The Professional

ENGINEER

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South Elkington,
Nr. Louth, Lincolnshire

The Society of
Professional Engineers
was founded in 1969.

Features in this Issue

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To be appointed

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1972/73	J.D. BURROWS	1978/79	W.E. HUMPHREY	1986/87	D.T. COATES	2000/02	BRIAN R. DIXON		
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1974/75	D.J. AYRES	1980/81	V.C. EALEY	1990/91	K.A. STATHAM	2003/05	DAVID PARRATT		

The Editor Writes

Welcome to the Winter 2008/2009 publication of the Bulletin, in this issue we feature articles on 'The Forensic Engineer', 'Why Choose a Career as an Engineer' 'Famous British Engineers', 'The Earth, Moon and Time Relative to the Calender', 'Terminal 5, Heathrow Airport' and The President Writes.

As Editor I am always looking for articles from members for future Bulletins, and I shall be pleased to hear from you if you would like to contribute, and finally, I do hope you find this issue of the Bulletin of interest to you.

Brian R Dixon, BA, P.Eng
Editor

New President Appointed

Brian R. Dixon, B.A., P.Eng, (left) Immediate Past President, and David Hardcastle, P.Eng, Hon F.S.E, (right), President.

At a brief Council meeting following the AGM on Tuesday, 18th November 2008, Brian R Dixon stood down as President of the Society, having served for 3 years, and a new President was appointed.

He is David J Hardcastle, P Eng, Hon FSE, FCMI, who was warmly welcomed by those present.

David has previously served as President some 25 years ago in 1983/84, and we all wish him well as he leads the Society into its 40th Anniversary Year.

In Numbers

2 - The number of years the construction industry will remain in recession, according to a survey published by the Construction Confederation and the Construction Products Association.

2.1 - The percentage rise in average contractors' salaries this year, compared to 7.7% between 2006 and 2007, according to research compiled by Hays.

181 - The number of construction-related legal claims filed in the first six months of the year, down 10% from 202 in the same period of 2007. The news has confounded legal experts, who expected a rise in claims as economic problems bite.

42,000 - The number of recruits that UK construction will require per year between 2009 and 2013, according to a report by the Construction Skills Network. That's half the number CSN quoted in a report published before the economic downturn.

120,000 - The total amount, in pounds, contractors Spanclad and Westminster Building were fined after construction worker Darren Handley fell to his death through a missing scaffold rail.

74m - The amount, in pounds, that Vinci Construction paid to purchase Taylor Woodrow, a deal that will double the size of its UK turnover to £1.4bn.

90m - The amount, in pounds, the £400m London Olympic media centre is expected to go over budget unless a value engineering programme is successful.

100m - The value, in pounds, of Premier Inn's new-build programme. The hotel chain is targeting sites previously earmarked for office or residential development.

2bn - The number of bricks expected to be manufactured in the UK this year, the lowest that production has sunk since the 1940's, according to figures from the Construction Products Association.

Flood Report Points Finger at Building Regulations

The Building Regulations must be revised to make new homes more flood-proof. This is one of the principle findings of an independent review into last summer's floods carried out by Sir Michael Pitt.

The report, published on 25 June, also recommends that the government establish a cabinet committee to tackle flood risk and give the issue the same level of importance as risks such as terrorism.

Pitt, who examined more than 1,000 written submissions in putting together his 400-page report, was assisted by staff from engineering firms Arup, Halcrow, Jacobs and MWH. The report found that the government must be held to account for improving the country's flood resilience and made 92 recommendations in all, including the implementation of above-inflation increases for flood resilience measures and the use of flood-resistant materials in public buildings.

Pitt emphasised that the recommendations were not all costly and four-fifths of them could be put in place using existing budgets. He said: 'A great deal is about people changing the way they do things. My view is this report is affordable. I'm not proposing anything here so outlandishly expensive that it should stand in the way of implementation.'

Pensioners Outnumber Under 16s

Britain now has more pensioners than children for the first time in the country's history.

There are 11.58 million pensioners (men over 65 and women over 60) compared to 11.52 million under 16s.

Those aged over 80 have almost doubled over the past 30 years to 2.7 million, making this age group the fastest growing due to increasing life expectancy.

"The world hates change, yet it is the only thing that has brought progress." – Charles Kettering

The President Writes

From Our New President: David Hardcastle P.Eng, FCMI, Hon FIET

Following the AGM of the Society 18th November 2008, I was installed as President for the year to December 2009. This great honour is not without some concern as I follow the care and hard work put in over 3 years by Brian Dixon. I will endeavour to maintain this standard.

Our Society is strong. It is recognised as a leading professional Society for the many and varied disciplines of the world wide Engineering profession. To maintain our status it is essential that membership is only granted to a proven qualified applicant. The Engineering profession generally has always had difficulty when recognising requirements for full membership. We are proud that we have always maintained a fair balance between academic qualification and work or site experience.

Efficient administration of the Society is naturally most essential. We are fortunate to have David Gibson who with his ABE staff has to ensure a satisfactory control of correspondence, financial control etc. to enable the Council to act appropriately at all times.

I seek every opportunity to liaise with other similar bodies and trust that whatever discipline all qualified Professional Engineers will work to ensure that cost, safety and the minimising of energy consumption will be their aims in life!

David Hardcastle
President

The Society at the Salon Maitrise D'Oeuvre Exhibition

At the invitation of the Societe Nationale des Ingénieurs Professionnels de France (i.p.f.), the Society attended an Exhibition in Strasbourge along with the Association of Building Engineers on Wednesday 24th September 2008.

We had a joint stand with the ABE and had an interesting and useful time.

Our then President, Brian R Dixon, BA P.Eng attended with David Gibson, BA P.Eng our Chief Executive, along with Rhys Taylor F.B. Eng, President of the ABE.

