

**NASA: INTELLIGENT  
ASSET MANAGEMENT**

**HITTING THE RIGHT  
NOTES WITH H&H**

**133 YEARS OF FLOUR  
MAKING IN SILLOTH**

Spring/Summer 2020

# WEST CUMBRIA NEWSLETTER

Institution of  
**MECHANICAL  
ENGINEERS**

## A BRIDGE TO THE FUTURE

**REVEALED: The Queensferry  
Crossing - how Scotland's biggest  
infrastructure project for a  
generation was delivered**

### PLUS

The Bloodhound Education Team brings the excitement of 'real-life' STEM challenges to schools in West Cumbria





## Proud to support the IMechE in West Cumbria

Arup is an independent firm of designers, planners, engineers, consultants and technical specialists working with every aspect of today's built environment.

Founded in 1946, we are more than 14,000 people in 87 offices across 34 counties. Together we help our clients solve their most complex challenges - turning exciting ideas into tangible reality as we strive to find a better way and shape a better world. We are passionate about the work that we do in West Cumbria and are committed to supporting our local communities.

[www.arup.com](http://www.arup.com) | [markholmes@arup.com](mailto:markholmes@arup.com)

ARUP

## BEP Project Team



The Box Encapsulation Plant Project Team are delighted to work with the West Cumbria branch of IMechE to inspire future engineers by supporting the educational work they do in local schools.

## WORLD LEADING PROSPECTS ON YOUR DOORSTEP

Lakes College  
West Cumbria

University level  
learning with hands  
on experience at  
**Lakes College**  
and the  
**National College  
for Nuclear**





## Institution of MECHANICAL ENGINEERS

### EVENT WRITE-UPS

#### 4 Harrison & Harrison, Durham

A follow-up visit to a previous talk, we toured the Harrison & Harrison organ builder's Durham workshop, observing the stages of design, manufacturing and assembly.

#### 6 NASA Asset Management

Presentation given on NASA and Jacobs Engineering UK's multi-year journey at the space agency's testing facilities at the Langley Research Centre in Virginia.

#### 7 Carr's Flour Mill, Silloth

A technical visit to Carr's Flour Mill in Silloth where we saw flour manufacturing first-hand at this historical Victorian mill which has been supplying flour to customers for over 130 years.

#### 8-9 The Queensferry Crossing

A talk on the joint venture between Jacobs and Arup in planning, designing and constructing the Forth's Queensferry Crossing, the longest three-tower cable-stayed bridge in the world.

#### 10 Bloodhound Education

West Cumbria students enjoyed a fun-filled day in putting their classroom learning into practice with Bloodhound Education Team, whilst learning about key employment skills.

#### 11 IMechE & REACT Bursary Awards

To encourage West Cumbrian Students to think about a career in Engineering, IMechE & REACT once again have been awarding bursaries to students heading for university and 6th form.

### ABOUT IMECHE

The Institution of Mechanical Engineers is the professional body overseeing the qualification and development of mechanical engineers. It has 120,000 members in 140 countries.

Visit [imeche.org](http://imeche.org) for more information about membership or professional registration and its benefits; visit [www.imeche.org/membership-registration/become-a-member](http://www.imeche.org/membership-registration/become-a-member). Alternatively, contact David Williamson on our area committee via email: [djw7@sellafieldsites.com](mailto:djw7@sellafieldsites.com)

If you're an existing member of the Institution with a vision to be a future volunteer in education, become a STEM Ambassador, visit [www.imeche.org/get-involved/volunteering-opportunities/volunteering-opportunity-details/stem-ambassador](http://www.imeche.org/get-involved/volunteering-opportunities/volunteering-opportunity-details/stem-ambassador).

### EDITORIAL

Design and Editor: Matthew Williamson  
Published on behalf of the Institution of Mechanical Engineers West Cumbria Area.

Views expressed in this publication are not necessarily those of the Institution, its members or its publisher.

# CHAIR'S COMMENT

Hi all,

It gives me great pleasure, once again, to reflect on the achievement and activities the West Cumbria area of the IMechE has made over the last six-month period.

Welcome to the Spring/Summer edition of our bi-annual Newsletter which sets out the events and visits that we have hosted over the last six months. Included are write-ups on our visits to Carr's Flour Mill in Silloth, and Harrison & Harrison Organ Builders in Durham, as well as talks on NASA Asset Management and the Queensferry Crossing Project in Scotland. In addition, we welcomed the Bloodhound Education Team to West Cumbria schools again, plus exciting bursary news for student engineers. What is most encouraging with our events is that the attendance figures continue to be robust, with many being fully booked—we thank you for your continued support, we really do.

Our upcoming Events Programme offers a wide variety of talks and visits. We have visiting speakers from the world of engineering maintenance and reliability, and the field of biomedical, plus some of our visits take us not too far away to Carlisle; to Pirelli and Kingmoor Traction Maintenance Depot which is operated by Direct Rail Services.

Please keep informed of the future events, details of which are on the back of our Newsletter, with further information available on our website and shared via our social media channels on Facebook and Twitter. If you use any of these platforms, please give us a follow, as well as encourage your colleagues and friends to come along.

The highlight of the year is also very much fast approaching, the Annual Dinner on the evening of 18th June. This will be our 16th dinner, with planning already well underway, with a sneak preview enclosed—we hope to be able to share further details with you very soon, so keep an eye on our website and social

media. We received superb feedback on last year's event, so we have a challenge and a half to match or even better it with this year's. So, save the date, book your taxi and get your dinner suit or dress dry-cleaned in readiness!

