National network of regional offices from which individual PEIs operate. 	<ul style="list-style-type: none"> Common recruitment operation. Dedicated PEI representative in HE/FE establishment. 	<ul style="list-style-type: none"> Common content management system. Groups of PEIs form to share back office functions. Shared international offices, staff, legal entities with one person acting as the lead for all PEIs.
Option: Heavy					
<ul style="list-style-type: none"> EngC to be separate, autonomous body to ensure independence of standards. Common PEI reviewing organisation to include centralised allocation, training, recruitment and administration. Common accreditation process for academia and industry 	<ul style="list-style-type: none"> Common engineering policy team. Common team to engage with UK government departments to provide policy advice. Common press and media office with established team of talking heads. Engineering policy advice to be focused through PEI groups rather than each PEI contributing to each debate. Hence one PEI education policy team provides the common POC for educational advice. 	<ul style="list-style-type: none"> Common body to determine engineering research priorities. Common futures group to help drive research priorities and thought leadership. 	<ul style="list-style-type: none"> National network of regionally based offices to operate as voice of engineering. 	<ul style="list-style-type: none"> Common membership recruitment organisation. Common vehicle for outreach to schools. Common team to advise on educational policy and teaching. 	<ul style="list-style-type: none"> Common back office for HR, payroll, IT & MIS, legal services. Common member management system linked to EngC. Common subscription collection system. Single corporate HQ as home of engineering. Common back office building. Common website. Disposal of all surplus property.

Notes:

1. "Common": Activity which is the same in every element, managed by one entity on behalf of all PEIs, responsible to a PEI suprabody, with identical unified branding.
2. "Coordinated": PEIs conduct their own activity but in conjunction with others with identical branding with parent PEI logo.

Terms of reference

A review of the governance of the engineering profession to ensure it is fit for purpose and relevant to support the needs of future UK engineering capacity.

1. Background.

a. The Presidents of the ICE, IET and IMechE believe that the UK engineering landscape is complex and inefficient. Policy makers, industry and educationalists are confused by the variety and mix of groups and bodies. Schools don't know who to listen to. Companies don't know who to fund. Government departments consult randomly. This applies especially to the Professional Engineering Community which comprises some 35 Engineering Institutions, three overarching organizations (ie the RAEng, EngUK and the Engineering Council) and a plethora of policy sub-groups and committees. Trends in society and the pace of technological change are impacting upon the engineering landscape (identified in a paper on The Role of the Professional Institutions in 2025 by CEO ICE), while the Profession has been declining in numbers over the long-term, and its governance and structure have remained largely unchanged for decades. Various reports over the years, such as the Finniston report and the RAEng Universe of Engineering Report, have called for significant change, but the challenges remain largely unaddressed. There is a pressing need for a structure that is better configured to deliver professional leadership and support for engineering and engineering-related businesses, and for individuals working in them who have engineering skills, and to the society we serve. This is likely to involve a significant reduction in duplication and overlap of functions across independently-governed organisations and of unhelpful competition between them. The Profession will be better able to focus its leadership and resources to address key issues including support for effective public policy across all fields, including education. **The Presidents therefore wish to appoint an independent review to examine options for the governance of the Profession to ensure it is fit for purpose and relevant to support the needs of future UK engineering capacity for the foreseeable future.**

b. Engineering underpins the UK economy to the tune of £1.2 trillion per annum. To maintain this contribution and to ensure future growth, a doubling of the number of engineering graduates and technicians is required over the next 10 years. Despite significant investment by industry, by professional engineers (through their professional subscriptions) and Government, the future supply of engineers and technicians will not meet this demand under current arrangements. Industry and the Engineering Institutions are increasingly being asked to resource a greater number of programmes with the aim of increasing the supply of engineers into the industry. These include the Engineering Talent Programme of the RAEng, the Tomorrow's Engineers and Big Bang programmes under EngUK, STEMNET under BIS, and over 200 other charitable and CSR initiatives. Whilst many are individually excellent, the net effect is not making sufficient impact. Efforts to coordinate them have been, to date, largely ineffective. The Presidents of the IET, ICE and IMechE, which collectively provide nearly £4M annually to EngUK alone, wish to allocate their resources in a more effective manner. They wish to consider more efficient and effective funding mechanisms than current arrangements for implementation after 2016, for programmes which can demonstrate how they will significantly increase the supply of engineers and technicians. **Therefore, a key part of the review will be to advise on the most effective way in which resources should be organised and used to influence the future supply of engineers and technicians.**

2. Scope of the Review.

The scope of the review is to:

- Review the governance of the profession and its relevance to the future, specifically the roles of the RAEng, the Engineering Council, Engineering UK and the engineering institutions (*"The Profession"*), in relation to the needs of the memberships, employers, academia, governments and society with regard to future relevance and value for money.
- Clarify the future requirements of the UK for professional engineers and technicians, and review the effectiveness of existing arrangements between education and training establishments, employers and the professional engineering community in supporting their delivery.

c. Provide a unifying vision and mission for the profession.