During the day the Society and ipf signed and exchanged an agreement between the Society's to encourage closer relationships.

The then President, Brian R. Dixon BA, P.Eng (right) with Rhys Taylor, President of the ABE, at the Salon Maitrise D'Oeuvre Parc d'exposition, Strasbourge.

Strasbourge

Report of the Annual General Meeting

Society AGM, some of those present

The AGM of the Society was held at Combisafe International Ltd, Grange Park, Northampton, on Tuesday 18th November 2008.

The then President, Brian R Dixon, BA P.Eng, took the chair and the Notice convening the Meeting was read by the Chief Executive.

Minutes of the last AGM held on 26th September 2007 were approved and the Statement of Accounts for the year ending 31st December 2008 were also considered and adopted. The retiring members of Council were re-elected to serve for a further term, and the Vice-Chancellors were also re-elected.

Barry Hardy of London was appointed to Council, there were no Special Resolutions, so the Chairman formally closed the meeting. After the meeting those present enjoyed refreshments and a tour of Combisafe International Ltd.

Famous British Engineers

Sir Edwin Alliott Verdon Roe
(Brief Resumé Relative to Aviation)

Edwin Alliott Verdon Roe (April 26th 1877 - Jan 4th 1958) was born in Patricroft, Lancashire and in this area matured, developing an interest in steam engineering. At 14 he went to Canada to train as a surveyor but with a slump in silver mining he had to take odd jobs to save for a passage back to Britain. On return he was apprenticed to the Lancashire & Yorkshire Railway Company locomotive design and building works in Horwich near Bolton. During this time he studied engineering (evening classes) at the Railway Mechanics Institute. On completion of his engineering apprenticeship and engineering studies he moved away to gain experience in marine engineering and went to sea as a junior engineer. During this time, watching sea birds, he developed his interest in flight with thoughts of building a flying machine.

When Wright Brothers successfully flew a Kitty Hawk. A.V. wrote complimentary and technical request letters to them and when their European trip was planned he was invited to meet with them in France and view their flying machine. Inspired by his interest and experience he designed and built a model flying machine and entered it in a Daily Mail model flying competition and won the prize money. With this money in 1909 he built from his model drawings a full size flying machine. It weighed 330lbs including a 9hp engine which with its propeller created just enough lift to rise from the ground and he became the first Briton to fly an all British aeroplane known as the Roe 1 on 13th July 1909 at Lea Marsh in Essex. On January 1st 1910 A.V. registered the company 'A.V. Roe' at Brownfields Mills in the Oldham area of Lancashire. He continued designing and building flying machines and self assembly kits one of which was supplied in 1910 to a Miss Lillian Bland in Ireland who it is thought was a first lady aviator. This kit utilised an Edward Brothers, of Bolton, patented horizontally opposed two stroke aero engine. In 1928 he bought S.E. Saunders Company and formed Saunders-Roe Aviation. In 1929 Edwin Alliott Verdon Roe was knighted for his service to aviation.

During WW1 conflict (1914-1918) the company built the Avro 504 elementary trainer and continued with this successful design into the 1920s with many built overseas under licence.

During WW2 Avro designed and built the Avro Lancaster and Avro Shackleton bombers. Saunders Roe built flying boats and many land based aircraft thus contributing to the war effort.

B.W. Gerrard, BSc, MIET, P.Eng, DipTec.

We need your help!

With a view to obtaining local and worldwide publicity for our 40th Birthday year, we are planning an E-mail newsletter campaign for 2009.

In order to design an eye-catching format for this newsletter, we need a selection of interesting pictures of a wide range of engineering projects. Even to those who work in different specialisations from those shown, they need to be obviously engineering and will illustrate the fact that every profession from medicine to catering is dependent upon the support of professional engineers. If you have any pictures which can be used without any breach of copyright, it would be helpful if you could send them to mail@davidparratt.com with a note of your name, address, membership number and your own e-mail address. We hope to be inundated with pictures so it is likely that only a few of them can be used because many will not be suitable for combining with others to form a cohesive group but even if they cannot be used initially, they may be useful for a second phase of our publicity.

The second way you can help is with the compilation of a suitable list of people to whom this and later newsletters could be sent. What we need are the titles and names of people who will have (or should have) an interest in engineering. The following is a list of different categories of possible recipients but it is not claimed to be comprehensive and suggestions for other categories will be welcome.

A. Officers or officials of other professional bodies.
B. Journalists of national newspapers.
C. Journalists of local newspapers.
D. Solicitors.
E. Barristers.
F. Members of the Judiciary.
G. Senior Local Government Officers.
H. Schools career officers.
I. Senior Management in industry.
J. Executives of Trade Associations.
K. Managements of Trade Directories.
L. Local politicians.
M. Senior Civil Servants.
N. Technical Officers in the armed services.
O. Insurance brokers.

We do not seek to record any personal information except that which is necessary to determine whether someone is an appropriate person to receive the information we are sending, such as their position and qualifications (e.g. C.Eng. Partner in Smith & Co, Structural Engineers).

Their E-mail address is essential and the information we will need to record should already be in the public domain. If you can research any suitable information like this, please send it separately to mail@davidparratt.com

Thank you
David Parratt, Past President

The Forensic Engineer

by John Seeger-Snowden, MIEE, Fellow S.P.Eng., Assoc L.I.V

How and when does a Civil Engineer become a Forensic Engineer, or require the services of a Forensic Engineer? What does a Forensic Engineer do, and, what makes the Civil Engineer different to a Forensic Engineer engaged to investigate a civil engineering matter? The term Forensic Engineer is a relatively new one and too one not frequently used by those very people who are practising Forensic Engineers! A more familiar description is Expert Witness. How do you distinguish between a Forensic Engineer and an Expert Witness? What is a Forensic Engineer? This paper attempts to differentiate between these roles, while at the same time defining what a Forensic Engineer is, and the manner, processes and techniques that he/she has to use. The paper is not intended to describe in detail the specific processes, (typically accident reconstruction, 3D modelling etc) but it does identify the legal processes and implications that the Forensic Engineer should take on when accepting instructions on a particular matter. The paper also provides examples of these processes and the implications they hold for the engineering community as a whole in a litigious society. The paper does not attempt to discuss any differences between the numerous engineering disciplines (civil, structural, mechanical et.al.); the same principles apply to all.

