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DATA CENTRE WORLD

Tech Show London is one of the largest specialist exhibitions in the UK for electronics professionals. Taking place at the ExCel Exhibition Centre on 6th. and 7th. March the event incorporated five sub-exhibitions, namely Cloud Expo Europe, DevOps Live, Cloud and Cyber Security Expo, Big Data and AI World, and Data Centre World.

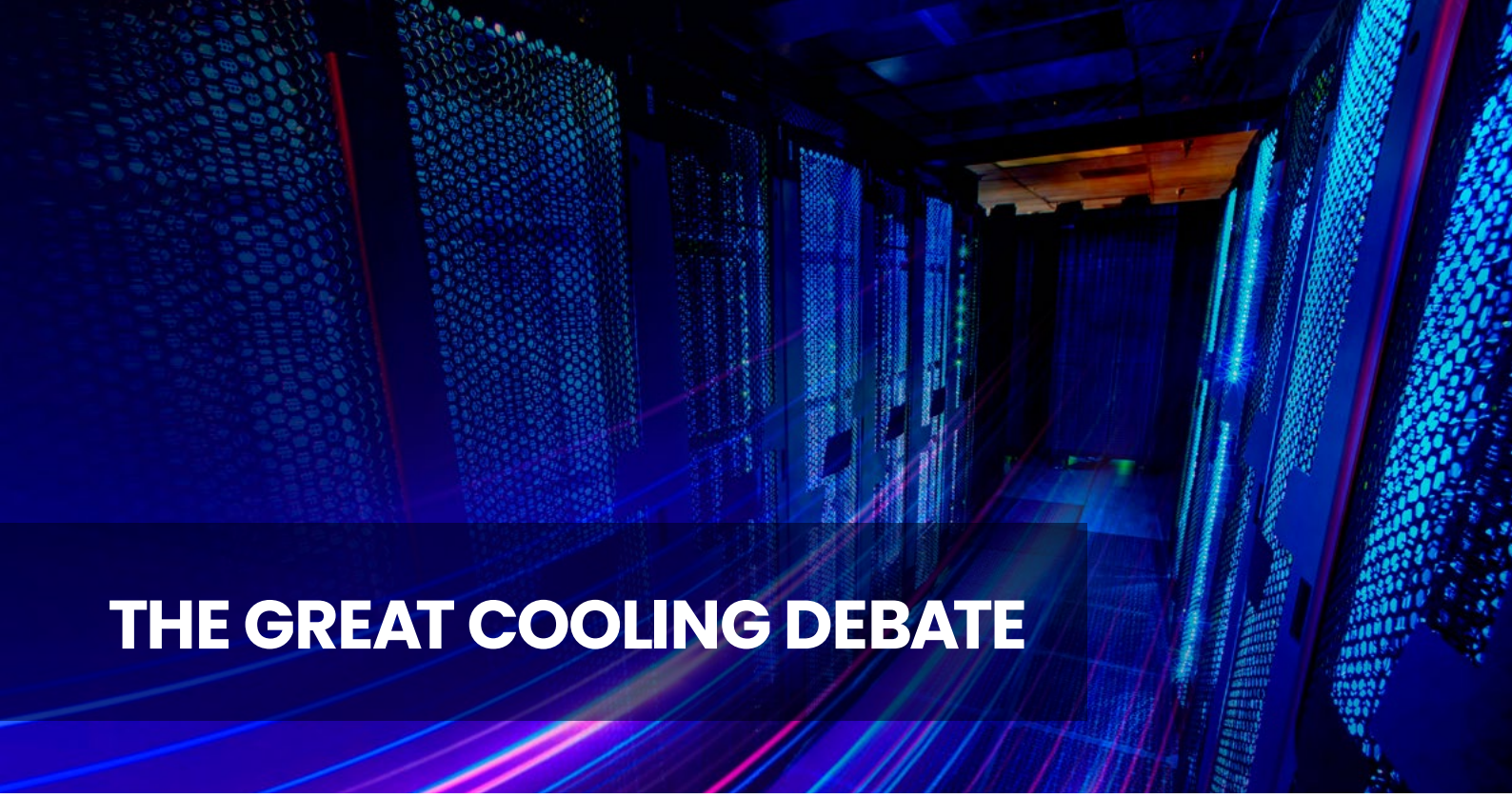
Of these Data Centre World was the largest with around 225 exhibitors. Now in its fifteenth year, its centrepiece was the fourth Data Centre Awards ceremony, which celebrated the industry's achievements with the support of its sponsor Dunwoody and a panel of sixteen independent judges representing a broad spectrum of the industry.

Ten awards were presented as follows on Wednesday March 6th.:

- Best Talent Developer: ALET UTCs and Partners
- Data Centre Security Award: pure DC
- Environmental Product of the Year: Wooden Data Centre
- Special Contribution in improving Resilience through Innovation: Panduit
- Special Contribution to improving Energy Efficiency: Stack Infrastructure
- Innovation Product of the Year: Wooden Data Centre
- Green Data Centre of the Year: CSSi3
- Most successfully delivered Data Centre: Scala Data Centers
- Best Data Centre Operator: pure DC
- Best Re-use or Recycling of Products, Energy or Data Centre Infrastructure: Stack Infrastructure

Key themes at Data Centre World were:

- Refining Data Centres: Sustainability, Resiliency and Tech Innovation
- Navigating the Regulation Landscape
- Efficiency Cost Management and DCIM
- The Pillars of Data Centre Resilience, Security and Continuity
- Designing the Future: Next-gen Strategies for Data Centre Infrastructure
- Cultivating a vibrant Data Centre Workforce



THE GREAT COOLING DEBATE

A particularly topical area of data centre management at present is that of cooling, which was reflected in a number of Data Centre World's 80-plus presentations. Central to the debate is whether data centres should be cooled primarily by air, water or liquid spray.

Exhibitor FlaktGroup (Reference: Data Centre Review, Spring 2024, p.19, 'The Latent Power of Air') clearly advocates air cooling, as evidenced by the following narrative:

"Air, or more accurately, the movement of air, is so versatile that if (a small word that embodies big engineering) managed properly, is more than capable of taking on the evolving cooling needs of modern data centres today and in the future. It is true that these data centres now have, and will continue to have, diverse cooling demands of AI and ML applications. However, these tasks can easily be handled with advanced air cooling systems and methodologies. The notion that superior performance is exclusive to liquid cooling solutions in data centres is incorrect."

The overarching strategy in data centre management has always been to distribute workloads to alleviate hot spots and ensure uniform cooling at the desired set-point. This strategy has always been supported by air-based systems. The distributed workloads have become , and will continue to become, more complex with AI/ML, but by thoughtful design of the data centre halls relative to anticipated workloads, facilities can maintain optimal performance without resorting to specialised liquid cooling systems. '

FlaktGroup argue that the vast majority of racks within data centres are still operating below 30kW and that this ' can be comfortably managed by air movement '. Only over 30kW rack densities would liquid begin to support air-based systems.

In the same journal (Reference: Jackson, L., 'Cooling the Compute-intensive Future', p22) Liam Jackson, Senior Director at Red Helix, argues that liquid cooling solutions can be particularly effective at driving cost and energy efficiencies:

"Typically, data centres have relied on HVAC systems to cool their equipment, using a cycle of refrigerant compression and decompression to create a thermal exchange mechanism. This cooling is a critical process as the immense heat generated by servers and computer systems can quickly lead to hardware malfunctions if not adequately managed - as evidenced by the Google server outages during the 2022 heatwave."

The issue is that these HVAC systems aren't very efficient. They depend on electric pumps to facilitate the compression process, which are constantly running, translating into substantial energy consumption.

Air cooling is also not particularly well

targeted, as it is difficult to evenly distribute cold air across the data centre. While many data centre operators have addressed this through containment strategies, reducing the amount of space that requires cooling by isolating different areas of the room does not totally fix the problem. The energy usage remains high, smaller spaces means less computing capacity, and the system is also highly susceptible to environmental factors.

Owing to these challenges, and the consistent rise in data consumption, industry-wide Power Usage Effectiveness (PUE) improvements have halted.'

By contrast, liquid cooling leverages the higher thermal transfer properties of water to cool equipment. With water having a higher heat capacity than air, it is able to absorb more heat before its own temperature rises, making it ' a more effective medium for the job '.

The author points to the following advantages of liquid cooling:

1. The process is more efficient, which drastically reduces the energy required to cool the equipment.
2. It is more compact than HVAC, which helps to liberate space.
3. By directly targeting specific areas, liquid cooling ensures that each component is operating within its ideal temperature range, which extends the service life of the equipment with performance improvement benefits.
4. There is potential to integrate heat exchange with nearby facilities - for example warm water from the cooling system can be directed to heat adjacent buildings.

This, however, is not the end of the debate as the vendor view from Airsys (Reference: Datacentre Solutions, Issue 0, 2024, p40-41) shows. The limitations of air cooling are acknowledged, but so are the limitations of liquid cooling. The article states:

"Some data centres are already adopting liquid cooling, but the specific technology that has so far been predominantly implemented is immersion cooling. Although it is an efficient method in removing heat from CPUs, the technology still has some reliance on mechanical cooling, which makes it less sustainable and limits the ability of the data centre in moving closer to net zero."

In order to address these challenges, Airsys, a market leading cooling solutions provider and exhibitor at Data Centre World, has pioneered the development of LiquidRack™ , an innovative cooling technology that utilises liquid spray as the cooling agent:

"LiquidRack™ is a liquid spray solution designed for multiple types of digital data infrastructures, such as cloud service, telecommunication facilities and more. Differing from immersion cooling, our pioneering approach keeps the dielectric fluid moving, spraying directly onto the CPU. Adopting a liquid spray cooling approach significantly increases the heat transfer coefficient in comparison to immersion cooling. Increasing the heat transfer coefficient allows the dielectric fluid being sprayed onto the CPU to be elevated up to 65 degrees Centigrade without compromising performance of the CPU."

These elevated fluid temperatures are seen to eliminate the need for chillers, which can be replaced by dry coolers in environments with ambient temperatures up to 50 degrees Centigrade. This means that there are potential free-cooling applications in regions such as the Middle East, where this has previously been difficult to achieve. In addition, elevated water temperatures allow for heat recovery, making the data centre effectively a net energy producer.

A further benefit identified is removal of the uneven fluid flow that can result using other methods of liquid cooling technology, which can cause server reliability issues:

"Uneven flow can occur where there is a mixture of different servers immersed or if one or more servers are removed for maintenance, resulting in the dielectric fluid following through the path of least resistance, thus starving the CPU of the flow needed to remove heat. Therefore, LiquidRack™ offers a more reliable solution to preserve servers and maintain data centre uptime."

The article concludes:

"Liquid cooling is the next step for the data centre industry to achieve its aims of sustainability and net zero, and liquid spray cooling is the pioneering next step in the liquid cooling journey".

OTHER DATA CENTRE NEWS

World-first Quantum Data Centre to be built by Cisco and Nu Quantum

The UK Government has awarded Cisco and start-up Nu Quantum a £2.3 million contract to deliver a 'world-first' quantum data centre prototype.

The new LYRA data centre aims to deliver 19-inch rack-mount modules for control-plane and optical interfacing.

The modular architecture will facilitate in-field upgrades, allowing users to make modifications without requiring extensive reconfiguration or system replacement, and supports various quantum computer modalities and alternative wavelengths, enhancing its adaptability to evolving quantum computing technologies.

The solution incorporates a new high-precision timing architecture and digital control bus, allowing the system to scale to support a large cluster of quantum-compute nodes. This scalability is necessary for handling complex computational tasks and expanding the capabilities of the quantum computing infrastructure.

Co-founder and CEO of Nu Quantum, Carmen Palacios, states:

" LYRA takes the cornerstone quantum networking units from optical-bench to a deployable, prototype product, capable of supporting test-bed integration with trapped-ion qubits and software stacks. "

Reference: Uffinell, R., Tech News, 31st. January

New French Data Centre to support Large Hadron Collider

The European Organisation for Nuclear Research, commonly known as CERN, has unveiled a new data centre at its Prevessin site in France to support the Large Hadron Collider.

