

First Name	Last Name	Question	Answer
Jean	Venables	In my Presidential Address in 2008 I discussed the need to reduce carbon: what actions are you taking now?	Personally I have never owned a car and cycled and used public transport, <u>however there are numerous industry responses such as that from ACE: https://www.acenet.co.uk/campaigns/net-zero/ and many consultants publish their routes to zero carbon on their websites</u>
Paul	Perry	Superb presentation. What is the one change that was made in the 1970's / 1980's was the most important factor in changing the consulting engineers world amongst those you have suggested, and could it have been seen off?	Besides the very positive (from consulting engineers' viewpoint) changes brought about by privatisation, the most profound change was the introduction of fee competition. Until the 1980s consultants were paid for most work – public or private sector, UK or overseas – under fee scales decided by ACE, typically between 4%-5% of the value of a job for large projects to 10% for small. This suited consultants very well, and fee competition certainly resulted in lower fees – an estimated 25% reduction in the first three years on highway schemes – but it also encouraged consultants to pare down the amount of work they did – for example, with less iteration to optimise design. This may have resulted in greater construction costs, only partly offset by lower fees. I think the pendulum has now swung too far in the direction of minimising fees, with a sacrifice in quality of design and (for example) investment in staff training. But it's difficult to see how it can easily be reversed!
Paul	Perry	Where do you recommend an aspiring 21 year old consulting engineer to aim for now in the world?	The quest for zero carbon means there is plenty to do everywhere; it is relatively easy through corporate websites to establish the ethos and kind of work tackled by most consultants and identify those which would provide the kind of challenge young people are seeking. I would advise anybody to be ambitious and follow their 'heart'; there are plenty of opportunities for regrets later, but if you close down opportunities early they may never come back. [HF - Agreed]
		Should we have a structured training with time spent in different groups undertaking a variety of work within the civil engineering sphere in that three years, with a length in the design office and on a construction site, outwith the commercial cloud?	This is the traditional British approach for centuries; for some individuals specialist expertise may suit them better.
Peter	Richardson	Do you think there are any small firms today (or yet to exist?!) that may grow to overtake the larger dominant firms of today as opposed to being acquired by them?	There are still plenty of opportunities for niche operators, but to be big you have to want to be big, and some well-known names have preferred to remain relatively small. The WSP story is probably instructive, and of course it could be repeated. [HF - Agreed]
Keith	Hitchcock	With the move to Design and Build contracts is there likely to be a permanent integration of consulting engineers and construction contractors?	Design and build has always existed in the industry, but independent consultants have argued they can provide better value independent design. There is plenty of room for coexistence. [HF - That's what contractor Balfour Beattie thought when they bought US consulting engineer Parsons Brinckerhoff in 2009. Integration didn't seem to work, and they sold PB on to consulting engineers WSP, whose chairman Chris Cole told me: 'I don't believe the two (consulting and contracting) go together, or ever will go together. Some say customers want a 'one stop shop' for design and construction, but I disagree and so far I've been proved right!' He may be right.]
Anusha	Shah	Fascinating presentation! How do you think Thomas Telford would deal with the Climate Change challenge?	I would only add that Smeaton carried out research into the efficiency of wind and waterpower, and Telford wrote a report on (Wind)mills. They would have been guided to solutions through empirical research. [HF - If Thomas Telford came back, his first reaction would be amazement about our concern for the environment: in his day, the environment was there to be tamed. Civil engineering, in the words of ICE's first Royal Charter which Telford established, 'is the art of directing the great sources of power in nature for the use and convenience of man'. But having recognised the 21st century challenge, I think he'd have approached it with gusto, much as Mike has suggested.]

Alan	Roper	With some contractors pursuing 'in house' consultancy services (for example Balfour Beattys ownership and later sell-off of Parsons Brinkerhoff), do you see benefit or disbenefit to the separation between consultant and contractor?	This example illustrates such decisions are guided by commercial considerations. There is plenty of evidence that larger victorian contractors either employed inhouse design engineers, or specialist consultants to support their businesses. Even when a contractor offers a design and build solution, clients will normally employ some kind of engineering advice, directly or as a consultant. [HF - See my answer to Q9 above.]