I have been approached many times over the years to provide a definition of a Forensic Engineer. In terms of qualifications, the normal, accepted pre-requisites of the numerous professional engineering bodies and which are an absolute essential for practicing as a professional and or chartered engineer, and subsequently as a Forensic Engineer, are recognised and accepted degrees. Most will have post graduate degrees in their discipline, with some being Fellows of their specific body. The Forensic Engineers experience is a major factor in the passing of opinion and the making of judgemental decisions. It is this accumulated knowledge, gathered after practising as a professional engineer for many years that enables the Forensic Engineer to utilise the reverse engineering methodology.

- The best definition of a Forensic Engineer I have found, defines the role as: *"Forensic Engineering is the application of the art and science of engineering in the jurisprudence system, requiring the services of legally qualified professional engineers. Forensic Engineering may include the investigation of the physical causes of accidents and other sources of claims and litigation, preparation of engineering reports, testimony at hearings and trials in administrative or judicial proceedings, and the rendition of advisory opinions to assist the resolution of disputes affecting life or property."*

This paper is intended to specifically address the role of Forensic Engineering as attributed to civil engineering. Hammurabi's Code had a section that dealt with, amongst others, punishment for the designer of a house if the roof collapsed or if the foundation failed. One addition I would make to Hammurabi's Code, is the Expert Witness. I as an engineer, whose qualifications and experience have been recognised, and, who has investigated and prepared a report on the findings of a particular matter, will in the majority of cases, be required to attend the Court proceedings and under questioning, support and demonstrate your findings to the judge. Hence, I consider that the two roles, Forensic Engineer and Expert Witness, are in the majority of cases, one of the same thing..

In today's environment there is an increased emphasis on investigating cause, be it failure, performance rated, or as in my own areas of specialisation, related to fires, explosions and accidents. The validation or otherwise of accidents, incidents and failures is sourced largely from insurance claims or civil torts in regard to non performance or compliance. In addition to the Forensic Engineers specific discipline and expertise, the Forensic Engineer also needs an understanding of the legal practices involved in demonstrating his expertise and findings to the Court.

"The defence doesn't always accept the scientific finding. That's the difficult part of the job, not the analysis but standing alone in the witness box to defend it under cross examination .If a man's no good in the box, then all the careful work he does here goes for nothing." Death of an Expert Witness, Faber & Faber 1977

A common principle utilised in establishing the cause of failure of a structure or product is reverse engineering. This is a process all engineers understand and frequently undertake, sometimes not appreciating that this is what they are actually doing, or under the guise of a different name, e.g. Failure Mode and Effect Analysis (FMEA).

What appears an obvious methodology to many engineers is not always adhered to and frequently overlooked, but does require a disciplined analytical approach. The scientific method of determining the cause of such an incident requires the Forensic Engineer to:

- State the problem
- Carry out numerous observations
- Formulate an hypotheses as to the cause
- Carry out any testing considered necessary
- Analyse the results
- Draw a conclusion

In today's world the above means utilising more sophisticated means and knowledge to provide a satisfactory outcome.

"State the problem" may sound to many as being so obvious that they consider it automatic. In carrying out a failure analysis of say, a concrete mix, it may be necessary to recreate the original engineering that went into the failed building or structure. The Forensic Engineer may be completely unaware of the original concepts utilised in the design, the parameters that were specified, what raw materials were utilised, where they came from and other unknowns. Hence in carrying out a failure analysis, the Forensic Engineer may spend considerable time and money in establishing what was considered as so basic that with most people it is not taken seriously – "state the problem".

There are some pitfalls. For example, in the process of carrying out observations I have utilised on many occasions a digital camera and have been questioned in court as to the authenticity of those photographs. After all, they can be digitally modified. I would however strongly recommend to the Forensic Engineer that as many photographs as possible are taken, regardless of cost and apparent need. I have attended the scene of fires where I have been extremely grateful that I took many photographs. In the investigations afterwards I have found that a photograph that was taken from a particular angle has had a significant impact on the outcome of the case. It is worth investing in a good quality camera and learning how to take photographs properly.

Other techniques that are now utilised (primarily to provide the evidence in such a manner that a non technical person can understand), include among others: 3D animation, reconstruction where it is possible, Ultrasonic Pulse velocity (UPV) measurement, Impact Rebound Hammer (IRH), fracture mechanics, electron microscopes, finite element analysis, fluid dynamics, re-enactment, code/standard/regulation interpretation and failure analysis. Always keep in mind that the people you are trying to explain a failure to, may not be engineers, nb. lawyers.

One of the processes utilised by the Forensic Engineer is that of taking samples, having these samples analysed (in most cases by an independent laboratory), and, establishing a hypotheses on the basis of the findings. This is sometimes very difficult. I have been called upon to provide expert evidence on matters that occurred several years previously – which makes taking a sample very questionable. On one rare occasion I was instructed to provide evidence on a building fire that was caused by the failure of an overhead electricity cable. Everybody concerned, accepted that the cable was the cause of the fire. What was not known was what had caused the cable to fail. Five years after the event it was established that a piece of the cable had been removed from the scene of the fire and kept by one of the people involved. It was concluded that, after suitable laboratory analysis, the cable had failed due to the failure of the outer insulation through UV damage. It is the authors experience that the Forensic Engineer is called in far too late after the event – which tends to confirm the opinion that as a Forensic Engineer you are only called upon as a last resort.