Finally, but by no means the least important, we aim to continue our work in developing our STEM (Science, Technology, Engineering, and Mathematics) Educational Engagement activities, and this year we will revisit STEM Sport as our annual event in conjunction with the dinner. We'd be delighted to get more of you involved in our STEM activities, so if you're interested, get in touch. We are also seeking a STEM Coordinator on our committee to help focus our STEM commitments and ensure we are inspiring the next generation. Any help is appreciated, not just from us but from those who come along to enjoy our activities,

As ever, we are actively looking for new IMechE Members to reinforce and supplement our Committee, so if you feel like enhancing your Chartership/Fellowship credentials and adding an extremely worthwhile activity to your CV (as well as wanting to help us maintain the West Cumbria branch as one of the most productive and successful Area Committees in the country) get in touch with me via our website. We meet once a month and your supper is provided!

I am looking forward to the coming term, which will sadly be my last as Chair, with enthusiasm as we present another superb programme of events to further the cause of the IMechE, engineering and STEM, in our beautiful part of the world.

With best wishes,

**Caroline Hamilton CEng MIMechE**  
Honorary Chair – IMechE West Cumbria Area

### KEEP IN TOUCH

Stay up-to-date with our Institution, locally and nationally, through our websites and social media networks:

IMechE West Cumbria: [near-you.imeche.org/near-you/UK/North-Western/West-Cumbria-Area](http://near-you.imeche.org/near-you/UK/North-Western/West-Cumbria-Area)

IMechE West Cumbria Young Members: [near-you.imeche.org/near-you/UK/North-Western/West-Cumbria-Young-Member-Panel](http://near-you.imeche.org/near-you/UK/North-Western/West-Cumbria-Young-Member-Panel)

IMechE UK: [www.imeche.org](http://www.imeche.org)



IMechE West Cumbria



@IMechE\_WCumbria



Get in touch with us directly via our Near You website

# HARRISON & HARRISON TOUR PULLS OUT ALL THE STOPS

Harrison & Harrison Operations Manager **Jeremy Martiz** and Operations Director **Duncan Mathews** welcomed us to their purpose-built workshop in Durham, where the firm makes and restores pipe organs throughout Britain and abroad.

On 8th October 2019, IMechE members and friends were privileged to see behind the scenes at one of the UK's most famous builders and restorers of pipe organs.

Harrison & Harrison (H&H) is one of only a few firms still capable of designing and building new organs from scratch as well as undertaking major renovations and rebuilds. H&H also carry out routine cleaning, maintenance and tuning of these magnificent instruments that give so much character to cathedrals, churches and concert halls round the world.

## The Harrison Story

Thomas Hugh Harrison was born in 1839, the second son of Thomas William Harrison of St Pancras, whose firm made parts for the organ-building trade. At 12 years old, Thomas began as an apprentice to the organ builder Henry Willis. Seven years later, Thomas joined the Bristol firm William Allen as manager. Clearly ambitious on his own account, in 1861 he moved to Rochdale to set up his own firm.

After establishing the organ building company in Rochdale, Thomas moved to Durham in 1872. The company was moderately successful but did not achieve real success until 1896 when Thomas' sons Arthur and Harry took over. Harry designed the organs and Arthur became a voicer (tuning), resulting in commissions for rebuilds of several great organs including Durham Cathedral, the Grand Organ at the Royal Albert Hall as well as new commissions at Westminster Abbey.

Arthur Harrison died in 1936 and Harry retired in 1946, with H&H passing to Harry's son Cuthbert. The firm was led by Mark Venning from 1975-2011 who was succeeded by Dr Christopher Batchelor from 2011 - 2017. It was in



Removing the keyboard from Canterbury Cathedral's main organ for refurbishment

October 2017 that current Managing Director, Andrew Reid, left his job as Director of the Royal School of Church Music and joined H&H.

## The History of Pipe Organs

Using the same technology which goes back many centuries, the sound of the pipe organ is produced by air being blown through metal or wooden pipes. Early organs were simple instruments, whereby each key on a conventional keyboard was mechanically connected to a valve to admit air from a windchest (air receiver). Air is sent to a sounding pipe, whose length determines the resulting fundamental frequency or note produced by the air vibrating as it passes over a sharp edge or a resonating reed.

Around three hundred years ago, these instruments became much more elaborate, with

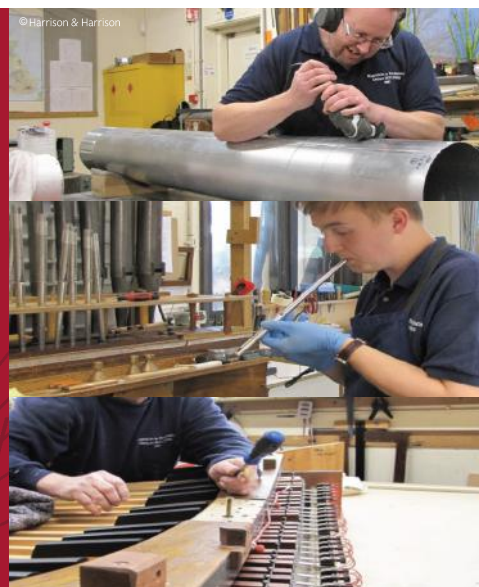
pipes made of different shapes and materials thus producing different tones. The organist was able to choose the desired tone colour by selecting one or more stops that directed air to ranks of pipes, each rank covering the 61 notes available on the keyboard. Multiple keyboards (called manuals) and a pedal-board allowed different combinations of stops to be played.