The 6,000 square metre site incorporates six IT rooms each with a cooling capacity of 2MW and

equipped with up to 78 racks.

The centre will host CPU servers for physics data processing alongside a small number of CPU servers and storage capacity for business continuity and disaster recovery.

The need for the new Prevessin site has arisen from the increasing rate of data production from experiments conducted at the Large Hadron Collider, and the new data centre will provide much needed additional computing capacity for CERN.

The experiments conducted at the Large Hadron Collider generate a massive amount of data, currently around 45 petabytes per week, which is expected to double with the implementation of the High-Luminosity Large Hadron Collider.

The data generated by the Large Hadron Collider experiments is processed and stored in the Worldwide LHC Computing Grid, a global collaboration involving some 170 data centres spread across 40 countries. The current storage capacity is around 3 exabytes with a million CPU cores distributed across the network.

Reference: Uffindell, R., Tech News, 27th. February

FUTUREBUILD

Taking place alongside Tech Show London was the 18th. Futurebuild exhibition and conference and for those electronics professionals who were prepared to venture across the concourse at ExCel there was some interesting technology on show.

Redefining Appliances

The official guide to Futurebuild was incorporated into the January/February issue of Showhome magazine, where, in addition to an introduction to tech-trench bathrooms by Geberit's Product and Marketing Director for the UK Pete Davis, and the Washbot® Smart Toilet, Showhome Managing Editor Rebecca Spayne explained how smart technology was redefining people's interaction with everyday household appliances:

' AI-powered efficiency stands as a beacon of innovation with embedded artificial intelligence and machine learning algorithms empowering appliances to discern and adapt to user habits, dynamically optimising settings for peak efficiency. We can expect to see a greater number of new build kitchens with refrigerators that discern temperature adjustments based on individual usage patterns or washing machines adeptly selecting optimal cycles for varied fabric types, all autonomously. '

The author then highlights developments by Beko Appliance Partners that introduce AI-Sense technology in washing machines that automatically and intelligently identify the load weight, soil level, fabric type and rinse requirements of each load in order to optimise detergent, energy and water use. Mike Beech, National Contracts Specification Manager for Beko Appliance Partners, is quoted as follows:

" Users are able to control and monitor their washing machine or dishwasher remotely using their smartphone or tablet via Bluetooth and the HomeWhiz app. The programme wizard selects the optimal wash-cycle for each load, with new programmes available to download to match specific needs. "

The Role of Technology in Offsite Construction

The article 'Redefining how we build' by Dr. Ehsan Noroozinejad of the Urban Transformations Research Centre at Western Sydney University, Australia, in Issue 41 (January/February 2024) of the journal Offsite, explains in more depth how specific areas of electronic engineering are now beginning to have an impact on the construction sector, and offsite construction in particular.

First on the author's list is drones and remote monitoring with drones now 'indispensible' for aerial photography, surveying and remote monitoring, enhancing site security, tracking progress, and enabling inspection of hard-to-reach areas:

' As drone technology advances, its integration into offsite construction is expected to deepen, with potential applications in logistics management and real-time adjustment of project plans . '

Next, smart sensors are highlighted, embedded within construction materials or placed around the site so as to provide critical data on environmental conditions, structural integrity and material quality, including the facilitation of predictive maintenance and the potential reduction of errors and rework.

AI and machine vision are viewed as being 'set to transform offsite construction through the automation of design, enhancement of precision in the manufacture of components, and the optimisation of logistics:

' By analysing vast datasets, AI can predict project outcomes, optimise resource allocation,

and even guide robotic systems in assembling complex structures, ensuring adherence to design specifications with minimal waste. '

The author then turns to extended reality (XR), incorporating augmented reality, virtual reality and mixed reality. These collectively provide immersive design and planning tools that bridge the gap between digital models and physical construction with engineers able to visualise and interact with building designs pre-construction.

Digital platforms that integrate project management tools with real-time data from the construction site are 'becoming a cornerstone of efficient offsite construction' whilst wireless technology promises to significantly enhance connectivity between offsite manufacturing facilities and construction sites:

' Enhanced bandwidth and lower latency enable the seamless transfer of large datasets, support remote operations, and facilitate the use of IoT devices, improving coordination and efficiency across projects. '

Meanwhile robotics 'heralds a shift towards more automated and precision-driven processes' and IoT devices can be used to monitor the condition of materials during transport, track inventory and ensure that components are assembled correctly.

Finally, 3D-printing and 4D-printing (where objects can change shape over time) are seen as having the potential to revolutionise how components are produced for offsite construction, opening up new design possibilities that have been hitherto unachievable.

Further information may be obtained from ehsan.noroozinejad@westernsydney.edu.au

Wireless Technology - The Key to Smart Buildings

This article, by Co-founder and Vice President of Business Development at EnOcean GmBH, Ermin Anders, in Electrical Engineering, February 2024, p.32-33, argues the case for wireless solutions to supersede systems that rely on wiring for their operation, and advocates in particular battery free installations:

' With a large number of wireless sensors - in an office building this can quickly amount to several thousand - the process of battery replacement and disposal can easily become a full-time job for a facility manager, from access coordination, device localisation, battery exchange, device testing, documentation, battery storage, and finally to disposal. '

The solution is achieved through the application of the concept known as energy harvesting:

' Products with battery free wireless technology harness the energy available in their immediate surroundings.'

Energy harvesting has three forms - kinetic, solar and thermal. With kinetic energy harvesting a single press generates enough energy for three wireless messages. An electromechanical energy converter inside the switch housing then converts the button press into electrical energy in a similar manner to a bicycle dynamo. A small, powered magnet drives a magnetic flux through two magnetically conductive anchor plates, which then close inside a U-shaped core. An induction coil is wound around the core which can be placed in two positions in which it touches the respective opposing anchor plates. This movement results in a sudden change in the magnetic field, producing a voltage pulse in the induction coil. Application is envisaged in miniaturised switches and sensors in building technology and industrial automation.

Solar energy harvesting is made possible through the use of miniaturised solar modules which can power radio modules with electricity even with low interior light intensity. A temperature reading that is to be transmitted every 15 minutes needs just 3.6 hours of charging per day at a brightness of 200 lux for uninterrupted operation. At this brightness the solar cell can produce 3V whist an additional Poly Acenic Semiconductor charging capacitor allows the module to work in periods with no ambient energy. When the energy storage is fully charged the module can operate in complete darkness for about a week without interruption. Miniaturised solar modules are envisaged to allow for maintenance-free window contacts as well as sensing devices for temperature, gas, humidity, light and human and animal presence.

The third type of energy harvesting, thermal, is achieved using a Peltier element in combination with a DC/DC converter (the EnOcean ECT310 Perpetuum). Even a small input voltage of 20 millivolts, corresponding to a temperature difference of about 2 degrees Centigrade, can be converted into a usable voltage of over 3V. The larger the temperature difference, the greater the amount of energy that can be harvested and used, for example for radio communication and actuation changes in in radiator actuation valves. In combination with a solar-powered room sensor a fully energy-autonomous individual room control can be realised.

CASE STUDY: SELWOOD HOUSING

Selwood Housing is a social housing provider in South West England with over 30 years of experience and a portfolio of some 7,000 properties. A further 1,700 homes are expected to be added by 2034. With the help of Aico's IoT technology a pilot initiative was devised to enhance customer wellbeing by leveraging advanced technology to monitor and manage environmental conditions within the housing stock.

Initially 100 properties were selected for the pilot, representing a diverse range of housing archetypes that had previously been identified as having risks. Aico's Ei1025 Environmental Sensors were strategically installed in key areas such as wet rooms, habitable rooms and kitchens. This installation involved the integration of Aico's HomeLINK Gateway, enabling communication between sensors and the cloud-based HomeLINK portal.

Post installation training was provided to surveyors and members of the management team at Selwood Housing to help them navigate the system. The HomeLINK portal empowered the Selwood team to readily access real-time data and customise notifications, ensuring that the correct department responds to each specific need and that transparency enables efficient resource allocation and timely intervention. The training also covered the system features and how data is calculated in order to produce actionable insights, risk scores and damp and mould risk intelligence.

Aico eagerly absorbed feedback from Selwood Housing's users, subsequently developing a Property Insight Scores Report, which provided a sortable, filterable 0 to 100 score for each room and home.

Robert Mcferran, Planned Improvement Project Surveyor for Selwood Housing, commented:

" The equipment and devices are first class. They provide real-time data that is crucial for damp and mould surveyors as we look to eradicate damp and mould from within our housing stock.

The equipment allows us to be proactive in our approach with regular updates provided by Aico's HomeLINK technology, flagging up any of our stock that is of high risk of damp and mould.

From a damp and mould perspective the development of the system has been helpful as the alerts for damp and mould have been adjusted so only the very high risk properties are flagged. Going forward, I believe the approach to historic damp and mould will be very much data driven, so further development may be required which we are happy to be part of. "

With damp and mould having featured in a number of news reports, this case study is seen as offering crucial insights for organisations seeking to proactively address the quality of housing through advanced environmental monitoring solutions.

Reference: Electrical Review, Volume 258, No.1, Spring 2004, p.26-27

SUSSEX SCIENTISTS DEVELOP POTENTIAL ALTERNATIVE TO BLUETOOTH

Researchers at the University of Sussex have developed a potential alternative to Bluetooth that could have wide reaching implications for electronic devices such as mobile phones.

The underlying technical theory involves the use of electric waves for data transmission, a method which contrasts markedly with the traditional approach of utilising electromagnetic modulation, which is used for Bluetooth, WiFi and 5G.

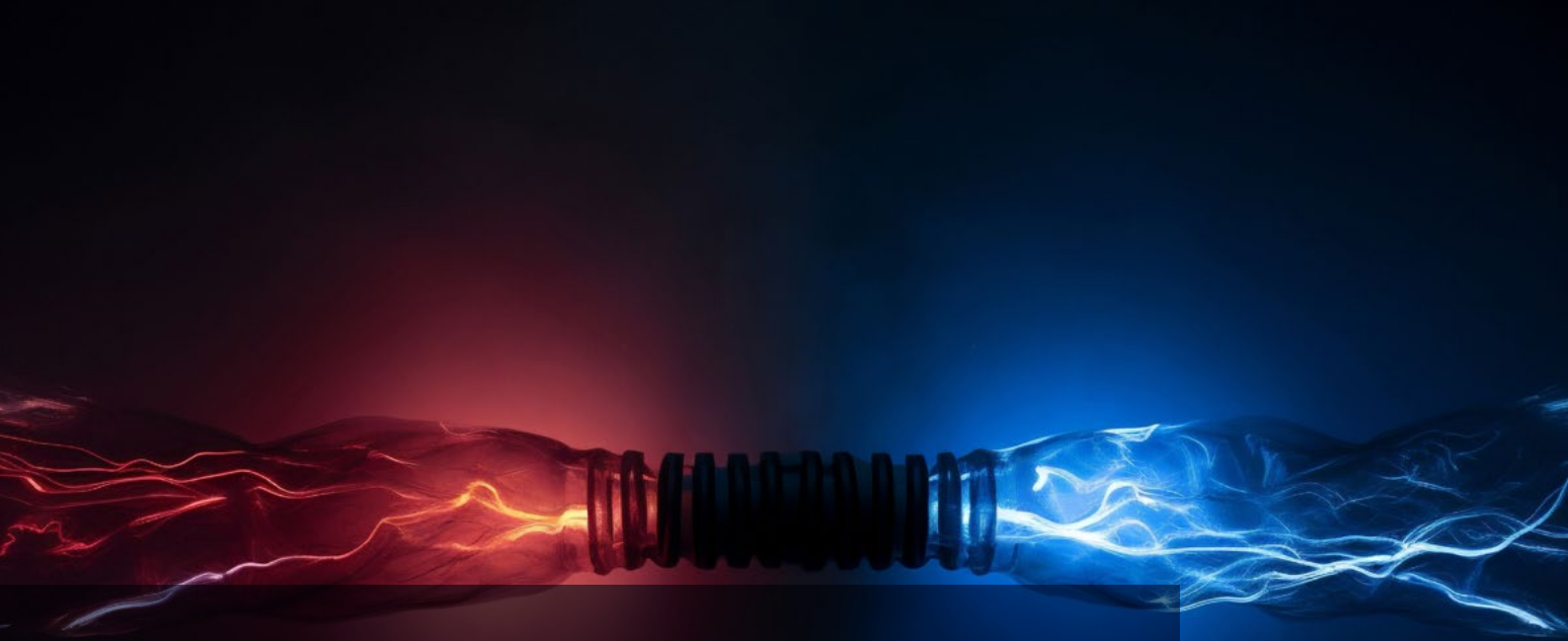
The main advantages of this pioneering approach lie principally in its low power consumption, which is especially useful for the short-range communication that is common in personal and smart home devices. It is expected to extend battery life during everyday tasks such as streaming music or using fitness trackers, as well as paving the way for innovative interactions with technology. Wearables equipped with this technology could, for example, allow phone numbers to be exchanged with a handshake or doors to be unlocked with a simple touch.