Outside of the academic qualifications you would anticipate any engineer to have, e.g. an Engineering Degree, the Forensic Engineer probably holds a higher degree, is a member of his or her professional body and (and this is important), is recognised by their peers in the industry or discipline.

The Forensic Engineer's workload primarily comes from litigation. It is an unfortunate fact of life that in most cases, the engineer is only called upon (as previously emphasised) to practice his skills long after the event when the majority of other venues have failed to provide an answer, and after much of the evidence has been demolished or removed.

The engineer is normally contacted and briefed by a solicitor, and provided with the relevant documentation. The engineer is then instructed by the solicitor to concentrate on specific areas of concern. These areas may include concrete quality, reinforcing bar type, quality and design, structural compliance, and other specific, specialist areas. Usually civil Forensic Engineers accommodate "failures" or "non compliance" with the exception of natural disasters and the subsequent aftermath. Fortunately most civil engineering forensic investigations do not relate to major disasters. The typical civil engineering case involves the failure of walls, leaky roofs, concrete slabs, footings, inadequate trenching, and even the non performance of underfloor heating. There are some more specialised areas of expertise that are called upon, for example, the structural engineer may have to carry out an analysis of some steelwork, providing expertise on metal fatigue, secondary stressing or stress relieving and many others.

An area that has become particularly active over the last few years is that of building services or environmental systems. With the development of and requirement for, more sophisticated building management and communications media, the end users require performance and reliability from these services. This is particularly apparent in applications such as national libraries, art galleries, hospitals and drug manufacturing facilities. The failure of one of these components in any one of these types of facilities may result in injury, death, or extensive financial loss. The failure rate of any one of these individual system components can be directly related to the number of sub systems.

To demonstrate the process I will use as an example a smaller case where I was called in:

Recapping, the Forensic Engineer is usually called upon for his services after the event. This particular matter involved a multi storey office building, three floors of which had been let to my client. The end user had moved in to the premises. Previously the end user had explained to the letting agents what the office area was to be used for. It was in fact something similar to a call centre, providing "across the phone" medical nursing advice to patients across the country on a 24/7 basis. The end user had installed spacious, well planned, office accommodation, all fitted with computer and accessories.

Within days it became apparent that the electrical load of the new office area equipment was too heavy.

I was called in to evaluate the situation and provide data that could be presented to the agents, in order to have remedial work carried out. Load testing and monitoring was carried out over several weeks. Individual floor electrical loads were checked and recorded. The ability of the building distribution system was checked to evaluate what, if anything, could be done. At the same time it also became apparent that the incoming supply was not big enough, as the feeder to the supply company's transformer was only capable of providing a limited amount of additional power. Furthermore, the supply company acknowledged that the geographic district demand, was in excess of what they could provide, without significant works being carried out.


"With thanks to the West Gate Bridge Memorial Committee"

The forensic component of this matter was the investigation of the electrical loads being placed upon the system, and the system capability. Small but significant to the end user.

Hence the question arose: Who was responsible?

This example is used to demonstrate how even a small item such as defining specific usage in a rented building, can impact upon the architects and builders.

The outcome. The end user sued the agents. The agents pursued the architects and builders for not identifying the limitations of the building and bringing this to the attention of the lessee.

A much larger and more catastrophic example is the case of the West Gate Bridge as an example of where flaws in the engineering process were found and subsequently corrected.

The bridge was in the process of construction across the Yarra River in Melbourne, Australia. The bridge when completed, was intended to act as part of a major feeder in and out of the Western suburbs of Melbourne; an area that was growing consistently and attracting a lot of new industries. The longest span of the bridge was to be 336 metres utilising a cable stayed box girder design. Total length of the bridge was 2,582 metres with a maximum width of 37.3. metres.

On the 15th October 1970, at 11.50am, a 367ft span of the bridge suddenly collapsed.

The Royal Commission attributed the failure to two main causes:

First. The designers of the bridge, FF & P, failed to give proper and careful regard to the process of structural design. They failed also to give a proper check to the safety of the erection proposals put forward by the original main contractors. In consequence, the margins of safety for the bridge were inadequate during erection and they were also considered inadequate for the service conditions had the bridge been built.

Secondly. The failure was also attributed to the

The Forensic Engineer

unusual method proposed by the main contractor for the erection of the spans. The erection method required more than usual care by the contractor, and subsequently the consulting engineers. Neither party appreciated the need for additional care and expertise. The consultants in particular, were considered to have failed in their duty of care.

At the time of the collapse, men were working on and near the span concerned. Of the men on the bridge or beneath it, 35 were killed outright or died later as a result of injuries sustained.

On this particular bridge the structural members utilised a box type construction which had been previously used on the Milford Haven Bridge in Wales. On the Milford Haven Bridge, the box girder was much less in width but much greater in depth than the West Gate Bridge. It was only a single cell section having no internal webs.

After the incident, considerable argument took place between the parties involved and those associated with the West Gate Bridge design and construction. Maunsell and Partners, London had been previously requested to provide a review of the calculations and design of the Milford Haven Bridge, this in turn was submitted to the West Gate Bridge Authority in Australia, via Maunsell's office in London. The Authority concluded that the report provided an objective statement of their thorough analysis of the stresses within the bridge structures, utilising this form of design.

Numerous Forensic Engineers or Expert's were called in to provide evidence and submit reports, including Professor J.W. Roderick, Dipl. Ing Hans Grassl, Professor N. W. Murray at Monash University, Professor L. K. Stevens at Melbourne University, Professor R. Barbre at the Technical University of Braunschweig and Dr. M.S.G. Cullimore at Bristol University. These very experienced engineers carried out extensive testing on materials, materials of construction, welding techniques, and numerous other methods of positive material identification.