Over the years, types of linkage between keyboard and the valves serving the pipes have evolved from purely mechanical linkages (tracker action) using wood and metal rods and levers, to pneumatic and electrically linked systems. Combinations of stops can be memorised and stored so that they can be called up on the press of a single button (piston). Each keyboard or manual can be selectively linked (using couplers) to other keyboards, so that, for example, a manual played with the hands can be

## The H&H Workshop

- H&H moved from central Durham to a purpose-built workshop on the city boundary in 1996, completely designed with organ building in mind
- Built around a glazed courtyard providing a source of natural light for the working areas
- Well-equipped machine shop runs the whole length of the workshop and includes an overhead crane
- Archive room containing extensive records dating back to the 19th century which can be used for reference
- Two voicing rooms at a strategic distance from one another, with the Metal Shop between them
- Glazed viewing area for visitors and management to view organ builders in action
- A memento of 124 years in the old workshop in Hawthorn Terrace is the spiral staircase which still connects the offices and the workshop

HARRISON & HARRISON  
ORGAN BUILDERS

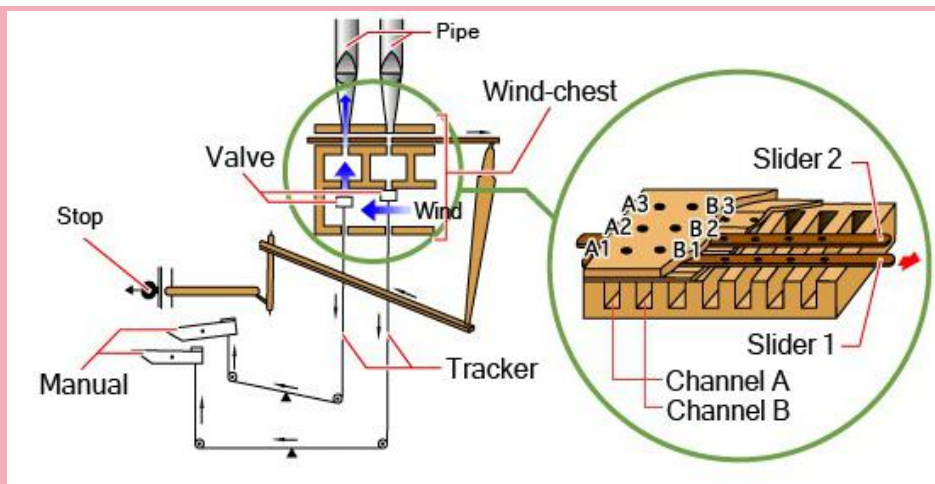




## How a Pipe Organ Produces Sound

The console is where the organist plays and is made up of the manuals (keyboard), pedals, stops and couplers. Air is sent from the blower installed on the side of the organ to the wind-chest. Pressing each key on the manual opens a valve on the wind-chest (this motion is carried by the tracker) and sends air to the pipe to produce sound.

The pipe organ acts on a similar principle to how we blow into a flute to play a sound.



used to play the deep notes that are normally accessed from the foot pedals. Electrical linkages offer the ability to duplicate the main keyboard, providing a remote playing console that can be moved on a trailing cable away from the main organ in order to provide the organist with a better line of sight to the choir or conductor.



## Organ Manufacturing

Materials used in the construction of organs has relatively remained unchanged over centuries. The pipes are made either from various types of wood, or from metal, usually alloys of lead and tin. Their ends may be open or closed: the closed pipes produce a note at half the frequency of an open pipe of the same length. Pipes range in length in the largest organs from 64ft for the lowest notes, down to the shortest pipes of just a few inches for the highest note.

Some ranks of pipes may be enclosed in large wooden boxes (swell boxes) fitted with pivoted louvres, whose opening can be varied by the organist's foot using a swell pedal, so as to alter the resultant volume. Some of the pipes may be situated in another part of the building, physically separated from the main organ but played from the main keyboard. These are used to provide a stereo or echo effect.

Organs are equipped with blowers, originally hand-pumped bellows (now generally replaced with electric fans) which supply air as quietly as possible to the windchests. These are usually made in two halves from wood, with leather bellows to allow them to expand or contract. The windchests are designed to provide air to the pipes at constant air pressure despite the varying flow demands. Different windchests allow different wind pressures for particular sets of pipes.

Each key has its own pallet valve consisting of a hinged flap valve cushioned with felt. When a key is pressed, wind is sent to the channel and the rank of pipes selected by the sliders. Above the sliders is the upper board which seals all the

channels and closes in the sliders - it is drilled with holes into which the lower end of each organ pipe is inserted. At H&H, most flat wooden components are made off-site using NC machines to improve accuracy.

## The Tour

IMechE guests toured the H&H workshops with H&H Operations Director Duncan Matthews and Operations Manager Jeremy Maritz, seeing all stages of the organ building process. The work starts with building the windchest, on the lower side of which the pallet valves are situated. Graphite is used as a lubricant for the sliders, with each being moved by pulling out or pushing in the corresponding stop.

Guests learned how H&H used to manufacture its pipes by casting, but now forms them over a metal mandrel from sheet metal soldered to form a complete tube. The conical toe is soldered to the tubular body and supports the pipe's weight as it fits into the corresponding hole in the upper board. The mouth of the pipe is cut and formed to provide the sharp edge, which as in a flute, enables the pipe to sound its note.

The upper end of the pipe's toe is almost blocked by a piece of wood or metal called the languid, which directs the air flow onto this sharp edge as a thin jet. This design has no moving parts and is known as a flue, but another more complicated design is known as a reed. In this, a brass reed vibrates as the pipe speaks providing a brighter sound with more overtones, adding to the instrument's overall tone colour.

All of these parts require careful adjustment

during the voicing process, something that the firm's craftsmen pride themselves upon. Voicing is the procedure of adjusting the various parts of a pipe to produce the desired tone and is designed to ensure that all the pipes in a given rank produce the desired timbre, loudness, attack and decay, so that the pipe's matches that of the neighbouring pipes.

H&H also builds and renovates the ornate carved casework that is a feature in most large organs. It was explained that testing at the works involves the trial assembly of the completed organ in the high central hall, before dismantling the various sections into sub-assemblies that allow them to be transported to the customer's site.