Professor Daniel Roggen of the Engineering and Design Department at the University of Sussex, states:

" We no longer need to rely on electromagnetic modulation, which is inherently battery hungry.

We can improve the battery life of wearable technology and home assistants, for example, by using electric field modulation instead of Bluetooth. This solution will not only make our lives much more efficient, but it also opens novel opportunities to interact with devices in smart homes. The technology is also low cost, meaning it could be rolled out to society quickly and easily. If this were mass produced, the solution can be miniaturised to a single chip and cost just a few pence per device, meaning that it could be used in all devices in the not-too-distant future. "

Reference: West, P., Electronic Specifier, 2nd. January



NEW SOFTWARE STREAMLINES THE PROCESS FOR PLANNING SMALL POWER CONNECTIONS

A trial led by UK Power Networks has tested an automated planning tool known as 1Streetworks Software, designed to streamline the process for planning small power connections.

The software, developed by Cambridge-based 1Spacial plc., simplifies the traditionally labour-intensive process of streetworks planning and by allowing surveyors to quickly assess sites and generate traffic management plans it has been found to reduce planning times from hours to minutes.

The software works by allowing users to map out work locations, after which it automatically generates site-specific traffic management plans. This integration of mapping layers allows for rapid approval of traffic management permits by local highway authorities, potentially leading to fewer required modifications.

The initial phase of the trial demonstrated a significant reduction in the time required for surveyors to create streetworks design plans, cutting the average connection time for new or altered power connections by a quarter at approximately 300 roadworks sites in Surrey.

There is now a plan to undertake a broader test in Kent with the aim of assessing the tool's applicability across different work streams within UK Power Networks service areas.

Reference: 'Could this automated Planning Tool speed up Electrical Connections', Electrical Review, February 22nd.

RAIL UPDATE

McLaren helps maintain Railway with 5G Connectivity

McLaren Applied is helping Network Rail to maintain the railway with the installation of its F1-derived Fleet Connect software and 5G Edge Active Antenna hardware on 14 of its infrastructure monitoring trains.

This first implementation of Active Antenna technology in the UK brings a new, simplified approach to on-train connectivity infrastructure and an advanced capability for data offloading in the move.

The UK's infrastructure monitoring trains travel across the country checking the condition of bridges, tunnels, viaducts, signals, level crossings and around 20,000 miles of track. These trains report back using live data streams including sensor readings on the track, foliage and network monitoring, and the remote and automated monitoring helps to target maintenance work and maintain safety and reliability for rail services.

The patented Fleet Connect software splits data across networks in real-time and then reassembles it in the cloud, reducing blackspots and providing a consistent connectivity stream for any moving vehicle in any environment.

Since the introduction of this new technology Network Rail has registered upload data improvements of up to a thousand times faster than previous systems with speeds of up to 70 MB/s per train.

Reference: Fowle, H., Electronic Specifier, 16th. January

AI revolutionises Track Inspection for Bullet Train

AMD has joined with the JR Kyushu Railway Company (JR Kyushu), a prominent operator of the Japanese Bullet Train to bring AI to its track inspection.

The solution, engineered by Tokyo Artisan Intelligence and powered by AMD, uses rapid image processing coupled with AI to identify and examine issues such as loose bolts and other track anomalies. Central to this is a vision computing box mounted on a cart which conducts track inspections at 12 mph. A high-speed camera is incorporated into the unit along with an AMD Kria K26 System-on-Module that provides the AI-powered data and image analysis both before and after capture. The Kria K26 is a compact, integrated platform that incorporates a custom AMD Zynq UltraScale+ MPSoC, DDR memory, non-volatile storage, a security module and an aluminium thermal heat spreader.

The AMD Kria SoM's programmability, durability and embedded intelligence has allowed it to adapt to the diverse and evolving landscapes, conditions and demands of JR Kyushu's extensive territory and passenger base with over 1,455 km of track. The dynamic natural environment of railway tracks necessitates the capacity for ongoing updates to the Kria SoM in order to ensure the longevity and relevance of the technological investment.

Chetan Khona, Senior Director of Industrial, Vision, Healthcare and Sciences Markets at AMD, states:

" AMD Kria SoMs are accelerating innovation at the Edge and simplifying solution development through deployment. JR Kyushu is a perfect example of how the endless programmability of Kria SoMs, combined with Edge AI computing, can automate processes and dramatically enhance operational efficiency across a variety of applications, from machine vision to industrial robotics and AI/ML computing. "

Reference: West, P., 'AMD powers AI Track Inspection Solution for Japanese Bullet Train', Electronic Specifier, 14th. February

FURTHER ADVANCES IN AI

New Chip to provide AI Computing at Light Speed

Engineers at the University of Pennsylvania have developed a chip for AI computing that uses light waves rather than electricity for computation, marking a 'monumental step forward' in computing technology.

The chip uses silicon-photonic (SiPh) technology to merge the pioneering work of Benjamin Franklyn Medal Laureate and H. Nedwill Ramsey Professor Nader Engheta in nanoscale material manipulation for mathematical computations using light, with the cost-effective and widely available silicon used in mass computer chip production.

Light's interaction with matter is identified as a key pathway to transcending the limitations of chips, the operational principles of which date back to the 1960s despite periodic refinements.

Instead of using a silicon wafer of uniform height the silicon is made thinner, around 150 nanometres, in selected places. The resulting height variations, which are achieved without incorporating additional materials, manipulate the propagation of light through the chip, allowing the chip to scatter light in precise patterns, so making for the performance of calculations at the speed of light.

The aim is to create a platform that can execute vector matrix multiplication, which is an essential mathematical operation in neural networks and hence the AI tools that are powered by such networks. This operation is therefore crucial for both the development and functionality of AI applications.

Potential application of the technology is envisaged most notably in graphics processing units, for which there has been a surge in demand following the growth in AI development.

With the capability for numerous computations to occur simultaneously there is also no necessity to store sensitive data in a computer's working memory, such that computers that are powered by this technology can become 'virtually impervious' to hacking.

Reference: West, P., 'New Chip opens Door to AI Computing at Light Speed', Electronic Specifier, 23rd. February

AI applied to create new rugged Microstructures

Researchers at the Massachusetts Institute of Technology Computer Science and Artificial Intelligence Laboratory have developed an innovative AI system which utilises simulations alongside testing to forge new microstructures. By combining computational design with physical experiments and advanced neural networks a new approach to material creation has been devised that has led to the creation of microstructured composites that redefine the benchmarks for toughness and durability in engineering materials.

Neural networks are deployed as 'surrogates' for simulations, streamlining the material design process. An evolutionary algorithm enhanced by neural networks efficiently pinpoints the highest performing samples combining stiffness with toughness.

The methodology commenced with the fabrication of 3D-printed photopolymers, each no larger than a smartphone, but considerably thinner. These were then subjected to a unique ultraviolet light treatment followed by tensile testing using an Instron 5984 machine. This physical testing, combined with advanced simulations within a high-performance computing framework, enabled the prediction and refinement of material characteristics with unprecedented accuracy.

A key aspect of the research was the development of a method to coalesce different materials at a microscopic scale. This process, characterised by a complex pattern of miniscule droplets that amalgamated rigid and subtle substances, achieved a harmonious balance between strength and flexibility. The close correlation between simulation outcomes and physical testing results underscored the methodology's validity.

A 'Neural-Network Accelerated Multi-Objective Optimisation algorithm' resulted, which navigates the intricate landscape of microstructure design, uncovering configurations that exhibit near-optimal mechanical properties. The algorithm thus serves as a self-optimising mechanism that constantly refines its predictions so as to more closely reflect actual results.

Ultimately it is aimed to design fully automated laboratories that minimise the need for human intervention and maximise efficiency.

Reference: Fowle, H., Electronic Specifier, 19th. February

AI challenges uniqueness of Fingerprints

Engineers at the University of Columbia have used AI to demonstrate that fingerprints from different fingers of the same person are not as unique as previously thought.

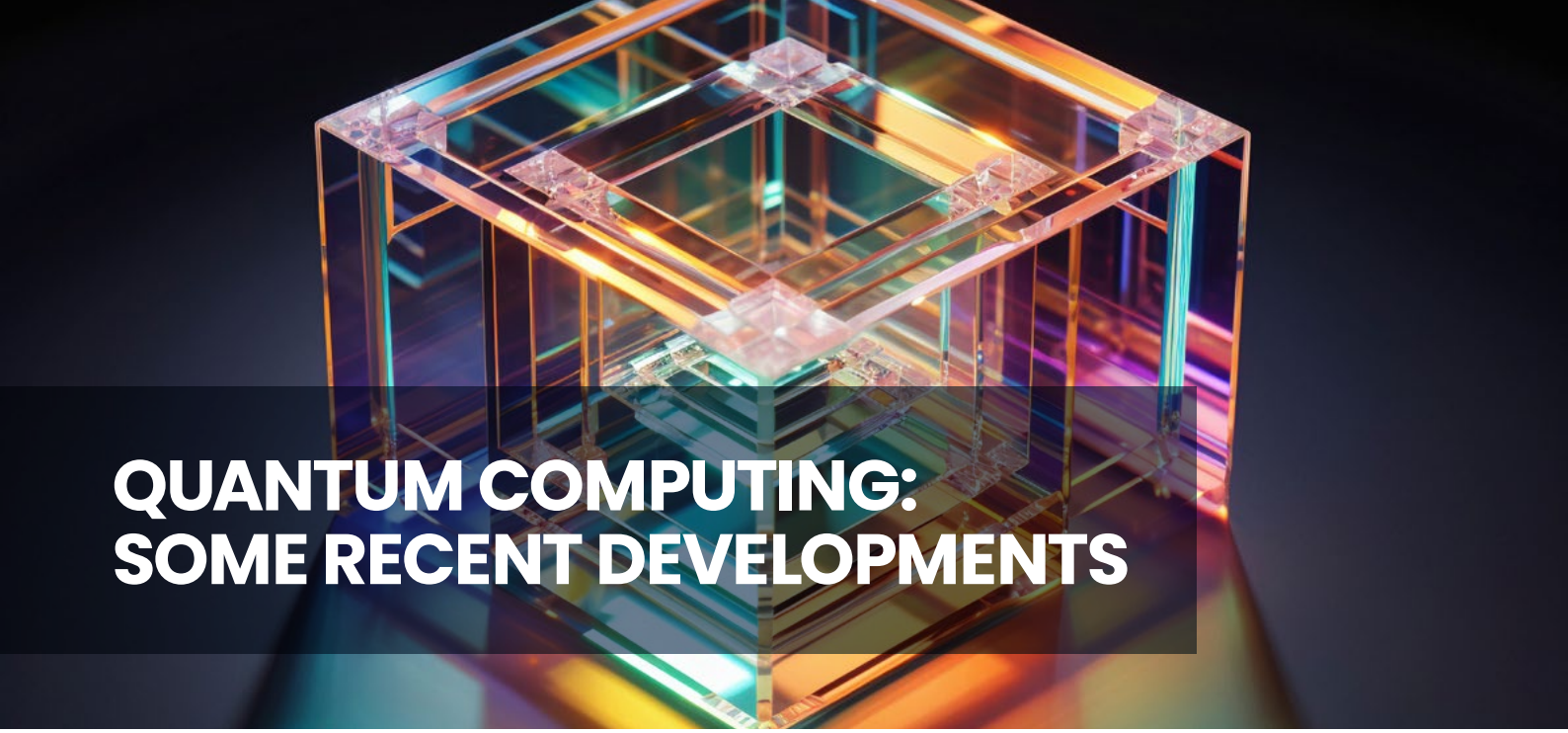
The team used a public US Government database of around 60,000 fingerprints to feed pairs into a deep contrastive network AI system. Sometimes the pairs belonged to the same person (but different fingers) whilst in other cases they belonged to completely different people.