The outcome of the whole incident was, as previously noted, a total lack of duty of care on behalf of the main consultants. The report was damning: "The various companies who supplied the materials used were not shown to be in any way at fault, and must be held blameless. However, among those engaged upon the design and construction of the steel spans there were mistakes, miscalculations, errors of judgement, failure of communication and sheer inefficiency"

The level of professionalism, the need to keep an open mind, the necessity to investigate every venue and question every conclusion and statement, and the preparedness to pass an opinion that may not be what your client wants to hear, is paramount in the job description of the Forensic Engineer or Expert Witness. Add to this one other requirement (the lack of which on many occasions has completely destroyed the best laid plans and investigations, and/or destroyed or severely damaged the professional position and integrity of many an engineer), cross examination in Court.

The West Gate Bridge case highlighted the duties and errors of judgement amongst the engineers specifically. Fortunately the majority of cases I have handled have not involved engineering failures of this magnitude; most have involved product failures or liability, installation problems or non compliance with standards or regulations in some form. All have required an engineering expertise to either reverse engineer a problem and/or have the knowledge to carry out various test and analysis as required.

Remember this from the very beginning. You, as a Forensic Engineer or Expert Witness can:

- pass an opinion on your speciality
- pass an opinion that is factual and substantiated by evidence
- pass an opinion that is non biased and based on scientific knowledge
- provide an opinion that does not take sides.

You are in Court to assist, not to win. Your primary responsibility is to the Court to assist in understanding the problem. Then along comes the Barrister, who is paid to win, his/her client is paying them to win, almost regardless. Your feelings and sensitivities do not come into the equation. If they can trip you up – they will. If they can cast the slightest doubt upon your argument - they will. They may also have engaged there own Forensic Engineer or Expert Witness, who you may well know professionally. If your argument can be questioned with the intent of destroying it – they will. The question thus arises for the intending Forensic Engineer or Expert Witness, are you ready for this and can you work with it.

The Forensic Engineer, in addition to his/her discipline professional qualifications, needs to be trained in handling or being prepared for cross examination. Several organisations around the country can provide this type of training. My advice is, if you are seriously considering offering yourself as a Forensic Engineer or Expert Witness, go to a Court where a case is being handled and look and learn.

Terminal 5, Heathrow Airport

Terminal 5 will handle approximately 30 million passengers per annum and makes a significant statement on the world travel scene.

The design of Heathrow Terminal 5 was a direct reaction to BAA's desire to create a building that would be an aviation landmark and could adapt over time to the ever-changing requirements of the industry. The building does not force itself onto the local community, it sits low in its surroundings and only brief glimpses are possible from outside the airport.

The structure's single span roof provides a coherent building envelope while remaining independent of the building's internal superstructure. The roof soars 156m from the east side of the building to the west creating two separate 'canyons' each of which responds to the structure's functions.

It is supported by 22 pairs of 914mm diameter steel legs that reach down to apron level in dramatic full-height 'canyons' just inside the facades. The roof arch is formed from steel box girders at 18m centres: 800mm wide and up to 3.8m deep.

These are tied at high level by pairs of 115mm diameter pre-stressed steel cables, while 914mm diameter steel arms reach up from the tops of the legs to support the rafters, and solid steel tie-down straps from the rafter ends complete the 3D hybrid portal frame structure.

The roof, as it is independent from the building's superstructure, provides for a fully flexible and adaptable internal space. The scale of the roof's structural components clearly pointed to the use of steel as a way of creating the simple, independent building enclosure. Building movements and deflections for this type of span suggested that only steel construction would be suited.

Efficiency of design, fabrication and steel erection was aided by Watson Steel Structures providing large pre-fabricated units, up to 55t each that were bolted together at low level to form the central section of the roof.

The central arched section of each phase of the roof build was assembled, clad and pre-stressed at ground level and was then strand jacked 30m vertically into position and bolted to the abutment steel.

Once each phase was complete the temporary works frames that had been used to assemble the abutments were rolled north by 54m ready for the next phase. Prior to the work commencing on site a full sized trial erection was conducted to refine the fabrication and increase efficiency.

All aspects of the roof were planned and designed to maximise safety and minimise site risk. As much work as possible was carried out off site at low level, including the steel nodes which are made from pieces of steel plate that were flame cut to shape and slotted together. This avoided site welding and allowed a speedy fit up on site.

Society of Professional Engineers Representatives attend AGM of Society of Diagnostic Engineers

The eleventh Annual General Meeting of the Society of Diagnostic Engineers was held on Friday 12 September 2008 at the premises of Terex Construction, Coventry. The Society of Professional Engineers was invited to send Representatives, & David Parratt (& Mrs Parratt), Arthur Watt (& Mrs Watt), & Hugh Wynne attended.

Attendance at the AGM was positive, and the five guests from SPE were able to support the activity.

The AGM started at 11:30, & we received the outgoing Chairman's report. The society had experienced acute difficulties due to the untimely death in service of its former Chief Executive, Jo Mullins. There had been a prolonged transition period, but this had been brought to a satisfactory conclusion with the appointment of a new Chief Executive, Karen Seiles.

A formal statement of the Accounts of the Society of Diagnostic Engineers was not available to the AGM and it was agreed that the accounts would be issued later, together with the outgoing Chairman's report, to those members attending the AGM & those who had sent their apologies for non-attendance.

The AGM confirmed appointment of its Auditors, & elected directors, a new Chairman, & a new Vice-Chairman. A small temporary change to the Constitution was agreed to allow more future freedom in such elected appointments. An inflation-related rise in membership fees was agreed. Nominees for the Collacott Prize (for published Journal articles) were discussed, as was a proposal to make the John Logue award, both of which would be considered further by Council.