To round off our visit, we were given a superb demonstration of a 19th century H&H tracker action organ at the nearby church, St. John's, played by the firm's Managing Director, Andrew Reid who has held organ posts at Westminster Cathedral, Westminster Abbey and Peterborough Cathedral.

He was able to show off all the organ's tonal colours in works by Bach, Couperin, Dupré, and Stanford - a fitting end to a unique visit that was enjoyed by all those lucky enough to be able to attend.

Any readers who have the urge to take up the organ themselves may wish to know that H&H also make small domestic-sized organs. I am sure the firm would be delighted to hear from anyone with the necessary space and depth of pocket!

Jim Furness





# LAUNCHING NASA'S CBM ASSET MANAGEMENT

**Doug Cook**, Vice President and Head of Asset Management Support for the Critical Mission Solutions, International (CMS-I) Business Unit of Jacobs Engineering UK, reveals how Jacobs and NASA are improving system reliability and reducing maintenance costs on 270 facilities at the Langley Research Centre.



**ImechE West Cumbria members and guests attended a presentation on Asset Management on 17th September 2019, which depicted the multi-year journey undertaken in partnership between Jacobs and NASA, who use the space agency's testing facilities at the Langley Research Centre (LaRC) in Virginia to provide a critical engineering service.**

The speaker was Doug Cook who is the Vice President and Head of Asset Management Support for the Critical Mission Solutions, International (CMS-I) Business Unit of Jacobs Engineering in the United Kingdom.

Doug has spent 27 years at Jacobs, which has seen him working at the Aldermaston facility here in the UK, supporting their Asset Management programme. Jacobs, founded in 1947, employs over 50,000 people worldwide in more than 30 countries with a revenue of over \$12 billion.

Comprised of more than 780 acres, the NASA Langley campus is home to 270 facilities, 220 of which are classified as critical, such as subsonic-to-hypersonic wind tunnels used in aeronautic testing and engineering sensors that will measure the atmospheric conditions and heatshield performance during the Entry Descent and Landing phase of the Mars 2020 mission. Efforts at Langley focus on revolutionary improvements to aviation, expanding understanding of Earth's atmosphere and developing technology for space exploration.

Jacobs has held the account with NASA LaRC since 2004, but the client was wanting change, describing the Jacobs Maintenance program in 2011 as being 'in the ditch'. Prior to 2004, the NASA approach to Asset Management had been very reactive and time based, then

between 2004 and 2011 Jacobs continued to be somewhat constrained by their customer in implementing new technologies.

Driven by shrinking budgets, unplanned downtime, increased maintenance costs and a resource shortage, NASA got together with Jacobs to develop reliability-enhancing maintenance strategies for the Langley Research Centre campus. This new proposal would be a paradigm shift from the existing program requiring the client to be onboard and very much part of the entire process.

In an Air Force base in Tennessee, Jacobs had been developing a new approach and proposed that this may be a good fit to begin to address the issues at Langley. In 2011 the journey began to completely change the Asset Management approach, and in the early stages there was a great deal of data collected for all the systems and key pieces of equipment.

The main aim of the analysis of the data was to be able to provide a system that could improve the overall availability and reliability of the assets, identify potential failures early to save on cost of repair by identifying performance issues, maintain efficiency of assets and schedule repairs, minimizing impact to research and building occupants.

An \$11 million investment was used to introduce condition-based maintenance (CBM) approach. In this strategy, maintenance is proactive, preventive, and predictive using

advanced technologies to detect and assess actual asset condition.

Through integrating a team of CMRP, CMRT, and Lean Six Sigma-certified employees and 'the internet of things', the entire workforce is empowered to deliver solutions. This approach introduced instrumentation of assets for real-time monitoring of critical assets consisting of:

- A Building Automation System (BAS) monitoring and controlling HVAC systems in 216 Buildings
- Condition Based Maintenance (CBM) online monitoring of 675 critical assets
- Integrated Operations Centre (IOC) command centre for both BAS and CBM systems and all industrial alarms at NASA Langley Research Centre

Doug completed his presentation by explaining that since its introduction, the outages of key pieces of equipment had reduced from over 100 per week to zero.

In addition, he explained how the project had won a number of awards including 'Best Overall Reliability Program' (2017, Uptime Magazine Award Winner) and recognised in 2018 with the 'Jacobs Master Builder Award' for having the 'Best Asset Management Program' - one of six projects/programs in Jacobs selected to receive this prestigious corporate award.

*Thomas Pritt*



**YOUR LOCAL COMMITTEE NEEDS YOU!**

Volunteering on our committee is not an onerous commitment and members can get involved to a larger or lesser extent dependent upon interests and expertise. From student to fellow grades, come get involved in sparking new ideas and stimulus into what we do, whilst developing your skill-set and adding positively to your CV.

Interested? Get in touch with David Williamson: [djw7@sellafieldsites.com](mailto:djw7@sellafieldsites.com)



# GETTING THE BEST OUT OF WHEAT

Carr's Silloth Mill Manager **David Robertson** and Site Engineer **Paul Eastwood** welcomed IMechE West Cumbria guests to their Victorian-built Silloth Mill, which has been supplying flour to food manufacturers and bakeries for over 130 years.

On Thursday 5th December, IMechE West Cumbria visited Carr's Flour Mill in Silloth. Hosted by Mill Manager David Robertson and site engineer Paul Eastwood, the group were given a fascinating insight into the production of their range of high-quality flours.

## The Carr's Story

The Carr's business started as a small bakery and biscuit factory in Carlisle by Jonathan Dodgson Carr in 1831. Within fifteen years, it was the largest bakery business in Britain. Carr founded the business on the principles of quality, innovation and understanding the needs of his customers.

More than 180 years later, the same winning formula still prevails. Carrs Flour Mills is a thriving 21st century business but maintains old-fashioned values when it comes to producing a quality product for their impressive list of discerning customers.