The AI system, adapted from an advanced framework, improved its ability to discern when seemingly unique fingerprints were from the same person with the accuracy for a single pair reaching 77 per cent, whilst with multiple pairs it significantly increased to the point where forensic efficiency was potentially enhanced more than ten fold.

A notable achievement was the identification of a new type of forensic marker used by the AI, which was quite different from the standard 'minutiae', that is branchings and endings in fingerprint ridges. Instead, the AI focused on angles and curvatures in the centre of fingerprints.

The findings suggest that AI may have 'transformative potential' in some otherwise established fields. In particular, AI can provide new insights from existing data and it would appear that new AI-led discoveries are waiting to be made.

Reference: West, P., 'Not every Fingerprint is unique, AI discovers', Electronic Specifier, 11th. January



QUANTUM COMPUTING: SOME RECENT DEVELOPMENTS

Fujitsu speeds up Quantum Circuit Computation

Fujitsu has devised a technique on a large-scale quantum simulator that it has developed that speeds up quantum classical algorithms so as to increase computational speed by 200 times that achieved by previous simulations.

With the new technology simultaneous processing of large numbers of repetitively executed quantum circuit computations are distributed among multiple groups. This has made it possible to perform computations on a quantum simulator in just one day, where it would have taken 200 days to complete them using conventional methods. As a result it is now possible to complete simulations of large-scale quantum computation within a realistic timeframe and to simulate the behaviour of larger molecules computed by a hybrid quantum-classical algorithm, leading to algorithm development.

Quantum-classical hybrid algorithms seek a quantum circuit that provides the lowest energy state, for example the ground state of a molecule, by alternating between the process of performing quantum circuit computation and the process of optimisation of quantum circuit parameters using a classical computer. Parameter optimisation by classical computers, however, requires preparation of a large number of quantum circuits with small changes in parameters, performance of quantum circuit computation for all of them sequentially, and then derivation of the optimal parameters from the results. This requires considerable time for computation, especially for large-scale problems. Increasing the number of nodes simply to speed up circuit computation has been limited due to communication overhead, leading to a requirement for new technology.

Fujitsu has focused on the fact that quantum circuits with small parameter changes can be executed without affecting each other, allowing for the development of a distributed processing technology that enables each group to execute different quantum circuits by dividing the computation nodes of the quantum simulator into multiple groups and using so-called RPC technology to submit quantum circuit computation jobs through the network. Multiple quantum circuits with different parameters can thus be simultaneously distributed and calculated and the computation time can be reduced to one seventieth of its previous value.

Fujitsu has subsequently demonstrated for the first time that when distributed processing of 1024 compute nodes into eight groups for a 32 qubit problem, it was possible to achieve a quantum simulation run time of 32 qubits in one day where previously it would have taken around 200 days.

Reference: Fowle, H., 'Fujitsu speeds up Quantum Circuit Computation by 200x', Electronic Specifier, 19th. February

Using Coherent Spin Shuttling to scale up Quantum Computing

Researchers at RIKEN have succeeded in successfully connecting two silicon spin qubits that are physically distant using coherent spin shuttling.

This pioneering method addresses the long-standing challenge of linking quantum dots that are far apart, which is crucial for scaling quantum computers from hundreds to millions

of qubits, and much needed for the successful commercialisation of quantum computers.

Silicon quantum dots, with diameters in the tens of nanometres, have the advantage of being compatible with existing silicon fabrication technologies, but it has hitherto been difficult to connect quantum dots that are not in close proximity. In order to connect many qubits they have to be densely crammed into a very small area, and using wires to connect such densely packed qubits is not practical.

The RIKEN team has therefore devised a two-qubit logic gate between silicon spin qubits that are physically apart, a development that opens the door to scaling up quantum computing based on silicon quantum dots.

The technique, known as spin shuttling, enables the movement of single spin qubits across a quantum dot array without disrupting their phase coherence (vital for quantum computers as it transports information). It involves propelling electrons through an array of qubits by applying a voltage.

With coherent spin shuttling quantum information, specifically the spin state of a particle, is transferred between different locations without losing its quantum coherence (the property that allows particles to be in a combination of states at the same time).

Reference: Fowle, H., Electronic Specifier, 15th. January

Reaching the Ground State of Quantum Sound

Scientists at the Max Planck Institute for the Science of Light have successfully cooled sound waves in optical fibres using laser light, bringing the achievement of the highly desired quantum ground state of sound in waveguides ever closer.

Quantum ground state is a state with minimal energy and disturbance, and by cooling the system scientists aim to reduce acoustic phonons (particles of sound that can disrupt quantum measurements) to virtually zero, so bridging the gap between classical and quantum mechanics and enhancing the precision of quantum observations.

The study, led by Dr. Birgit Stiller, reports a significant reduction in temperature of a sound wave, initially at room temperature, by 219 Kelvin using laser cooling. This method, ten times more effective that previous methods, reduced the initial phonon number by 75 per cent, achieving a low temperature of 74 Kelvin (minus 194 Celsius).

Reference: Fowle, H., Electronic Specifier, 24th. January

World's first Fault-Tolerant Quantum Computer

The world's first commercial fault-tolerant computer equipped with so-called 'logical qubits' is expected to be operational later this year.

Logical qubits, that is physical quantum bits interconnected through quantum entanglement, enhance the accuracy of quantum computing by duplicating data storage across several locations, which diversifies the points of failure during computations, mitigating error risks.

The quantum computer that has been created, by QuEra in collaboration with Harvard University, has 256 physical qubits and ten logical qubits, and is said to lay the groundwork for software developers to commence experimentation with code for future quantum computing iterations.

The need for error correction in quantum computing stems from its use of qubits, which, unlike conventional computers that use bits that are either 0 or 1, can exist in a superposition of states between 0 and 1. Quantum entanglement enables qubits to be interconnected, facilitating simultaneous existence in multiple states so calculations can be achieved at much higher speeds than with conventional computers. Unfortunately, however, qubits are prone to disturbances, which cause a high error rate. Around one in a thousand qubits have a tendency to fail, as against one in a billion billion bits in traditional computers.

By utilising data redundancy, where identical information is stored in multiple locations, logical qubits serve to reduce error rates should physical qubits fail, so ensuring that calculations can continue without disruption.

In order to create the logical qubits, error-correcting computer code is applied to regular qubits, and logical gates or circuits introduced to create the entanglement. The quantum computer then calculates the 'syndrome' (an indicator of potential errors) and corrects any detected errors before moving on to the next operational phase.

[Reference: Fowle, H., Electronic Specifier, 20th. February]

ROBOTICS NEWS

Five-axis Robots solve Domestic Appliance Wiring Challenges

In the modern world robots are able to assemble mechanical parts and automatically place surface mount components to populate printed circuit boards, but so far wiring harnesses have been unable to be incorporated into the full automated process. Wiring harnesses in domestic appliances remain a complex tangle of wires and connectors and have been recognised as the last major barrier to manufacturing automation for domestic appliances.

Currently 90 per cent of wiring harnesses are still assembled by hand and have connectors added. These harnesses require 100 per cent testing and typically operating equipment manufacturers (OEMs) will over-order harnesses in order to guarantee that they will have sufficient stock to manage quality control, for example if harnesses become damaged as a result of wires being bent, twisted or pushed during final assembly of the appliance. In addition, such harnesses are commonly over-specified in terms of conductor size to achieve the required ruggedness and insulation added to prevent short-circuiting. All of this adds cost to the end product.

Now, a robot cell designed for 'electrical function integration' (total or partial replacement of traditional wire harnesses) has been developed in an attempt to counter these issues. This five-axis robot with interchangeable tool heads, known as end effectors, is able to add well-secured bare

or insulated wires to system components and sub-assemblies even where these have complex three-dimensional shapes. The machine can also automatically attach electrical connectors to the wiring.

The robot routes wires with conductors up to 3mm in diameter, which is approximately 13 AWG. This means that each conductor can carry over 20 Amps, sufficient for powering motors, relays or fans, in addition to low-level monitoring and control signals.

The robot used as a stand-alone machine or integrated within a production line is noted to significantly cut the tact time for assembling an appliance control panel, which can be flat or curved, rigid or flexible. With each wire individually secured the panel may not require insulation, whilst the wires will be less prone to environmental damage as they are securely positioned.

Reference: Miles, S., Electronic Specifier, 1st. March

Introducing the Robotic Guide Dog

The University of Glasgow, in collaboration with industry partners and two prominent charities, is pioneering the development of an AI-powered four-legged robot designed to enhance the mobility of visually impaired people.

Known as the RoboGuide project, it uses a sophisticated amalgamation of AI, robotics and sensors in combination with advanced navigation and mapping technologies, surpassing the capabilities of traditional GPS and camera-based systems, which are noted for their limitations in indoor environments and in navigating around obstacles.

An array of advanced sensors, including LiDAR sensors and infrared, provide the robot with a 360-degree view if its surroundings, whilst sophisticated software interprets the sensor data in real-time, learning optimal routes and making split-second decisions to guide the user safely through their environment.

The RoboGuide also incorporates large language model technology, allowing it to understand and respond to voice commands, aiding navigation and facilitating interactive engagement.

Reference: Miles, S., 'Robotic Guide Dogs: Pioneering Assistive Technology', Electronic Specifier, 21st. February

Treating Liver Cancer with Microrobots

Researchers at the Polytechnique Montreal and the University of British Columbia, have pioneered a technique for treating liver tumours using magnet-guided microrobots embedded within an MRI device.

The biocompatible microrobots are crafted from magnetisable iron oxide nanoparticles and designed to deliver treatment to specific targeted areas so as to minimise harm to surrounding healthy cells.