Following lunch, the group was taken on a tour of the Terex Construction manufacturing facility, where earthmoving & access platform equipment are assembled. This type of equipment being used on building, road, & civil engineering construction sites. As it was a Friday afternoon, the workforce had left the site & the factory was quiet.

It was both interesting & revealing to see, at close quarters, how these large, robust machines are made, & to hear of the high quality targets set by Terex Construction, & how these are achieved. It was a pleasure to participate and meet with fellow professionals.

Dianostic Engineers AGM and Tour

Diagnostic Engineers AGM, and Tour

A Tale Of Two Cities' Glass Roofs

There's more than one way to give a shopping centre a glass roof, as these two recent projects show.

The focal point of the Victoria Square development in Belfast is a 27-tonne glazed geodesic dome. It is designed to flood the interior space with light and accommodate a series of public viewing platforms that rise into the dome to about 30m above ground level and provide unobstructed views of the Belfast skyline.

Comprising 648 triangular panes of glass and 990 steel members, the dome has a huge strength-to-weight ratio. The structure supported on an arrangement of curved steel trusses and columns.

'The structure is essentially a kit of parts, which is easy to transport and erect on site', says Andrew Cornett, project engineer at Building Design Partnership. 'The triangular glazing panels are attached to the structure with an aluminium sub-frame, which we thought would produce the lightest and most transparent structure possible'.

The 94,000m2 undulating roof covering Wintergarden atrium at Westfield London at Shepherd's Bush is so vast that the spans could only be supported by columns.

Structural stability was a potential problem in the troughs of the wave-shaped roof, so tree-like column structures with several branches were positioned underneath to resolve forces generated by the steel members and 1,681 individually sized panes of glass.

Designed to resemble a real tree canopy, the pattern of double-glazed panes of glass features intermittent opaque insulated panels, which partially block out the light and help reduce solar gain. All the outer panes also have a specialised coating to reflect the heat.

When building the roof, specialist Waagner Biro craned in 69 six-tonne sections of 'ladder frame', which were welded to adjacent sections from scaffolding positioned underneath.

Like Cabot Circus' domed roof, the structure was so heavy it could not support its own weight until all the steel members had been locked into position, so the support scaffolding (over £1m worth of it at the climax of work) had to remain in place for the duration of the project.

Victoria Square, Belfast

Westfield, London

Do you have non-member colleagues? Encourage them to join the Register

A membership information pack is available on request from

The Society of Professional Engineers, Lutyens House, Billing Brook Road, Weston Favell, Northampton NN3 8NW

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East Beach Café Littlehampton

An exposed seaside location dictated the choice of materials for an innovative single storey structure in Littlehampton.

Aesthetics were a driving force behind steel being used for the East beach Café in Littlehampton.

"The shape of the building is informed by the ways in which steel can be manipulated; jigsaw-puzzle like pieces were precision cut by machine and used as a template for curving ribbons formed and welded within a controlled environment," says Dave Rayment, Adams Kara Taylor (AKT) Associate Director. "The form of the building just couldn't be done in any other material."

The East Beech Café is a south-facing building with a single storey and located on Littlehampton seafront. The structure has a narrow footprint dictated by the promenade at the front and a car park at the rear of the site.

The building's southern façade is predominantly glazed to afford the maximum views from the café, while a level of interest and detail was achieved at the rear of the café by the rippling form.

The shell of the building provides both its skin and structure, comprising a steel shell formed from horizontal ribbons which are curved around a series of vertical slices. "This 'monocoque' steel shell in which all parts act together is similar to the hull of a ship," says Mr Rayment.

With the exposed seafront location in mind, the design team opted for naturally finished materials to respond to the environmental conditions, which contain a high salt content. The 8mm thick mild steel shell that forms the outer skin was initially allowed to rust to gain texture, colour and character. Once the surface had weathered, an oil based coating was applied to halt and inhibit any further corrosion.

The building was modelled using a finite element design package, with the architect's digital 3D model of the complex geometry directly imported into the analysis model. "This allowed the inherent stiffness of the sculptural shell to be modelled with the latest digital analysis methodology partly developed at AKT," says Mr Rayment.

The model was used to identify those areas of the shell where the curvature was not sufficient to provide the required stiffness. A series of 150mm deep steel ribs were then introduced at regular centres to stiffen the structure.

The glazed wall facing the sea is articulated by a series of columns fabricated from steel plate which incorporate rainwater pipes, glazing frames and shutter guide rails. The shell was prefabricated in Littlehampton Welding's workshop, dismantled and then brought to site in four sections, which were then subsequently welded together.

The Earth, Moon and Time Relative to the Calendar

The motion of the Moon around the Earth is termed in a unit of time, one month. The time from one new or full Moon to the next (the synodic or lunar month) is 29.53 days. The time for the Moon to orbit once around the Earth relative to the stars (sidereal month) is 27.32 days. The solar month equals 30.44 days and is exactly one twelfth of the solar or tropical year, the time it takes the Earth to orbit the Sun. The calendar month is a human invention devised to fit the calendar year. This is explained below.

Seasons and Years

My research back through the years show summers peaking through July and August with snow guaranteed from Christmas through February. To-day, summer does not appear to be about until September your more likely to see snow from March to April than over the Christmas period.

If this is an accepted pattern then over the course of past 30 years the seasons have shifted position by about two months or 60 days. This then caused me to wonder why February only has 28 days. If February had 30 days then the seasons over the past 30 years would have stayed in the right place. So should it have 28 days or was there some clerical oversight when we changed from the lunar calendar to the Julian and February slipped through the net?