The biscuit division and flour mill division were run as separate businesses until 1908, with the entire group being later sold to Cavenham Foods and then to McVities's (United Biscuit Group).

The Carr's Flour Mill business processes approximately 300,000 tonnes of wheat a year at mills in Silloth, Maldon and Kirkcaldy. The best wheat from home and abroad is obtained and there has been substantial investment in the latest milling technology to produce the best flour.

The range of flours are created with impressive attention to detail, with the company continuing to supply home and independent bakers as well as retail multiples and major food retailers. In an often volatile wheat market, Carr's have always worked closely with customers to minimise the impact of unexpected price spikes.

## The Silloth Mill

The Silloth Mill was constructed in the 1887 and is superb example of a 19th century Victorian flour mill. It is ideally situated next to Silloth 'New' dock which allows for bulk delivery of wheat by sea.



'Carel' steam engine that once powered the giant Carr's flour mill plant



The Silloth Mill was sold in 2016 to Whitworths Holdings as part of a £36 million deal for Carr's Group PLC to sell the entire Carrs Flour Mill side of the business. Whitworths are known for making dried fruit and home baking products, as well as crucially already producing a wide range of flour and grits milled from maize, rice and rye grains. With the purchase of Carr's Flour Mill it makes them the market leader in the UK flour market. Retaining the Carr's name, the Silloth Mill supplies flour to a number of food manufacturers such as Warburtons and its former owners United Biscuits.

## The Tour

The first part of the evening was held in the picturesque old power room with its wide array of historical artefacts and Victorian industrial equipment.

David and Paul talked through the production process in detail and many interesting questions were generated from the group. Particular interest was around the procurement of the wheat which comes from domestic sources as well as wheat from Canada, France and Germany. The hardness of the wheat was also discussed and this is a factor in

the strength of the flour. David also explained that flours can be blended using wheats from different sources to give the best end product.

The second part of the evening was a site tour led by David and Paul where we were able to see the milling equipment in action and the various stages that the wheat goes through to produce the final product. Interestingly, the bran is removed and then re-added to make wholemeal flour. By removing it totally and then re-adding, a highly consistent flour is produced.

The visit concluded with a final quick question and answer session before event organiser Craig Hamilton presented David with the customary 'Pit Tanky' and expressed his thanks for, what was, a fascinating visit.

*Caroline Hamilton*



## The Carr's Story

- 1831: Company founded by Jonathan Carr born in Kendal, Westmoreland
- 1837: Carr finished the new building in Carlisle of the factory he started in 1831 to produce bread, his business of baking bread and biscuits was successful
- 1842: Royal Appointment from Queen Victoria
- 1884: Jonathan Carr died of a stroke, the company was then run by various members of the Carr family
- 1887 Silloth Mill opened
- 1908: Carr's Flour Mills Limited was incorporated after acquiring the flour milling assets
- 1964: The business was bought by Cavenham Foods
- 1972: Joined United Biscuits
- 2016: Carr's Flour Mills division sold to Whitworths Holdings Group



# SAFEGUARDING A VITAL TRANSPORT CONNECTION

A fact-filled and interesting presentation in conjunction with The Institute of Civil Engineering (ICE) on the technical aspects and challenges of delivering what is the biggest infrastructure project in Scotland in a generation—The Queensferry Crossing.

**On 28th November 2019, IMechE and ICE held a joint event on the Queensferry Crossing Project. The talk was given by Paul Baralos and Mel Wheeler, both of Arup, who were part of the Jacobs Arup Joint Venture, delivering the client's advisor role for the scheme.**

Despite years of significant investment and maintenance since it opened in 1964, the Forth Road Bridge (FRB) had begun to show signs of significant deterioration in the early years of the 21st century. Internal inspections found that there had been an overall loss of bridge strength of between eight and ten per cent, giving rise to fears that significant traffic restrictions might be required in the future to allow for the repairs.

However, the need for a new crossing was driven by additional findings of corrosion in the main cables, with urgency for replacement exacerbated following discovery of a crack in a truss end link.

At that time, some 70,000 vehicles used the bridge every day and it was one of the most vital economic arteries in Scotland.

## Early Development

Paul and Mel began the event by setting out the background to the Queensferry Project, with an overview noting that the scheme included the construction of a 2.67km long bridge, 3.5km of new carriageway, 3km of carriageway widening, new and improved junctions, 15km of Intelligent Transport System and a Contact & Education Centre.

Scottish Ministers announced their intention to safeguard the economically vital cross-Forth transport corridor by building a new cable-stayed bridge to the west of the current FRB by May 2017.

Paul discussed the route selection process which had been carried out by Transport for Scotland, covering 65 options across 5 corridors including bridges and tunnels. Following extensive option evaluation, a cable-stayed bridge was selected, appointing the Jacobs Arup joint venture as design consultants in January 2008, prior to construction commencing in Autumn 2011.

The overall cost of the scheme fell

dramatically during development from £4.2bn in 2007 to £1.35bn at the time of opening. One of the key elements that led to some of the savings was the Managed Crossing Strategy, ensuring that the existing Forth Road Bridge infrastructure would be retained, where future travel growth could be managed through increased use of public transport, using the older Forth Road Bridge as a dedicated public transport route.

## Procurement

Paul went on to discuss the extensive testing which took place during development of the bridge to ensure that the unexpected deterioration of the Forth Road Bridge was not repeated.

Testing included concrete mixes, corrosion protection systems, modelling of thermal behaviour along with water tightness and durability of the stay cable systems which led to failure of the tensile test machine meaning testing had to be completed in Chicago!

One of the key decisions regarding protection of the deck boxes was to include a



**"The Queensferry Bridge is here to do a job and keep our country connected, but it is much more than that. It provides not just an essential transport link but also, alongside its sister bridges, a stunning new tourist attraction. This bridge is the greatest bridge in the world."**

**Nicola Sturgeon, First Minister of Scotland and SNP leader**

dehumidification system rather than a full paint system inside the bridge which would require ongoing touch up and repair.