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Terry	Hill	Ove proclaimed total design. Does Hugh think the separation of civil engineers (the designers) and Contractors (the builders) gets the best out of our projects?	Ove developed his concept of total design in the context of design of buildings, and I think subsequent evidence has proved him right: most of the world's best buildings came about through close collaboration (from the very start) between the professions – architect, engineers, QS's – and most of the worst came where the collaboration was weak or non-existent. The evidence is less clear about contractors. Certainly there are benefits to involving contractors at an earlier stage than with 'traditional' contracts, but I'm not so sure about total integration.
Aaron	Matthew	To what extent was the need for British engineers worldwide a result of centuries of appalling Imperial policies? Could you comment on Daniel R. Headrick claims that technology transfer was withheld from the native populations?	There can be little doubt that British engineers monopolised work in the British colonies c 1800-1950, but the work of consultants was more driven by British capital rather than simply the pink areas on the map. Most colonies after 1850 had a public works department who tended to control the work except for major new schemes, and certainly in the Indian Empire attempts were made to provide education insitu-the basis for Roorkee University for example. However there were generally glass ceilings for 'native' engineers before 1920. The multi volume histories of the British Empire/India published by Oxford and Cambridge University press, and works by authors like Ian Kerr and Casper Andersen referred to in the bibliography to our book give more context. In the dominions ie Canada/South Africa/Australia/New Zealand from the late nineteenth century senior positions were held by overseas born engineers who increasingly looked to non-UK railway materiel etc. as cheaper.
		Was the training of non-british engineers heavily suppressed? And were the projects that were built to serve shareholder profits and cost the colonies dearly (e.g. Indian railways costing up to 2 times as much as Australias)?	Much academic research has been done on colonial education and capacity building, but this often relates to public works departments rather than consultants. In the last 30-40 years some consultants have built up a reputation for capacity building and it is often a prerequisite for projects funded by the development banks. Reading shareholder reports in the railway press of the nineteenth century the issue of engineers pushing up the costs, or exercising little cost control is a common issue, I.K. Brunel often being the culprit. In part problems were caused by inappropriate technology transfer. US railways were generally much cheaper per mile than UK railways. Early Indian railways were built to a broad gauge and later lines built to a narrower gauge to try and bring costs down. Perhaps the most outrageous examples were to be found in Africa. Of course consultants did not have shareholders, and they were supposed to operate independently of commercial interests. That was as suggested in the lecture one reason UK consultants won work in the post-WW2 era. In Victorian times shareholders who put up money for for example south american railways might have an expectation that the railway's engineer might specify ironwork from a company the railway shareholders also had shares in. Not much work has been done on these kinds of business relationships.
Holly	Smith	Due to globalisation and the rise of technology, is there now more competition from abroad to challenge british consultants?	[HF - From the late 70s British consultants' share of overseas work started to decline]
Nick	Von Behr	Can you say anything on the role of architectural dynasties and links to civil and structural engineers?	Some of these relationships are explored in the book, particularly the chapter on the specialists, and the great consultants like Arup and Williams. Some, like Robert Mylne and family were multi disciplinary for several generations.

David	Mathieson	Do you think that there is still the scope for great new consulting engineering practices to be formed and built or have the market changes you have outlined made that really difficult in the future?	There are new practices and partnerships being established all the time, but generally in a specialist or local area, establishing a general consultancy on a national scale would be difficult without taking established reputations from existing practices with a recognised client base. However the world of BIM and zero carbon are creating lots of opportunities based around innovation. [HF - It probably will be more difficult in the future. But equally, as we have seen in many industries, the largest of firms can suffer sudden commercial or reputational damage, or simply ossify over time, and there will always be scope to replace them.]
Gordon	Masterton	Is our educational formation that created the competitive edge for UK-based consultants keeping pace with the rest of the world?	I think the blend of education, training, a reputation for business ethics, and access to technical innovation served British consultants well. Globalisation and geopolitical power shifts have changed the business landscape dramatically meaning there are plenty of non-UK businesses, but the UK still has some of the leading higher education establishments, and a portfolio of work likely to attract clients seeking added value, probably all to play for.
Gordon	Masterton	Your talk reminds me that 16 years ago when we started the President's Apprentices all seven chosen on merit - four to three in favour of women engineers. In consultancy, the most prominent was Molly Fergusson who became senior partner of Blyth and Blyth.	In the book we do discuss the rise of women and recognition of their role, but it has been unreasonably slow progress. Molly Ferguson was almost alone as a senior partner throughout her career c. 1945-1980.