.....and to make recommendations.

3. Structure of the Review

The Review will be chaired by a prominent and highly regarded person and will be supported by a panel of experts drawn from PEI CEOs (3), RAEng, Academia, Industry, Government and politicians. Its modus operandi should be to develop and test a framework with key stakeholders. It is intended to be influential and should consult widely, including the Engineering Council, RAEng, EngineeringUK, other PEIs, Trade Associations, Academia, Industry, and educationalists.

4. Key Deliverables and Timescale

Draft report for consideration by Trustees in July, public report and communications programme by September.

5. Key Factors

- The view of employers, as the end user, is critical.
- The review should look globally and at other potential models, such as the Automotive Council.
- The review should not be constrained by current dogmas or mantras. The Institutions are keen that all options are considered. However, the review must produce recommendations that are deliverable in practice and quickly.
- The Review should express an opinion on the current structure, effectiveness, number and range of organisations that the institutions currently fund; and where their activities are duplicated.
- They should recommend which organisations the three PEIs should continue to support and those from which funding and/or support should be withdrawn.
- The Review should identify lessons learned from similar initiatives (e.g. the Monty Finniston report et al.), but should take into consideration the effectiveness of these reports and why they largely failed to gain traction.
- The review should examine requirements necessary to achieve improved governance, propose a realistic but challenging timetable for implementation; identify strategies to be adopted to fulfil the goals and barriers which might prevent success, and identify strategies to overcome those barriers.
- The review should also identify risks and associated mitigating strategies, opportunities which might facilitate success and strategies to capitalise on them.
- The review should recommend an execution plan.
- Presidents of IMechE, IET and ICE commit to the principle of implementing the recommendations as directed by their Trustee Boards and will work to encourage support from other members of the engineering community.

6. Benefits

The review will provide the following benefits:

- An influential report to enable strategic improvement and future relevance in the way the profession of engineering is managed and governed, which is widely accepted and actionable.
- Significantly more effective investment in capability to attract the next generation of engineers and technicians in sufficient numbers.

7. Resources

The Institutions will seek external support for funding and will jointly commit to underwriting the review.