## Construction

Contractors moved onto the site in the summer of 2011. There were a number of compounds established in Echline, Kirkliston, Rosyth docks and Inverkeithing. The main compound was for Forth Crossing Bridge Constructors (FCBC) and Transport for Scotland and was established on the site of an old Ministry of Defence fuel bunker near Ferrytoll. The three-storey building was made of temporary modular units which were previously the main office for the London Olympics construction site.

Paul explained to us that it was into late Autumn of 2011 that the main works started on bridge construction. The route selected enabled the central tower to be located on Beamer Rock, a volcanic outcrop dividing the navigation channels of the Forth Estuary, therefore the first job was to blast the rock ready for the foundations of the 210m tower.



The foundations for the North and South towers were founded on 25 to 30m diameter circular steel caissons sunk to the top of the bedrock some 40-50m below water level. Once positioned they were sunk into the seabed by a combination of precision dredging and ballasting with concrete to guide the caisson to its desired level and position. A thick concrete



plug was then poured underwater within the cylinders to enable the construction of a reinforced concrete base for the foundations towers. The caisson approach is not that dissimilar to how 19th Century engineers approached the foundations that support the original Forth Bridge which still carries road traffic.

The foundations for the towers and handover to the tower construction was completed in the Summer of 2013, a significant milestone in the project which saw working in the wet turned to working in the dry. As well as work on the bridge itself, the project also involved the upgrade of the M90 in Fife and M9 Junction 1a. These were both completed in the Winter of 2012/13 and feature Intelligent Traffic Management; with gantries for managing congestion via variable mandatory speed limits and use of the hard shoulder for buses.

Ongoing safe access for maintenance of the deck internals is afforded by a system of walkways and a pair of deck shuttles that traverse the length of the bridge and approach viaducts, with the towers being accessed by rack and pinion lifts and stairs. Gantries have been provided for maintenance and inspection below the deck, along the stay cables and up the outside of the towers.

Paul then gave an extensive review of the methods of construction, including challenging transport routes and construction methods to enable delivery of the materials, which for each tower alone included 18000m<sup>3</sup> of underwater

concrete and 15000m<sup>3</sup> of foundation and tower concrete, 2760t of reinforcement. Fabrication of the deck units took place at the project's steel supplier of ZPMC in China, in a yard on the shore of the Yangtze river. Once complete, the units were loaded on to specially designed vessels before setting off on the 6 week voyage to the dock at Rosyth.

Mel then presented the mechanical and electrical aspects of the scheme, including the extensive monitoring and management systems required to ensure safe and efficient operation of the bridge throughout its intended life.

It was on Monday 28th August 2017 that Scotland's First Minister Nicola Sturgeon met with representatives of the Queensferry Crossing construction workforce to handover the completed structure from the contractor to the Scottish Government. The bridge then opened two days later, with a later official opening by Her Majesty the Queen on 4th September.

A engaging presentation by Paul and Mel, and thoroughly enjoyed by those who attended.

**Mark Holmes**



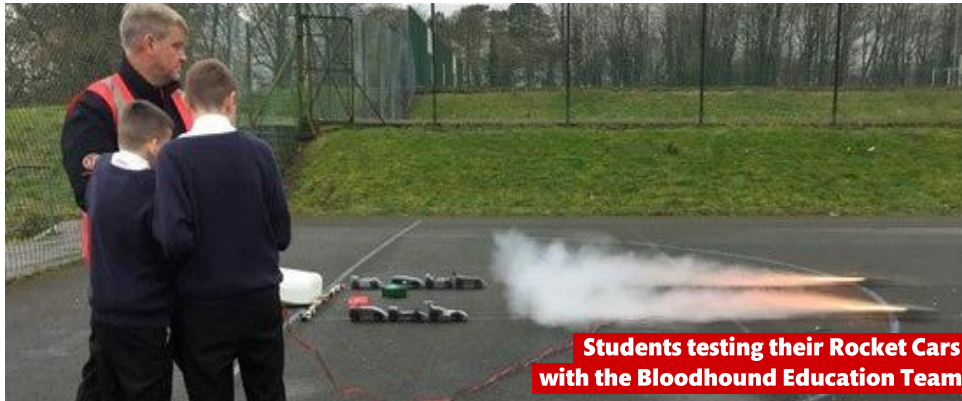
## World Class, World Record Breaking

- The structure spans 1.7 miles (2.7km) making it the longest three-tower, cable-stayed bridge in the world
- 15 days of pouring concrete 24/7 to achieve the Queensferry Crossing's first world record for the longest continuous underwater pour – 16,869 cubic metres of concrete into the water-filled south tower caisson
- 7,000 tonnes of steel were used to build of the north and south viaducts
- 25% higher than the Forth Road Bridge – The Queensferry Crossing is 207 metres above high tide (683ft), 50 metres higher than the Road Bridge
- 122 deck sections make up the bridge deck – each one of these sections can weigh up to 750 tonnes
- 23,000 miles of cabling used – a length close to being stretched around Earth
- 35,000 tonnes of steel used in the bridge superstructure



# BLOODHOUND STUDENT CHALLENGE

The Bloodhound Education team returned to West Cumbria to bring the excitement of the Bloodhound LSR world land speed record project to two local schools, sponsored by the Institution of Mechanical Engineers West Cumbria and supported by local IMechE members



**Students from Workington Academy and Beacon Hill Community School enjoyed a fun-filled day in putting their classroom learning into practice with the Bloodhound Education Team, while also learning key employment skills.**

The school visits on 4th and 5th December 2019 marked the third trip to the West Cumbria region for the Bloodhound Education Team, demonstrating the strong and invaluable relationship between Bloodhound and the IMechE. The hands-on Engineering Challenge event capitalised on the hugely successful high-speed trials of the Bloodhound LSR car in South Africa, which had reached a peak speed of 628mph just two weeks beforehand, providing the theme for the day.