The real answer to the February conundrum is less inspiring than centuries of government cover up. Looking back to the Romans who first tried to reconcile the moons 291/2 days cycle with the earths 3651/4 days rotation around the Sun. The original idea to build a year period around 12 lunar cycles resulted in being 11 days short so an extra month Mercendinus was added to February every other year.

History indicates it was Julius Caesar who decided that continued acceptance of the lunar cycle was complicated. He decided to ignore and get rid of the lunar cycle along with Mercedinus by arranging the number of days in 12 months so that they added up to 3651/4 days. February ended up with 29 days plus an extra day every 4th year making 30 days. In this arrangement July the month named to honour Caesar had 31. August by contrast had only 30 days, supporters of the emperor Augustus did not agree with this so a day was moved from February to August and the calendar as we know to-day was created.

Mercedinus

Which is the leap day in the leap year? Many will answer 'February 29th'. That answer is not correct surprising as it could be. The answer is 'February 24th'. Why?

The old Roman calendar was lunar. After the addition of February and January, it had a length, 355 days. Every other year an extra month had to be added in order for the calendar to keep pace with the seasons. This month was called Mercedinas, later Intercalaris, and had a duration of 23 or 24 days or other lengths as decided by the Pontifex Maximus. This leap month was added after February 23rd. The rest of the February days were placed after Mercedinus ended with intro. of Caesar's Solar Cycle. This is how the tradition of adding leap days to adjust the Solar calendar started. To-day we introduce February 24th twice in order to make February a 29 day month every 4 years.

B.W. Gerrard, BSc, MIET, P.Eng, DipTec.

Keep In Touch with The Society

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Attributions and Retributions

Aedas and Skanska were involved in renovating schools in Midlothian. When Aedas asked for its periodic payments, Skanska refused, claiming it had a large, ongoing fund of contra set-offs that were always much more than Aedas was claiming.

Clause 12.4 of the contract said that for a withholding notice to be effective it should be made in time and specify any amount proposed to be withheld, the ground or grounds for such withholding and the amount of the withholding attributable to each ground. The Housing Grants Construction and Regeneration Act 1996 has similar wording at Section 111(B): '…..if there is more than one ground, each ground and the amount attributed to it'.

The problem was Skanska's notices. They did not clearly attribute the amount it was withholding to each separate ground, the amount often exceeded what was due, time and place were not specific, and they mentioned nine set-off charges in general terms, but with valuations against only four.

However, these amounted to £1m and exceeded the amount Aedas had claimed. Aedas asked the court for summary decree that in full trial Skanska was bound to fail as it had not issued effective notices of withholding. Unfortunately for Aedas, the judge disagreed. He said he could only support Aedas if Skanska was bound to fail. It was not enough if it was only unlikely that Skanska would not succeed. His view was that the contract and the 1996 Act allowed Skanska to calculate the contra claims and then set-off a global sum.

Moral: Adjudication may be the better forum.

Why Choose a Career as an Engineer

by Ronald G. Schenk, M.Sc., MInstP., P.Eng(UK)

During our childhood, when asked what we would like to be when we grow up generally, most boys want to become Policemen or Firemen, and girls want to be nurses. My choice was a cowboy; long gone are those days of the cowboy, and diminished as I grew older going through school, never really knowing what I wanted to do as the world changed.

Young boys are always looking to be the hero, looking up to those men and women doing exciting and dangerous things, perhaps to satisfy their own ego, rather than planning, or even thinking about a life long career. Of course, most boys see the tough combat soldier as the hero, as well as the firefighters that save lives, and the police officer that protects lives. Little did we realize as children that everyone is a hero in their own field, but those that get the most recognition are those men and women working as public servants.

Perhaps the most overlooked Role Models are those men and women that make things possible for the combat soldier, the police men and the firemen to do their heroic deeds; The Engineer.

Without the skills of the various engineers in their respective fields, the combat soldier would not have the weapons to defend his country, the bridges to cross the rivers, moving much needed equipment to him. The vehicles that our police officers use in their job, and the fire truck the firemen uses to complete his tasks, the vehicles used by paramedics to save lives, all developed by an engineer through his skills and knowledge and how to apply such skills and knowledge for the better of humanity.

The Structural Engineer that designs the structures that applies to architectural designs, the Mechanical Engineer that designs the environmental systems for the occupants of those structures. The Civil Engineers that designs the roads, water supply, and the drainage systems, for those structures. The Electrical Engineer that provides the power, to operate lighting and power for the Environmental Systems provided by the Mechanical and Civil Engineers. The Aerospace Engineer, designs aircraft for transporting people and materials to various geographical locations.

As an Engineer, you become a part of an Elite Team of men and women working together for the betterment of humanity and its future. To get there, the road will not be an easy task, becoming proficient in math, physics and problem solving. One must decide early on if this is the career, they wish to pursue, and become a highly skilled professional in their field of Endeavour.

For those who wish to become an engineer, in a specific field, they should always keep in mind, that any professional engineer would be honored to be their mentor and guide them through any difficulties they may encounter when becoming fearful of failure. Your mentor will never let you fail, he can instill self-confidence in you, and the student must trust his or her mentor, as well as never being afraid of asking questions. There is never a 'Stupid Question'; any question worth asking is worth an answer, regardless of its simplicity or complexity. My mentor took me by the hand and led me through some very tough times, and I am proud to say that we work together, even today after 30 years.

This is how we learn; from each other. Your mentor has both the academic and field knowledge to help you through your journey on becoming a Professional Engineer. In addition, as Albert Einstein once said, 'Imagination is worth more than knowledge.' Imagination in the engineering field can take one to great heights, perhaps even becoming a pioneer of a new development.