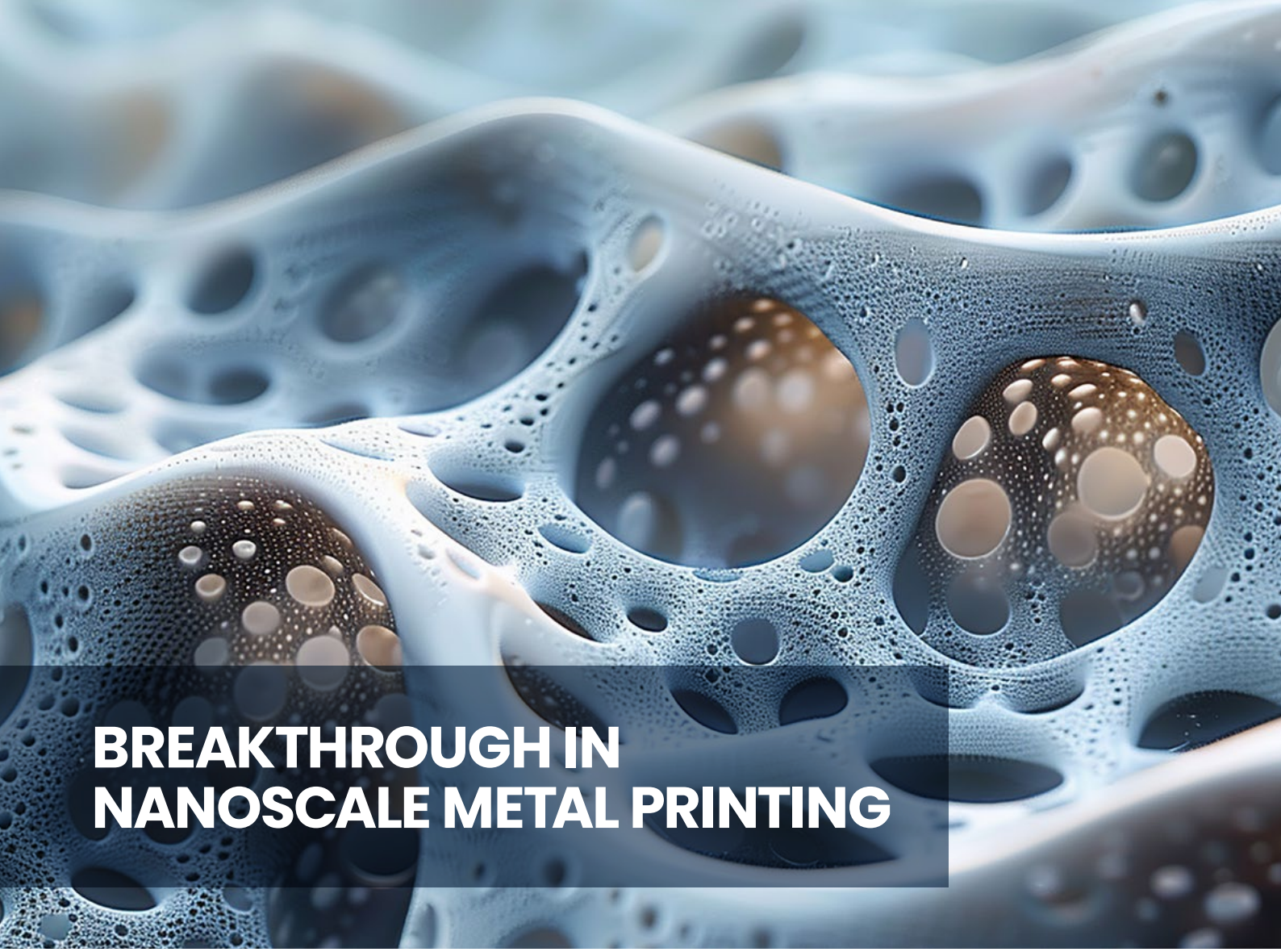
Currently liver cancers, especially hepatocellular carcinoma - a leading cause of cancer deaths worldwide - are treated by transarterial chemoembolisation , which requires specialised personnel and invasive procedures.

With the new method an MRI-compatible microrobot injector is used, capable of assembling 'particle trains' of the microrobots, which are easier to control and detect within the MRI. This precision ensures both the correct direction of treatment as well as the appropriate dosage, as each microrobot carries a portion of the therapeutic agent.

Testing using an anatomical atlas of human livers on patients previously treated with chemoembolisation revealed that in over 95 per cent of cases the tumour locations were compatible with the navigation algorithm.

Next steps involve leveraging AI to optimise real-time navigation and address challenges such as blood flow modelling and the impact of patient positioning on the journey of the microrobots towards the tumour.

Reference: West,P., Electronic Specifier, 25th. February



BREAKTHROUGH IN NANOSCALE METAL PRINTING

Researchers at the Georgia Institute of Technology have developed a light-based approach for printing metal at the nanoscale, a domain that is considered crucial for advancements, notably in electronics and sensor technology.

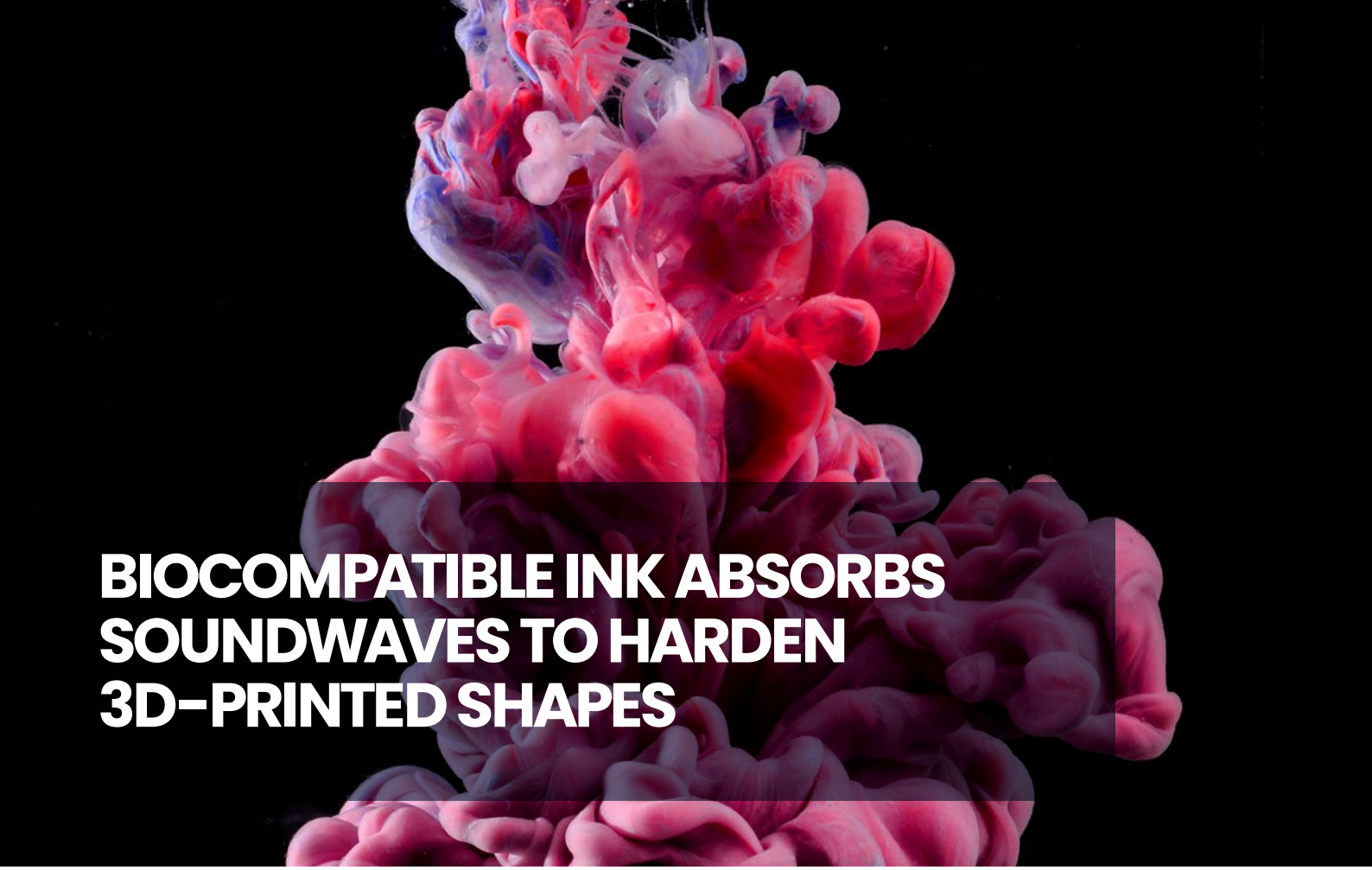
The method uses nanopatterning, which allows for the creation of unique structures with exceptional functions. In the past nanopatterning has necessitated the use of high-intensity light sources in the form of femtosecond lasers, but at a cost of around $500,000 these have been too expensive for many research laboratories and small-scale enterprises, making it difficult to transition nanotechnology from academic settings to practical real-world applications.

Now, pioneering application of superluminescent light-emitting diodes, or SLEDs, has enabled the development of an original projection-style printing technology which converts digital images to optical images that can then be displayed on a glass surface. The key innovation lies in the ability of the system to produce images that are sharply focused, which is a critical factor when it comes to ensuring that there are minimal defects in final nanostructures.

A specially formulated clear ink solution composed of metal salt and specific chemicals is used to absorb light, and when exposed to light from the projection system it produces a chemical reaction that transforms the salt solution into metal. The metal then adheres to the glass surface aggregating to form the desired nanostructures.

This method allows for the printing of whole structures in a single step, unlike the point-by-point method used in conventional systems, and has been shown to be 480 times faster and 35 times more cost effective.

Reference: McCann, K., 'Georgia Tech create 480 times faster Nanoscale Metal Printing Method', Electronic Specifier, 22nd. January



BIOCOMPATIBLE INK ABSORBS SOUNDWAVES TO HARDEN 3D-PRINTED SHAPES

Engineers at Duke University and Harvard Medical School have developed a new biocompatible ink that has the ability to solidify into various 3D shapes and structures by absorbing ultrasound waves rather than light.

The ink is what is known as a sonicated ink, or sono-ink, which as a blend of hydrogels, microparticles and molecules that are designed to react specifically to ultrasound waves. Once injected into a target area a specialised ultrasound printing probe transmits focused ultrasound waves into the ink transforming it into complex structures, such as bone-like scaffolds and hydrogel bubbles that can be placed on body organs.

As ultrasound waves can penetrate over 100 times deeper than light while spacially confined, tissues, bones and organs can be reached with a high spacial precision that has not been possible light-based printing methods. This makes it particularly suitable for biomedical fields such as bone healing and heart valve repair.

A recent application has been in chemotherapy where a chemotherapy drug was introduced into the ink, which was then delivered to a sample of liver tissue. The resultant hydrogels successfully released the chemotherapy into the liver tissue.

The ability to print through tissue is thought to allow for many new applications in surgery and therapy that currently involve invasive and disruptive methods.

Reference: West, P., Electronic Specifier, 1st. January

BREAKTHROUGH IN 2D MATERIAL TECHNOLOGY

Researchers at the University of Manchester have achieved a breakthrough in 2D material science that is believed to have major implications for the future of electronics.

The technology involves the use of a fully inorganic stamp in an ultra-high vacuum that has enabled the precise assembly of van der Waals heterostructures with up to eight individual layers. This has resulted in atomically clean interfaces over large areas, significantly outperforming existing methods bringing the commercialisation of 2D material-based electronic devices closer to reality.

The rigidity of the new stamp design dramatically reduced strain inhomogeneity in assembled stacks and a tenfold decrease in local observation was observed at 'twisted' interfaces relative to current assemblies.

The new method provides a means of stacking individual 2D materials in specific sequences, potentially creating designer crystals with unique hybrid properties. Previous techniques for transferring these layers relied on organic polymer membranes which tended to create surface contamination of the 2D materials.

Dr. Nick Clark is quoted as follows:

" To overcome these limitations we devised a hybrid stamp, comprising a flexible silicon nitride membrane for mechanical support and an ultrathin metal layer as a sticky 'glue' for picking up the 2D crystals. Using the metal layer we can carefully pick up a single 2D material and the sequentially 'stamp' its atomically flat lower surface onto additional crystals. The van der Waals forces at this perfect interface cause adherence of these crystals, enabling us to construct flawless stacks of up to eight layers. "

The team has since scaled up this ultraclean transfer process so as to be able to handle larger, gas-phase-grown materials, achieving millimetre-scale areas, a crucial capability for the scalability and potential application of such materials in next-generation electronics.

The next stage is to evaluate the effectiveness of the method for wafer-scale transfer of 2D films.

The University of Manchester has applied for a patent for this method and its associated apparatus, and is looking for collaboration with equipment manufacturers, semiconductor foundries and electronic device manufacturers focusing on 2D materials.

Reference: West, P., Electronic Specifier, 1st. January

ADDRESSING HEAT MANAGEMENT CHALLENGES IN MINIATURE SEMICONDUCTOR DEVICES

A team of researchers at Osaka Metropolitan University has tackled the increasing problem of heat management in miniaturised semiconductor devices by integrating gallium nitride (GaN) transistors with diamond substrates.

Diamond has a very high thermal conductivity and by using it as a substrate for GaN transistors it has become possible to more than double heat dissipation efficiency, potentially enhancing both the performance and the reliability of high-power, high-frequency electronic devices.