## Putting Learning into Practice

Together with the IMechE volunteers, Bloodhound Education's Mike Ford and Anthony Rhodes ran a full day of activities with selected students from Years 8 and 9 at



Workington Academy and Beacon Hill Community School.

At each school, the students worked in teams under timed conditions to design, build and test rocket cars, putting engineering skills and knowledge gained in the classroom into practice. Each day culminated in a race where the students' cars ran at speeds of over 50mph.

The Engineering Challenge events are designed to enhance students' careers enterprise skills, as well as giving them hands-on experience of an engineering activity. This is extended further by getting them to present their data, findings and results to the whole group after racing their cars.

As well as applying classroom STEM skills, they benefit from experiencing team building and decision making, and having to overcome challenges just as engineers do in the workplace.

"On a rainy, cold December day, Workington Academy students applied their STEM skills, and particularly their knowledge of forces from KS3 Physics, to design an aerodynamic rocket and water-powered car that would achieve as high a velocity as possible," explained John Savage, Curriculum Leader (Science), Workington Academy. "Alongside this, students were placed in mixed teams with others outside their usual friendship groups, to try to encourage their team building and

collaboration skills.

"The students fully engaged with the Bloodhound project and thoroughly enjoyed the competitive nature of the challenge. They also collected a large amount of real-world data that could be used to support what had been learned in the classroom", John added,

There was plenty of evidence that the students enjoyed the day as well as benefitting from many aspects of it, with feedback including from the children being really encouraging, particularly to do with designing the cars and working in teams.

## Local Engineers Provide Inspiration

Students also benefitted from working with IMechE members, who were invaluable in giving them a chance to engage with local engineers.

"Since 2017, the IMechE West Cumbria area and Bloodhound have provided educational events for over 1,000 local primary and secondary school children," said Simon Mandale, immediate past chair of IMechE West Cumbria area. "A key objective of the IMechE is to inspire the next generation and the programmes provided by the Bloodhound Education team do exactly that."



"Bloodhound Education provides a link between the school curriculum and the workplace using a fun mixture of practical and theoretical exercises. We look forward to developing our working relationship with the Bloodhound team into the future."

Kirsty Allpress, CEO of Bloodhound Education, commented: "We have greatly appreciated the support IMechE has provided over the years. This extends to regional IMechE networks like West Cumbria who make it possible for us bring the excitement of real engineering projects like Bloodhound LSR to their area. Their members and Ambassadors join us at schools and colleges to share their insights and skills, all of which helps students make links between the classroom and career opportunities.

"At a time when we need more engineers in the UK, both financial and practical support are vital to encourage more students to pursue engineering as a career, so we'd like to thank them for their great support for this event."

*Article courtesy of the  
Bloodhound SSC Education Ltd*

## Bloodhound LSR Project

- Bloodhound LSR is a venture based on the Bloodhound Project, using the Bloodhound SSC Car rescued from administration by businessman Ian Warhurst in December 2018
- The current world land speed record of 763.035 mph (1,227.985 km/h) was set over 20 years ago by a British team, including Bloodhound LSR driver Andy Green
- "Advances in engineering design, materials and computational fluid dynamics (CFD) since the last record was broken mean we can be confident of breaking that record with Bloodhound LSR" - Ian Warhurst, CEO, Grafton LSR Limited
- Bloodhound education activities are run by a standalone organisation called Bloodhound SSC Education Ltd, which is a registered charity



## IMECHE & REACT FOUNDATION BURSARY AWARDS

Cash awards have been recently presented to promising West Cumbrian students by IMechE West Cumbria and the REACT Foundation, with further bursary pledges promised for 2020.

Luke Todd of Netherhall School, Maryport was awarded the 2019 REACT Foundation £3,000 bursary award, with Sam Agnew of Keswick School given a bursary for £1,000 for the 2019 IMechE West Cumbria mechanical engineering award. Both were promised the top prizes back in May 2019 after applying for an engineering-related degree at university. REACT also awarded ten cash prizes to local students entering Sixth Form to study Mathematics and Science.

Looking ahead to 2020, REACT & IMechE West Cumbria have pledged bursaries to Cockermouth School Students Nikki Hutchman (REACT Foundation

Award) and Hazel Meier (IMechE Award) when they start university this September.

Families and teaching staff joined the students at the presentation ceremony at The Beacon Whitehaven. The awards have been designed to help local students kick-start their careers by offsetting some of the costs of going to university and sixth form.

Pete Woolaghan (REACT Foundation chairman) handed out the awards and pledges of cash to REACT Foundation winners, while Adrian Norendal (IMechE West Cumbria Committee Member) gave IMechE West Cumbria's award to Sam and pledge to Hazel.

Adrian said: "We are delighted to compliment the Foundation's bursary with our own mechanical engineering bursary each year. We need to encourage the pupils to study engineering subjects as it is essential to retain vital engineering skills in West Cumbria. This is a challenge very close to our hearts at the

IMechE and we will continue to support the REACT Foundation wherever we can.

While Pete said: "Our aim as a local engineering charity is to inspire and encourage young people from the area to follow a career in the industry."

"The whole purpose of the REACT Foundation awards is for us to give them a helping hand to follow their goals and aspirations in STEM subjects".

*Article courtesy of REACT Foundation*



## MEMBERSHIP: BE PART OF A GLOBAL NETWORK

Membership of the Institution of Mechanical Engineers connects you to the world of mechanical engineering. Whether you are working towards professional registration, wish to progress to a different category of membership or simply have an interest in the world of engineering - we can support you.