One may think that the field of engineering could become boring after awhile. I have been in the engineering field for 30 years and have never found it boring, because there is always something new to learn. I have yet to encounter a project that was the same as a previous project. Each project you encounter will have its own unique variables that will often tax your knowledge as well as your skills in the engineering field.

As an Engineer, you are a professional, and must maintain that status through continued education. One cannot stop his or her studies after becoming a professional engineer. As technologies change, the professional engineer must maintain his or her knowledge in those technological changes that could affect their respective fields.

The rewards of being a professional engineer are that of knowing you were a part of a project constructed for the betterment of humanity. In my opinion, that is one of the highest rewards anyone could ever achieve.

Articles for the Bulletin

We are always looking for news of members and project articles for publication in the bulletin, do you have something of interest, lets hear from you. Please supply articles up to 1500 words.

Reciprocal Membership Arrangements with other Professional Bodies

Reciprocal membership arrangements are in force with the bodies mentioned below. In every case Members wishing to apply should first contact the Society for an Application Form and/or a letter of recommendation.

National Society of Professional Engineers®

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The China Civil Engineering Society (CCES)
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How to Survive the Crunch

With many construction firms feeling the effects of the credit crunch, Business Link, the government-funded information, advice and support service, is offering a free online 'one-stop shop' providing guidance on surviving the market slump.

The 'beat the credit crunch' section of its website focuses on managing finance and increasing efficiency. It includes advice on cash flow and bad debt and improving environmental efficiency. It also offers a range of resources to help plan, prepare and protect businesses against a financial downturn.

www.businesslink.gov.uk/creditcrunch

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The Society of Professional Engineers, as a body, is not responsible for the statements or opinions expressed in this bulletin.

Seaside Heritage

A recent project has been undertaken to create and enhance NMR records for seaside-related buildings such as pleasure piers, seaside pavilions, winter gardens, hotels and fairgrounds.

English seaside resorts form an essential part of our cultural identity and contain some of the finest and most unique entertainment buildings in Britain.

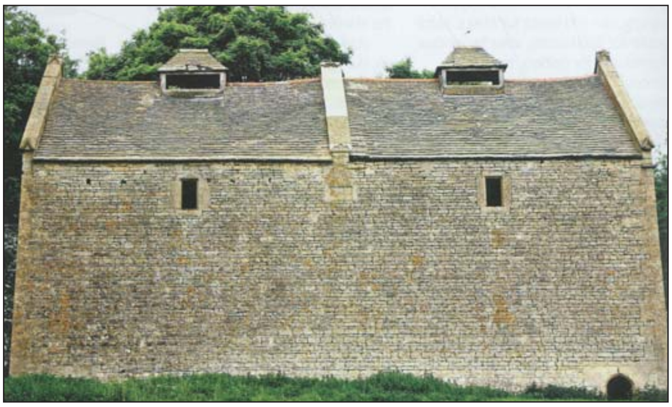
Nearly 230 monument records have been created or enhanced using the latest sources, including recent English Heritage survey work and publications.

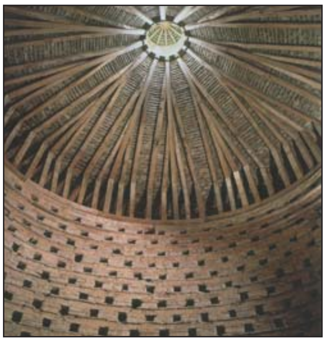

The pier, Lytham St Anne's, Lancashire.

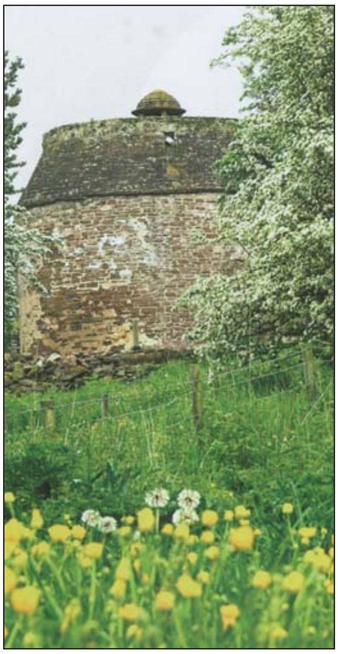
Grade II* Listed Midland Hotel in Morecambe

The Grade II* -listed Midland Hotel in the seaside resort of Morecambe is one of the most important 20th-century buildings on the English west coast. After years of decline, it was taken on by Urban Splash with the aim of reopening the hotel. English Heritage was able to enrich the architect's good understanding of the building's history and advise on the most effective ways of integrating new features with the old. In parallel, Lancaster City Council's drive and enthusiasm helped Urban Splash bring back to Morecambe the 1930s' glamour exemplified by this exceptional building.

Dovecotes - 3 historic examples







Dovecotes, (top) The huge Tresham Dovecote, Northamptonshire. It was probably built in the late 16th century and housed thousands of pair of birds. It is privately owned. (left) The interior of the dovecote at Minster Lovell Hall, Oxfordshire, English Heritage, which probably dates from the 1500s. (right) The oldest in England is thought to be that at Garway, Herefordshire, which dates from 1326, though possibly far earlier. It was associated with the adjacent Knights Templar church. Privately owned.

The Angel of the North

Since its unveiling in 1988, Antony Gormley's Angel of the North has become inextricably woven into the cultural, social and physical landscape of Gateshead. It is estimated that more than 8,000 people visit the site every week, which shows just how much this icon has been taken to heart.

Building a House Out of Mud?

Before you get your hands dirty, why not consider buying a GreenMachine? It manufactures precision-engineered tongue and groove compressed earth blocks for use in construction in developing countries such as Afghanistan. The 'TerraBricks' nicknamed after machine manufacturer TerraBuilt, are made from subsoil and cement or lime. Just don't go to Afghanistan and say you're starting a 'wall of terra'...