The increasing level of miniaturisation of semiconductor devices has resulted in a rising power density, and with it greater heat generation. The improvement to thermal management efficiency has therefore risen in prominence as a key requirement for the semiconductor industry. With diamond having the highest level of thermal conductivity owing to its tightly packed crystal structure, it is clearly the ideal substrate material, but until now its practical application has been limited due to the challenge of bonding it with GaN elements.

In order to harness the high thermal conductivity of diamond, the research team introduced a 3C-SiC layer 9 a cubic polytype of silicon carbide) between the GaN and diamond, significantly reducing thermal resistance at the interface. This led to the successful fabrication of GaN High Electron Mobility Transistors, or HEMTs, with diamond as a substrate as opposed to silicon carbide (SiC).

This innovation is anticipated to have potentially very significant implications in fields that require high-power, high-frequency operations such as 5G communication base stations, weather and radar, and satellite communications.

Reference: Miles, S., 'Diamond-enhanced GaN Transistors in Heat Management', Electronic Specifier, 2nd. January

TRANSFORMING FOOTBALL ADVERTISING WITH AUGMENTED REALITY

Historically, advertising in football has been largely static, with pitch-side billboards and logos on kits, but modern digital technology has changed all this with virtual advertisements and LED boards now offering brands more visibility. Now, digital marketing specialist Supponor is taking this a stage further with the introduction of augmented reality, potentially revolutionising the way brands engage with audiences particularly in areas such as football, where digital images can be overlaid seamlessly onto live broadcasts.

Augmented reality in sports advertising integrates digital information with the live broadcasting environment, allowing for a more immersive viewing experience. Broadcasters can replace physical advertisements in the stadium with virtual ones that can be tailored to different audiences watching the same match. This provides the ability to segment and target advertisements based on factors such as geographical location, language, and even individual preferences.

Supponor, with its proprietary AR technology, has enabled real-time digital replacement of existing advertising boards in sports broadcasts.

By utilising advanced algorithms to recognise specific areas within the live broadcast feed where advertisements can be inserted or replaced, the system overlays digital images or videos onto these predetermined spaces such that they appear as natural parts of the playing field or stadium.

The technology notably incorporates advanced analytics that allow brands to accurately measure the impact of their advertisements.

Reference: Fowle, H., 'The Augmented Reality of Advertising in Football', Electronic Specifier, 22nd. February

Some Applications of Electronics to Railway Engineering

by J. H. LITTLEWOOD*, M.Sc., and P. H. MANSFIELD*, B.Sc.(Eng.), A.M.I.E.E.

(A lecture delivered at the Twelfth Annual Electronics Exhibition and Convention of the Northern Division of the Institution of Electronics, of July, 1957, at the Manchester College of Science and Technology).

Railway Engineering Problems offer a wide field for the application of electronics to measuring physical quantities. Recent work done by the British Railways Research Department is discussed including: strains in various railway structures varying from bridges to rails, earth pressures, loads on buffers, vertical and lateral forces on locomotives, and Automatic Train Control.

As some people may be unaware of the existence of a a British Railways Research Department, a brief word about its origin may not be out of place. Sir Harold Hartley, when a Vice-President of the L.M.S. Railway, inaugurated a research department which forms the nucleus of the present British Railways Research Department, although all Regions of the railway have contributed sections to it. Divided broadly into two main groups of Chemical Services on the one hand and Technical Research on the other, the Department is supplied with problems from other railway departments.

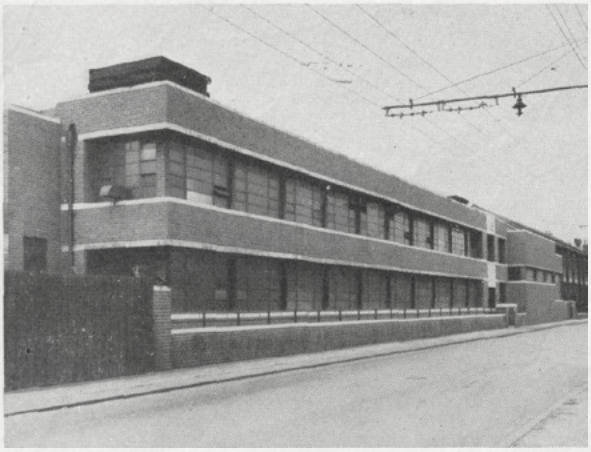


Figure 1.

Originally opened in 1935 by the L.M.S. Railway as laboratories for its Scientific Research Department, this building now houses the Engineering, Metallurgy and Physics Divisions of British Railways Research Department.

The building shown in Figure 1 houses the Engineering, Metallurgy and Physics Divisions and was opened in 1935 as the laboratories of the L.M.S.R. Scientific Research Department.

The widespread nature of the railways calls for field tests as well as laboratory work, and although portable equipment can be very useful, the advantages of a Mobile Laboratory are not to be denied in applying electronics to railway problems.

Built at Horwich by the Lancashire and Yorkshire Railway as a family saloon, and converted to a Laboratory in 1952, this vehicle (Figure 2) has travelled to test sites as far apart as Plymouth and Glasgow. It has a generous supply of single phase a.c. power from a 10 h.p. diesel engine at 230 volts, 50 c.p.s. This is essential when the vehicle is running on a mobile test, and when stationary at a site remote from a mains supply. The largest section of the coach is a laboratory which houses electronic recording equipment. An office and small dark room are also provided.

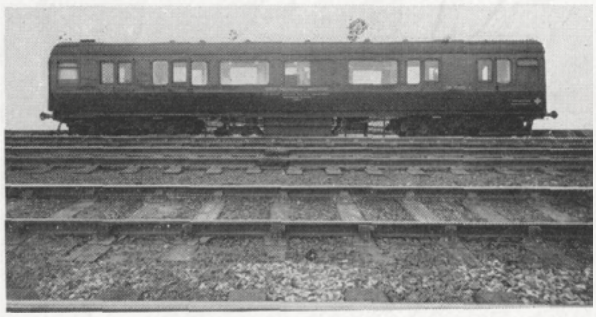


Figure 2.

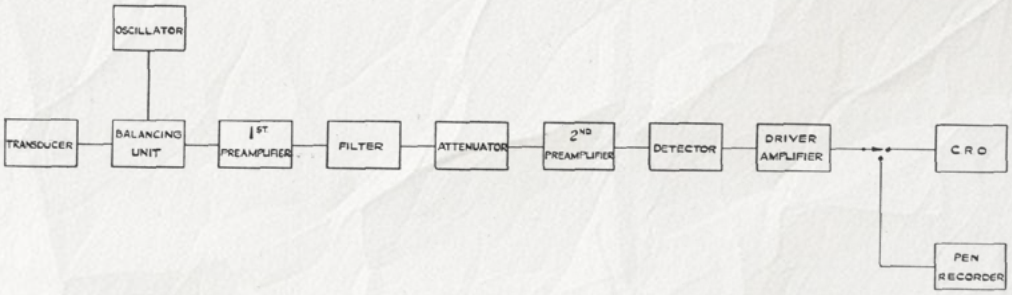
This vehicle, the mobile laboratory used by Engineering Division, provides laboratory space and an office as well as housing a diesel-generator set supplying $7^1/_2$ kilowatts at 230 volts 50 c.p.s. for use on mobile tests or at sites remote from an electrical supply.

Most jobs performed with the aid of the Mobile Laboratory use either cathode ray tubes with photographic film recording or pen recorders giving paper chart records. A twelve channel galvanometer recorder (designed by the Admiralty) is also used. The great virtue of this is that it will record strains satisfactorily without amplifiers, but it requires a very well regulated power supply for the strain gauges.

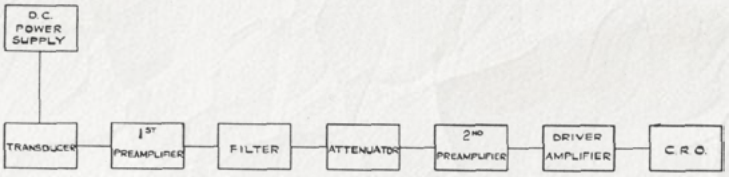
Recording is usually from a strain gauge Wheatstone bridge arrangement, and this is energised by a 3,000 c.p.s. carrier or d.c. The carrier method allows recording up to about 300 c.p.s. with cathode ray tubes or up to the limit of the pen recorder frequency response. When higher frequency signals are recorded the range is from about 5 c.p.s. to 35,000 c.p.s. using the d.c. method. Block diagrams of both recording methods are shown in Figure 3.

At the present time a considerable amount of work is being done on stresses in rails, and it is interesting

*British Railways Research Laboratories.



CARRIER WAVE SYSTEM.



D.C. SYSTEM.

BLOCK DIAGRAM OF RECORDING SYSTEMS.

Figure 3.

Detail alterations may, of course, be made to these two basic recording systems depending on the tests in progress, but the principle remains the same.

to observe in Figure 4 the sequence of stresses produced by a 4-6-0 locomotive and tender followed by coaching stock. The strain gauge for this record was in a vertical plane on the radiused fillet between the web and the rail head. The stresses were due chiefly to eccentric loading caused by tyre wear.

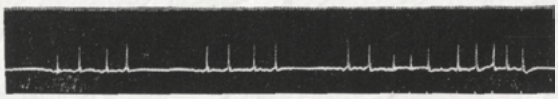


Figure 4.

Cathode ray oscillograph record of dynamic strains in fillet between upper fishing table and web of 95 lb./yd. bull head rail due to passage at high speed of 4-6-0 tender locomotive and coaches. (Timing marks 1/100 sec.).

Earlier this year the Mobile Laboratory was stationed at Newton recording stresses in the bolt holes in the ends of both bull head and flat bottom rail. Our aim is to find what factors affect the stresses in the rail, for example, such items of track maintenance as high or low joints, tight or loose fish plates, worn fish plates, etc., and from the vehicle standpoint the effect of varying axle load, speed and type of vehicle. In general records were obtained with service trains, but occasionally records were made with special runs (e.g. one Sunday five electric locomotives were coupled together and run over the test joint).

The results of these tests are being analysed statistically, and will be compared with previous results obtained at another site where the traffic was steam trains.

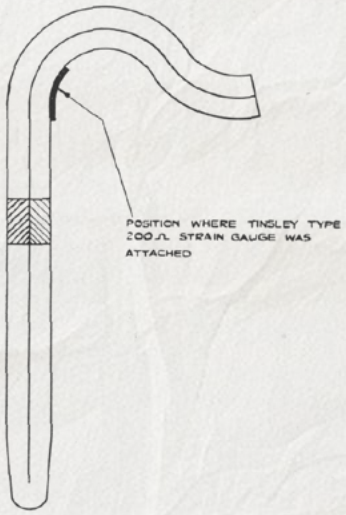


Figure 5.

An elastic rail spike, used to secure flat bottom rail to the baseplate and sleeper, showing position of wire resistance strain gauge from which the record in Figure 6 was obtained.