List of Contributors

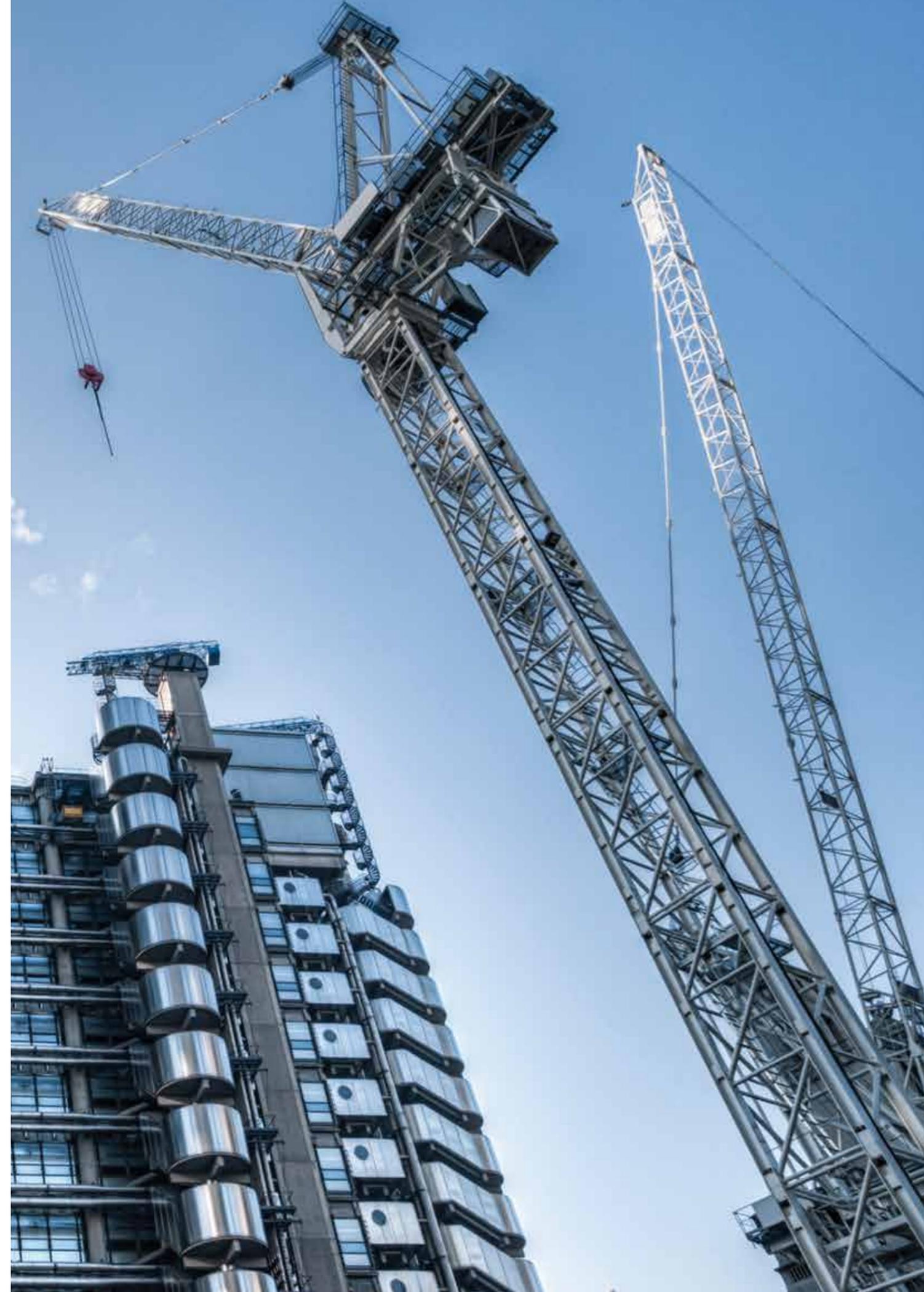
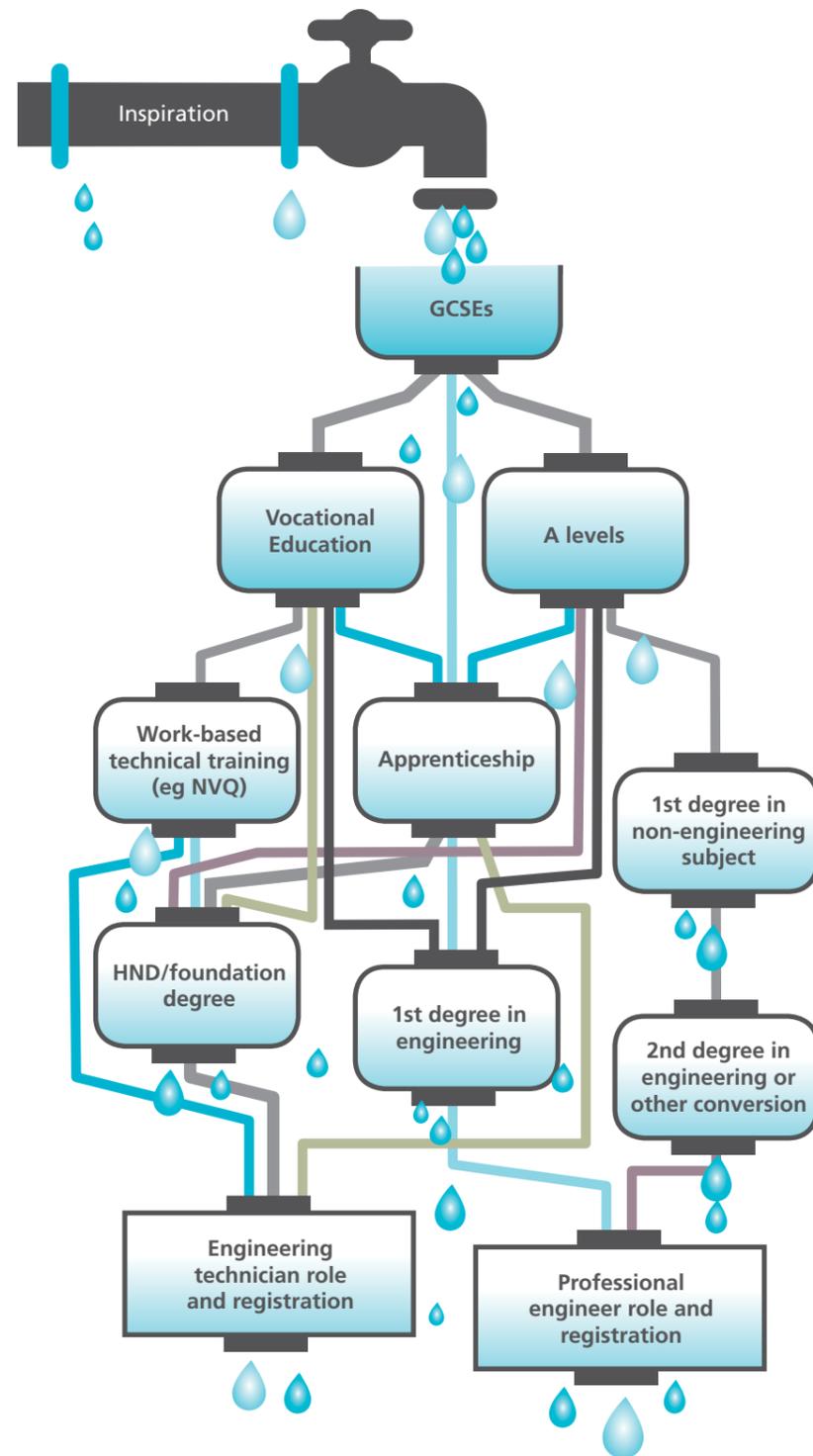
Organisations