Sylveste	Lamboi	With the rapid advancement of artificial intelligence (AI), what do you think of the future of consultancy and civil/structural engineering as a whole?	The Susskinds' 'Future of the professions', suggests many engineering services will be automated with consequent deskilling, but that some bespoke services will remain important. If the analysis is correct it suggests a world of niche firms, and large businesses offering a range of services based around AI and IT systems. [HF - Agreed. The answer, at least in part, is that consulting engineers should be leading the adoption of AI, not reacting to it. Last week I was talking to two bright engineers in their 20s, one working for a major UK consulting engineer, the other for a leading multinational professional services firm (not in construction). The former had a personal annual training budget of £500, the latter £10,000. This is not the case of the consulting engineer being mean: fees are tight, and the firm could not afford to invest much more in training. But guess which of the two organisations would be most likely to have the staff best-equipped for leading the adoption of AI! It's an issue, but I don't have the answer!]
	yuli	Do you see merging major PEIs ICE IMechE IStructE like in HK would help in achieving the SDGs as it will encourage closer cooperation less competition & therefore a better tackling of socioeconomic problems that lie ahead, especially in the post covid era?	Most of the great consultants have offered multi-disciplinary services which, as suggested by the questioner, bring together many kinds of expertise which will be required to solve global problems; such expertise extends beyond traditional engineering disciplines. [HF - Agreed. But in construction, the greater need is probably for better integration across the construction professions (architecture, quantity surveying, as well as civil/structural/m&e engineering) rather than across all engineering. See what Bath University has done.]
Tony	Barber	Do you think that the UK tax system could have been more supportive of consultants?	There is little doubt changes in tax regimes have an impact, but the UK regime is not necessarily the most challenging. [HF - Certainly that was the case in the 1970s and 80s. But also at that time, US tax laws were much more onerous for individuals working overseas and repatriating their earnings – which gave UK firms a big competitive advantage over US rivals. Nowadays, I agree with Mike.]
John	Park	Did the early engineers study at University and if not when did it become the norm?	Some early engineers attended university, but engineering courses were not available in the eighteenth century, and were very rare in the UK before the late nineteenth century. A University based engineering qualification did not become the norm in the UK until after the second World War. ICE and other engineering bodies organised their own university level examinations for much of the twentieth century. [HF - And it's also worth noting that Scotland was generally ahead of England, both in attracting budding engineers to general courses, and then introducing early engineering courses. And in my lecture I mentioned my grandmother who witnessed in Dundee the storm in which the Tay Bridge collapsed in 1879: shortly afterwards she studied at Edinburgh University – at a time when (I believe) women were not admitted to any English university.]

Chris	Brammeier	Where do you see the industry going? Do you think further consolidation is a good idea? Is there such thing as 'too big'?	It's not clear that 'too big' can be defined; some firms become unmanageable through growth in terms of work and/or staff, but others prove very resilient. The challenge of AI and requirements of megaclients of a range of services suggests there is still an expectation of bigger and bigger providers of services. The term 'consulting engineer' or even 'consultant' is probably not appropriate for such firms. [HF - Agreed]
		How much do you think the ongoing Working from home will help or hinder learning by early career professionals. Particularly 'learning by osmosis' just by sitting next to more experienced engineers	Education establishments and businesses are going to have to readjust, and possibly ICE reconsider its criteria for assessing education and training, but COVID has probably only accelerated pre-existing trends. When one considers how many early engineers 'learned', much was done through reading and individual experimentation, but many models of innovation assume serendipity through close proximity to many bright minds-it is yet to be demonstrated how this can be done remotely. [HF - And just about everybody agrees, and has agreed over the centuries, that an essential ingredient of an engineer's development is practical experience. That cannot be done by working from home.]
Michael	O'Shea	Would the mega firms model perhaps provide an opportunity to tackle the greatest challenge to consulting engineers - minimal fees for an ever expanding range of services?	There is a danger in this approach, as minimal fees may result in services being delegated to inexperienced or junior staff, resulting in the end in some kind of physical or financial disaster. Much has been written on the dangers of low fees. [HF - Agreed, and there's no easy solution.]