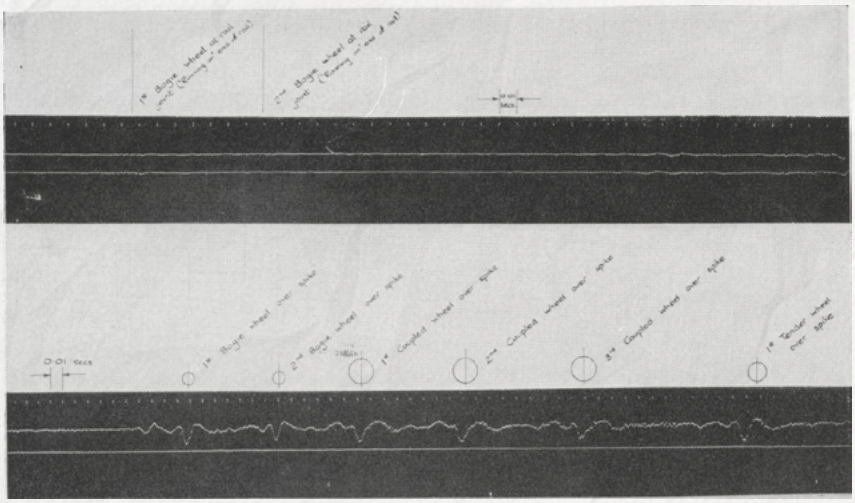
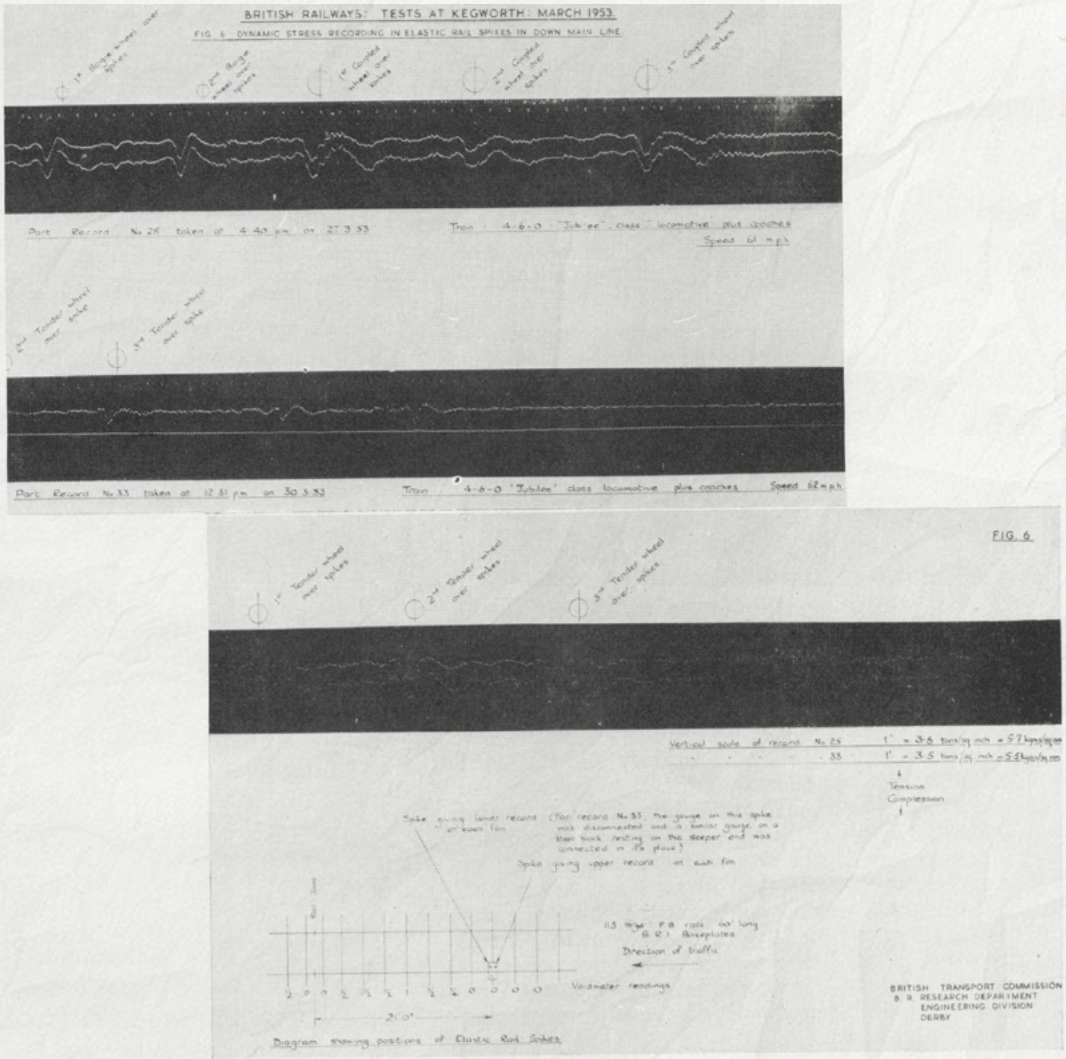


Figure 6.

A dynamic record obtained from strain gauges cemented to elastic rail spikes, during the passage of a train over the portion of track concerned. Note the precession wave as the first bogie wheel of the locomotive passes over the preceding rail joint.

(The diagrams show three consecutive sections of a continuous record).



Track components have also been tested for stress, for instance Elastic Spikes, Figure 5, which are used for holding flat-bottomed track to the sleepers, have been strain gauged in the radius, and the strain measured as the spike was driven into the sleeper. The static stress was thus known, and dynamic records were obtained with traffic passing over the track, and it is interesting to note the precession wave in Figure 6 as the locomotive first runs on to the end of the rail.

New track costs about £15,000 per mile, and therefore even a small economy can result in a substantial overall saving. One of the items making up the cost of track is that of ballast. We should like to know the optimum depth of ballast to use. Too little ballast will damage the formation and result in a premature relaying; too much ballast will unnecessarily raise the cost.

In order to study this problem, the department has in hand a programme of research into soil mechanics, including train loads in the ballast and formation.

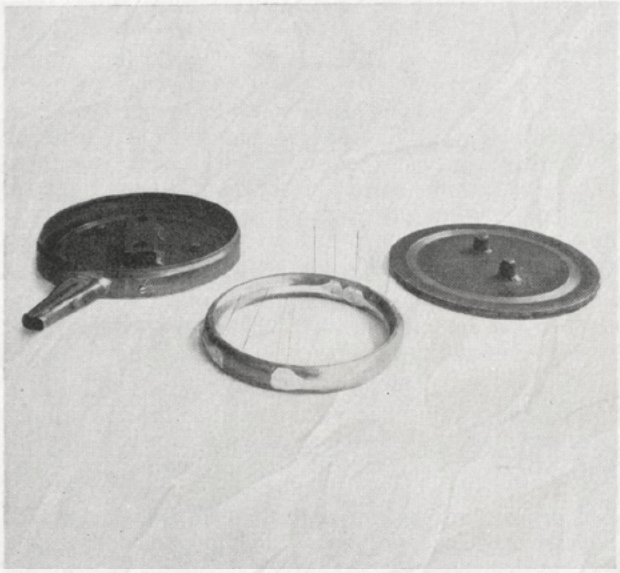


Figure 7.

Component parts of an earth pressure cell for use in the ballast.

Preliminary work was done with a large pressure cell developed at Derby in the late forties and used in ballast at Orpington in 1950. This cell (Figure 7) consists of a flat baseplate upon which is placed an annular tube of elliptical cross-section. Four wire resistance strain gauges, each a single length of wire cemented to a paper backing, are cemented to the inner and outer circumferences. A load distributing flat plate rests on top of the tube, and when load is applied the tube is distorted, compressing the inner gauges and stretching the outer gauges. By connecting them as a Wheatstone bridge an output proportional to load is obtained.

The large cell was intended for use in ballast; for the formation a smaller cell is required because of the smaller particle size. This cell has four strain gauges fixed to a diaphragm, and gives an output proportional to load. Figure 8 shows the comparison between the large and the small cell.

As low frequencies only will be transmitted through the ballast and formation, pen recorders and galvanometers are suitable for this work.

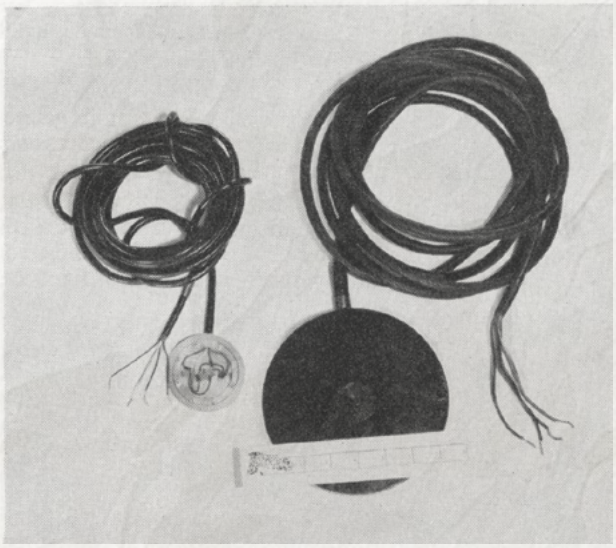


Figure 8.

Comparison of earth pressure cells for use in the soil under the ballast (the formation) and in the ballast. The scale is graduated in inches.

Many railway bridges are over one hundred years old, and were built with such a generous margin of safety that they are capable of withstanding the heavier loads of today. The factor of safety used has often been described as a factor of ignorance, and if the designers of those days had the measuring facilities available that we have today they would probably have built even better than they did.

One of these bridges (Figure 9) was built in 1885 at Cattewater Junction, Plymouth, and was a wrought iron structure. The Operating Department wished to use it for turning Merchant Navy Class locomotives via the adjacent triangle, and the Chief Civil Engineer had doubts about the safety of the bridge with such a load. Strain gauges were fixed to various members of the bridge structure (Figure 10) and a locomotive was run across the bridge. The measured stresses were only just less than the safe figure for a wrought iron structure, without margin for further corrosion, and so the bridge was dismantled.

At Boughrood on the other hand a bridge was saved. The old L. & Y. locomotives were to be withdrawn and

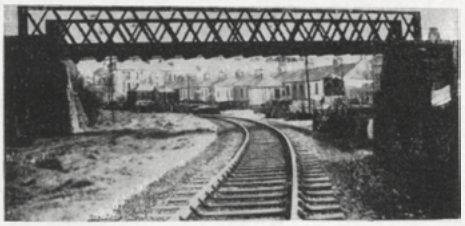


Figure 9.

Wrought iron bridge at Cattewater Junction, Plymouth, built in 1885. This bridge was tested to determine whether it was suitable to carry Merchant Navy class locomotives.

replaced by heavier rolling stock. The strain gauge tests made showed that the stresses were not excessive and rather heavier traffic now passes over the bridge.

Another bridge gave some trouble and the Ministry of Transport's Inspecting Officer of Railways called for tests to be made on one of a similar type depicted in Figure 11. Accordingly strain gauges were fixed to

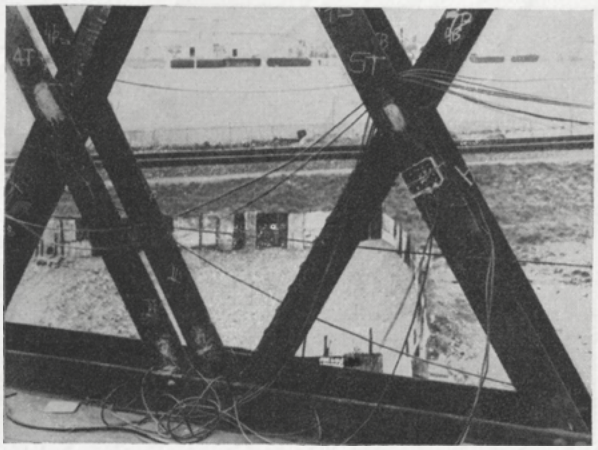


Figure 10.

Strain gauges cemented to structure of Cattewater Bridge.

various members and strains recorded when express locomotives crossed the bridge at various speeds. This was the first time that an Admiralty 12-channel Galvanometer Recorder was used for bridge work, and it was very successful.

Passing now from Civil to Mechanical Engineering we leave the track, and consider the vehicles which ride

Figure 11.

Tests in progress on a bridge near Shrewsbury.

on it. Considerable work has been done on testing the riding of locomotives including the measurement of lateral forces (i.e., the combined effect of flange forces and tread friction), and the vertical forces.

The re-built Royal Scots were particularly rough riding, and accordingly the lateral forces were measured in various axles. This was done by means of an electromagnetic strain gauge mounted in a weighbar, or proving ring, which was arranged to measure the force between the locomotive axle box and its main frame. The arrangement was energised by a 2,500 c.p.s. carrier and the output rectified and recorded on Duddell type galvanometers.

The riding quality was improved as a result of these tests by changing the strength of the bogie check springs, and adding friction pads.

In order to study the changes in vertical load of a locomotive, strain gauges were fixed to the spring links of a driving axle. In the example shown in Figure 12 the two channels represent strain from the front and rear links of the spring. The symmetry of the area between the traces shows that the load is in fact shared equally between spring links. Pitching and rolling may also be shown by this means.