- British Computer Society
- British Institute of Non-Destructive Testing
- Chartered Institution of Building Services Engineers
- Chartered Institution of Highways & Transportation
- Energy and Utility Skills
- Energy Institute
- Engineering Council
- Engineering Employers' Federation
- EngineeringUK
- Foundation for Science and Technology
- Institution of Civil Engineers
- Institute of Marine Engineering, Science & Technology
- Institute of Materials, Minerals and Mining
- Institute of Measurement and Control
- Institute of Physics and Engineering in Medicine
- Institution of Chemical Engineers
- Institution of Mechanical Engineers
- Institution of Royal Engineers
- Institution of Structural Engineers
- Intelartes & Dynamic Knowledge
- National Skills Academy
- Nuclear Institute
- Royal Academy of Engineering
- Royal Aeronautical Society
- Sellafield Ltd
- Society of Operations Engineers
- The Institution of Engineering and Technology
- The Welding Institute
- Water UK
- Allan Cook CBE FREng, Chairman, Atkins (Reference Group member)
- Alan Couzens FICE, Infrastructure and Projects Authority, HM Treasury (ICE nominee)
- Sir David Davies FREng
- Eur Ing Phil Davis FIET, Director of Technical Learning & Development, Atkins
- Eur Ing Dr Amanda Dowd FIET (IET nominee)
- Professor Bill Drury FIET, University of Bristol (IET nominee)
- Anna Elliott
- Steve Fox CBE FICE, CEO, BAM Nuttall (ICE nominee)
- Claire Gott MBE MICE, WSP (ICE nominee)
- Peter Hansford FREng FICE, former Government Chief Construction Advisor (ICE nominee)
- Dr Robert Hawley CBE
- Dame Sue Ion, FRS, FREng (Reference Group member)
- Eve Jardine-Young, Principal, Cheltenham Ladies' College
- Julia King FREng, The Baroness Brown of Cambridge (Reference Group member)
- Colonel Paul Loader FIET, Chief Engineer (Army) (IMechE nominee)
- Sir Terry Morgan FREng FICE, Chair Crossrail and Engineering the Future (Reference Group member)
- Roderick Muttram FREng, Fourth Insight Ltd
- Professor John Perkins CBE FREng (Reference Group member)
- Professor Dragan Savic FREng, Professor of Hydroinformatics, Exeter University (Reference Group member)
- Terry Scuoler, CEO, EEF – The manufacturers' organisation (Reference Group member)
- Professor Jonathan Seville FREng, University of Surrey / President of IChemE (Reference Group member)
- Chris Sexton FInstRE, Technical Director, Crossrail
- Neil Sandberg FICE, CEO Sandberg Consultants (ICE nominee)
- Sir William Wakeham FREng, Visiting Professor, Imperial College (Reference Group member)
- Air Marshal J A Young CB OBE FIET, Chief of Material Air, Air Member for Material and Chief Engineer (RAF) (IET nominee)

Individuals

- Professor Helen Atkinson CBE FREng, Head of Department of Engineering, University of Leicester (IET nominee)
- John Banyard OBE FREng
- John Barber FICE
- Anthony Best FREng, founder, Anthony Best Dynamics (Reference Group member)
- Erik Bonino, former Chairman, Shell UK Limited; EngineeringUK Trustee (Reference Group member)
- Malcolm Brinded FREng FICE, Chairman, EngineeringUK

The pipeline for engineering skills leading to professional registration



Institution of Mechanical Engineers

One Birdcage Walk
London
SW1H 9JJ

t +44 (0)20 7222 7899

enquiries@imeche.org
imeche.org

The Institution of Engineering and Technology

Michael Faraday House
Six Hills Way
Stevenage
Herts
SG1 2AY

t +44 (0)1438 313 311
f +44 (0)1438 765 526

postmaster@theiet.org
theiet.org

Institution of Civil Engineers

One Great George Street
Westminster
London
SW1P 3AA

t +44 (0)20 7222 7722
f +44 (0)20 7222 7500

communications@ice.org.uk
ice.org.uk