Claire	Burroughs	Question - As with every part of engineering, women are outnumbered by men due to history but are there any notable women you would like to mention?	<u>Our book does say something about women consulting engineers. The historic role of women may have been undervalued by eg looking for women engineering graduates, or membership of professional engineering institutions (PEIs), rather than looking at how women might have played 'backroom' roles vital to a family business- eg Smeaton's daughters helping with preparing drawings. Internationally Emily Roebling is an outstanding nineteenth century example. The Womens Engineering Society provides some great examples https://www.wes.org.uk/wes-centenary . [HF - Electrical engineering was quicker to embrace women than civils, and an outstanding early example was Rachel Parsons (daughter of Charles Parsons, the inventor of the steam turbine) who was a director of her father's company, and a founder member of the WES. Interestingly, one of the TBMs currently driving the Thames Tideway tunnels is named 'Rachel' after her, celebrating the women-only engineering works she established in Fulham, directly overhead! Others I'd include would be Dorothy Buchanan, the first woman ICE member, and Molly Ferguson, senior partner of Blyth and Blyth. But these were the exceptions. As late as the mid 60s my cohort of undergraduates at UCL had (if I remember correctly) not a single woman – in civil, mechanical or electrical. Things have changed out of all recognition since then, though I suspect there is still an issue of retention of good women engineers.]</u>
James	C	In your research has there been any significant impact to the industry by women? How do you think their representation in the industry might change if this journal was written 100 years today?	There have been many outstanding women consulting engineers with ICE currently having a number of great women on its Board. They can provide role models for the future, so why not a women dominated profession delivering zero carbon construction on time? [HF - Agreed. And as a next step, ICE is due (at last!) to have only its second woman President next year – Rachel Skinner of WSP!]
		Can you quantify how much value geologists are in civil engineering (from a geologist)?	Our book includes an early definition of the qualities required of an engineer, which included knowledge of geology, and the role of consultant geologists is recognised elsewhere in the book.
John	Banyard	How far do you think that the decline of Consulting Engineers arises from the failure of the partnerships and subsequent legal structures to understand the developments of the commercial world that they were being required to service?	There are plenty of examples of small partnerships still thriving. [HF - Undoubtedly the traditional partnership structure was found wanting – at least for the larger firms – by the need for greater business acumen in the last quarter of the 20th century. But is that still so? And do we agree about 'the decline of Consulting Engineers'? They've changed out of all recognition, but some would argue they're now stronger than ever!]

Karen	Sagar	Thanks for a very informative presentation (as a Canadian and former Candian WSP employee, I am not sure we'd describe WSP as British!). Why do you think there were no 'notable' female consulting engineers?	There have been some notable women consultants although there remains much to do to increase the numbers of women engineers. [HF - On WSP, you could argue it both ways. We took the view that as it was WSP who instigated the reverse takeover by Genivar to raise capital for growth, as WSP was the larger party, as the WSP name was retained, and as WSP co-founder Chris Cole remained as chairman, it was legitimate to call the firm 'British'. The case was much less clear with fellow-Canadian firm SNC-Lavalin's later takeover of Atkins!]
Elaine	Roberts	How can we encourage diversity in consulting engineering today despite our historical figures being entirely white men?	To some extent this picture is the result of a presentation about the history of British consultants. The Royal Academy has a useful page on BAME engineers https://www.raeng.org.uk/diversity-in-engineering/diversity-and-inclusion-at-the-academy/celebrating-leading-ethnic-minorities-in-engineer . There are plenty of examples of great south asian and Chinese engineers while one of the greatest historical engineers is Sinan, the advisor to Ottoman emperors https://en.wikipedia.org/wiki/Mimar_Sinan . Books on these topics can be found in the ICE Library.
Vijesh	Mehta	How did consulting engineers win jobs before the 1970's if they couldn't promote via advertising or offering varying fee's? How would the client differentiate?	Word of mouth, publishing articles on their works, listings in directories.
Bill	Hewlett	History and engineering tend to be presented pretty factually. Are there examples of a more narrative record, focussing on the emotion and social construct aspects of the profession?	<u>Hopefully our books achieve this. Some biographies e.g. of Brunel and the Stephensons, and more recently Karl Terzaghi do cover the social side. You might enjoy this https://www.tandfonline.com/eprint/G5TUTMUUAAEGHMCSB8GT/full?target=10.1080/17581206.2020.1782620</u>