### Engineering Technician

Engineering Technicians (EngTech) use proven procedures to solve practical engineering problems and can demonstrate learning to NVQ/ SQV level 3 or similar.

A Globally Recognised level and formal recognition of an individual's engineering skills, an important stepping stone towards IEng and CEng certification.

### Incorporated Engineer

Incorporated Engineers (IEng) are often involved in operational roles, maintaining and managing applications of technology to the highest efficiency. Academic knowledge is at bachelor's level or equivalent.

For Professional Engineers who maintain, manage and apply current and developing technology.

### Chartered Engineer

Chartered Engineers (CEng) work independently to solve engineering problems with innovation or creativity. Academic knowledge is at master's level or equivalent.

For Professional Engineers who develop answers to engineering problems using new or existing technologies in creative and innovative way.

### Fellow

Fellow (FIMechE) recognition is for Professional Engineers in a senior role with significant autonomy responsibility. It is the highest level of membership and demonstrates your wealth of experience, commitment and contribution to engineering. You can become a Fellow Engineering Technician, Incorporated Engineer or Chartered Engineer.

Visit [www.imeche.org/membership-registration/become-a-member](http://www.imeche.org/membership-registration/become-a-member) for further information on the benefits of becoming a member, alternatively contact David Williamson on our area committee via email: [djw7@sellafieldsites.com](mailto:djw7@sellafieldsites.com)

Institution of Mechanical Engineers  
West Cumbria Area Branch

## ANNUAL DINNER

*Join us at our 16th IMechE West Cumbria Annual Dinner*

This years theme is Sports Engineering as we look to engage with a leading light from the Sports World that has a personal insight into the Engineering behind success in sport. Our Annual Dinner is the perfect networking event to engage with clients from around our region, from the worlds of engineering and education. We hope to be able to share further details with you very soon, so keep an eye on our website and our social media.

For more information on reserving a table, contact Tom Pritt: [tom.pritt@jacobs.com](mailto:tom.pritt@jacobs.com)

Thursday 18th June 2020 | Lakes College West Cumbria | Drinks Reception from 18:30 | Main Event from 19:30



# WEST CUMBRIA EVENTS CALENDAR

Institution of  
**MECHANICAL  
ENGINEERS**



**TALK & PRESENTATION**

## Reliability across the Life Cycle

**25 February 2020, 19:00 (registration from 18:30)**

A discussion about the importance of asset and equipment reliability and an introduction to how we can impact this both during the Design Build Commission phase and the O & M phases of the Life Cycle. The presentation will cover Early Equipment Management, Reliability Targets & RAMS, Criticality & Maintenance Strategies, Maintenance Planning & Scheduling, and Asset Category Management.

**Location:** Lakes College, Lillyhall, Workington

**Organiser:** Caroline Hamilton (Caroline.Hamilton@holmen.com)



**TALK & PRESENTATION**

## Orthopaedic Engineering: Hip, Knee and Spine Implants

**26 March 2020, 19:00 (registration from 18:30)**

This talk will give a brief survey of the development of artificial skeletal joints over the past hundred years. It will then discuss recent developments in the field, including problems that have occurred as joint replacement surgery has become widespread and the work done to overcome them.

**Location:** Lakes College, Lillyhall, Workington

**Organiser:** Jim Furness (Jim\_Furness@hotmail.com)



**TECHNICAL VISIT**

## Direct Rail Services, Kingmoor Park Rail Yard

**23 April 2020, 18:30 (registration from 18:00)**

DRS is a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA). The company was established in 1995 as a lynch pin supplier of transport and associated services to the nuclear industry. This technical visit will go behind the scenes at the DRS Kingmoor yard to discover how the company's freight operations and passenger services are conducted.

**Location:** Kingmoor Business Park, Kingmoor Park, Carlisle

**Organiser:** Kate Dixon (Kate.Dixon@cumbria.ac.uk)

**PRE-BOOKING ONLY DUE TO LIMITED PLACES!**



**TALK & PRESENTATION**

## Visual Media

**12 May 2020, 19:00 (registration from 18:30)**

Through the latest visual media capabilities and mixed reality technology, we gain a better understanding of the integrated solutions and innovative digital media content available. The talk will take look at the technology behind Virtual Reality and Augmented Reality, while also touching upon Building Information Modelling (BIM).

**Location:** Lakes College, Lillyhall, Workington

**Organiser:** Tom Pritt (Tom.Pritt@jacobs.com)



**TECHNICAL VISIT**

## Pirelli Tyres, Carlisle Factory

**04 June 2020, 18:00 (registration from 17:30)**

Pirelli was founded in Milan in 1872 and today stands as a global brand known for its cutting edge technology, high-end production excellence and passion for innovation that draws heavily on its Italian roots. This technical visit to the Carlisle factory, which focuses on the production of tyres for premium and prestige cars, will take in the sights and history of the plant which opened in 1969.

**Location:** Pirelli Factory, Carlisle, CA2 6AR

**Organiser:** Adrian Norendal (Adrian.Norendal@altrad.com)

**PRE-BOOKING ONLY DUE TO LIMITED PLACES!**

**>> BOOK YOUR PLACE ONLINE NOW <<**

For more details and book visit: [nearyou.imeche.org/near-you/UK/North-Western/West-Cumbria-Area/events](https://nearyou.imeche.org/near-you/UK/North-Western/West-Cumbria-Area/events)

Pre-booking your place on an event is mandatory. Events will become active for bookings nearer its date. To hear first about bookable upcoming events, sign up to our IMechE West Cumbria mailing list; simply forward your email to: [WCumbSec@imechenetwork.org](mailto:WCumbSec@imechenetwork.org). Our events are for all ages with no specific requirements unless specified. You do not need to be a member of the IMechE to attend, all are open to the public and free entry unless stated. For additional event specific enquiries visit the events page of our website or contact the relevant event organiser.



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