Before leaving the locomotive one must mention one of the most important applications of electronics to testing locomotives. The Mobile Testing Units (Figure 13) of the L.M.S. are a classic example of a servo-mechanism. By means of electronic control (using thyratrons) the speed of a train can be held constant to better than 1 m.p.h.

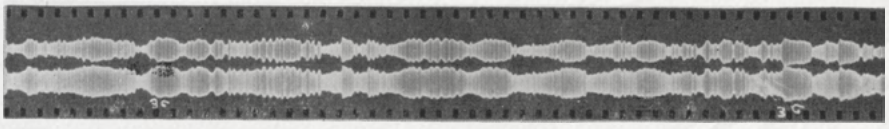


Figure 12.

Record obtained from strain gauges on the front and rear spring links of a driving axle of a locomotive. The symmetry of the area between the traces shows that the load is shared equally between the two links. The marks on the bottom edge of the film are for timing purposes and are one hundredth of a second apart.

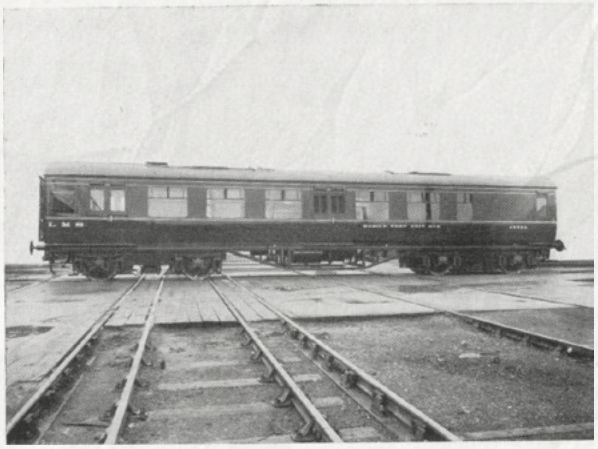


Figure 13.

Mobile Test Unit No. 2, one of three units which can hold the speed of a train constant to better than 1 m.p.h. by electronic techniques using thyratrons.

A project with high priority in the British Railways Modernisation Plan is the fitting of continuous brakes to freight trains. If freight traffic is to be speeded up, improved braking facilities are required.

With relatively short trains, this presents no difficulty, but with long trains it can be most difficult. The ideal brake system is one which applies brakes to the same extent on all wagons simultaneously. In the case of the vacuum brake, however, the vacuum wave takes time to travel along the train pipe (at a speed of about 300ft./second), and the result is that brakes tend to be applied at the front of the train before they are applied at the rear. The train contracts caterpillar-wise and with a long train this could be serious. Similarly when the driver takes his brakes off, it takes a considerable time for the vacuum to be established right to the far end of the train, and drivers can easily start their engines before the brakes are off at the rear, and break a coupling.

In order to study the propagation of a vacuum down a train pipe, strain gauge type vacuum gauges (Figure 14) have been developed. Spiral foil strain gauges fixed to both sides of two diaphragms arranged as a Wheatstone bridge provide a convenient transducer. The apparatus is supplied with carrier wave precisely as described earlier, and vacua recorded on charts with pens.

A gauge is fitted in the train pipe, one at the locomotive, one after 30 wagons, one after 50 wagons and one at the end (70 wagons). A brake application is made from the locomotive and the change of vacuum with time recorded at each of the four points. In this way the effect of modifications to the brake system can be studied. Some improvements have already been made, and more study on these lines is at present in progress. An example of records obtained, redrawn to

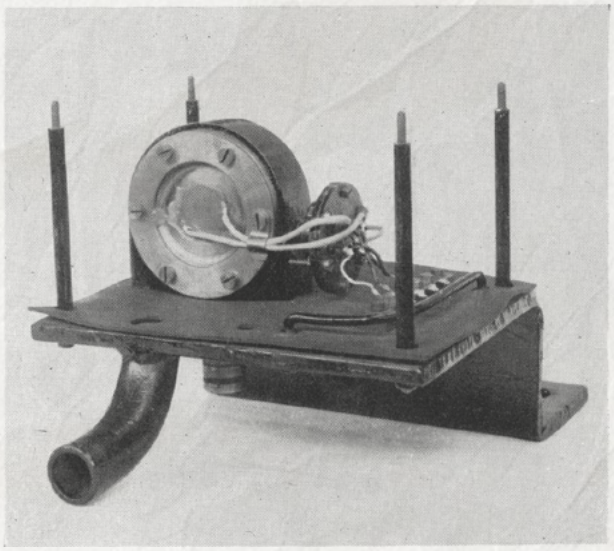


Figure 14.

A vacuum gauge developed in order to study the velocity of propagation of the vacuum wave down the train pipe of a freight train fitted with vacuum brakes.

different scales and superimposed for ease in comparison, is given in Figure 15.

The demand for higher speeds of freight trains brings the problem of the hot axle box, and much work has been done on recording temperatures of axle boxes with thermocouples. One aspect of the problem involving electronics, however, was the recording of various forces at the axle. The forces measured were the horizontal forces at each end and the vertical force (i.e., spring load), and the frictional torque due to end thrust at one end. Small beams were made and strain gauged in such a way as to enable one to record these quantities. A photograph of the layout of these beams is given in Figure 16 together with a key drawing.

British Railways are trying to reduce the shocks to goods in transit, and one method of doing this is to improve the design of buffers. In so doing the ability to test a new design is essential. The quality of a buffer is measured by the energy absorbed during the impact. This is the area of the force-displacement diagram, which is obtained as follows: Between the buffer and wagon headstock is a load cell (Figure 17) designed to accept a load of 200 tons maximum, and the output from this, after suitable amplification, is fed to the Y plates of a cathode ray tube. A displacement transducer of the potentiometer type is fitted to the stop block or wagon into which the test wagon is shunted, and the amplified output from this is fed to the X plates of the cathode ray tube. This is recorded on a quarter plate, care being taken to avoid fogging by means of a spot brightening device which operates as soon as the potentiometer moves from its zero position. After impact, a second exposure is made to calibrate both axes.

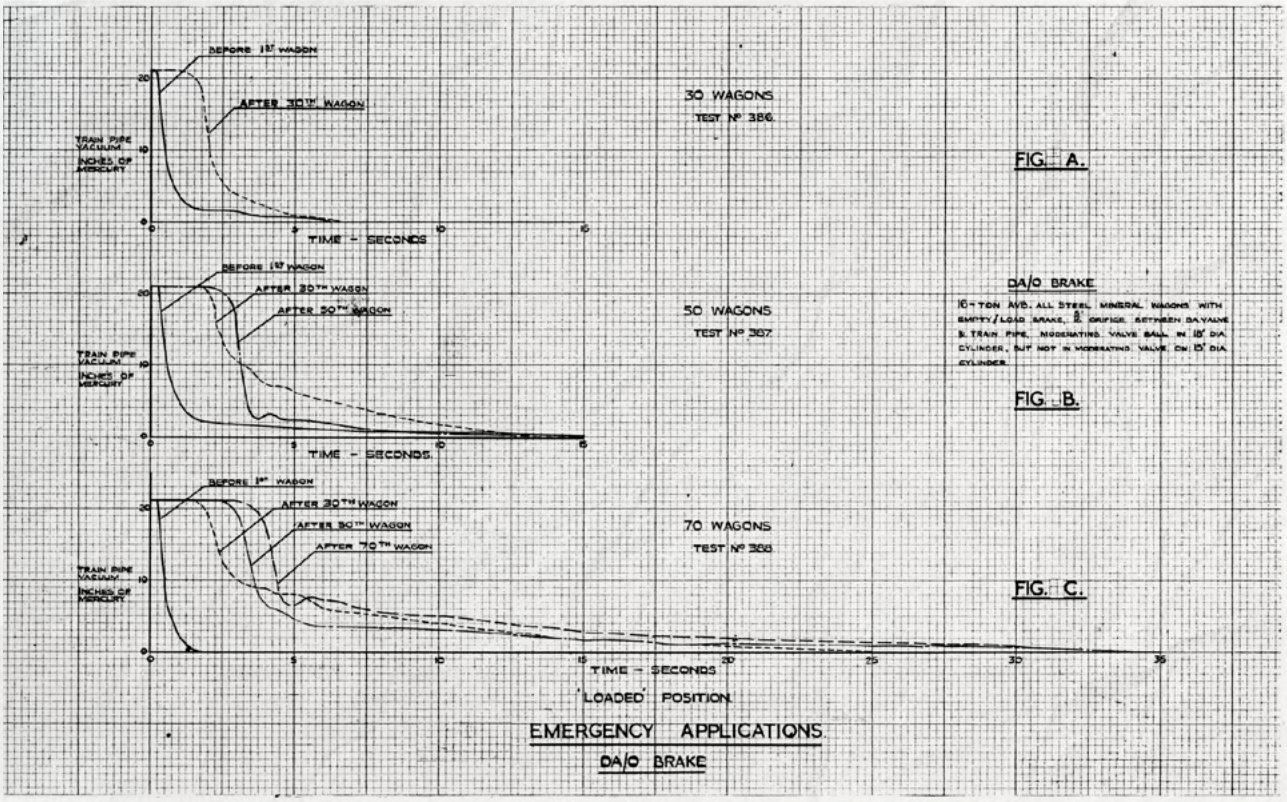


Figure 15.
Actual record, obtained from vacuum gauges of the type shown in Figure 14, redrawn to different scales and superimposed for ease in comparison.

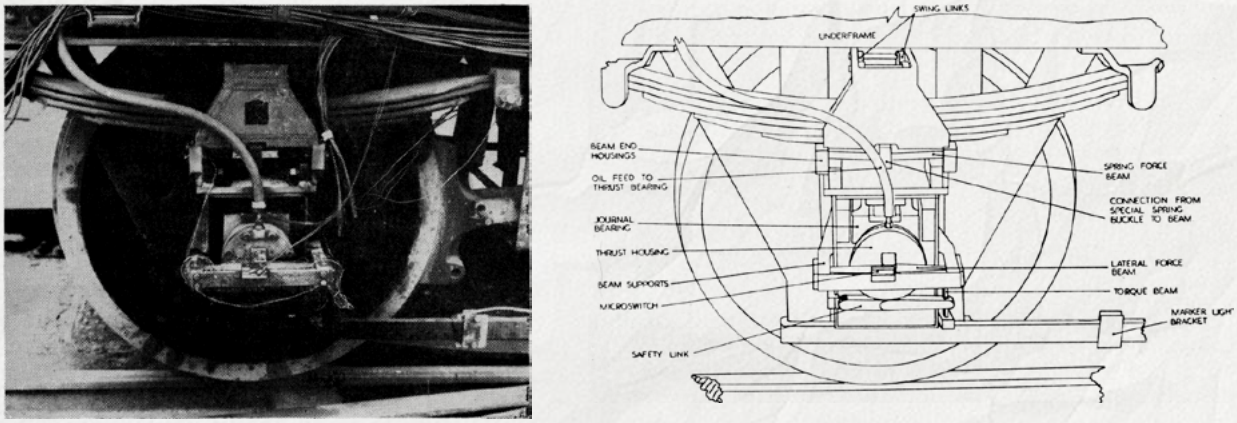


Figure 16.
Layout of beams for measurement of forces on axleboxes with key drawing.

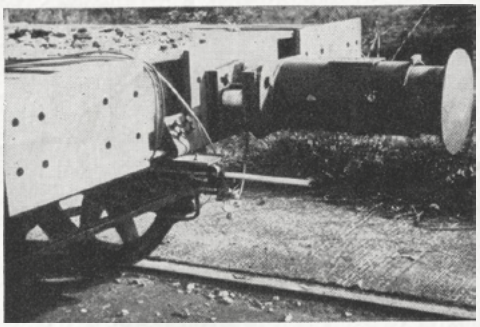


Figure 17.

The load cell and displacement potentiometer in position on a wagon during tests on rubber spring buffers.

The difference in character between spring buffers and hydraulic buffers is well illustrated by this technique, the hydraulic buffer being superior. Shock waves in the hydraulic fluid can be detected on the record, in Figure 18.

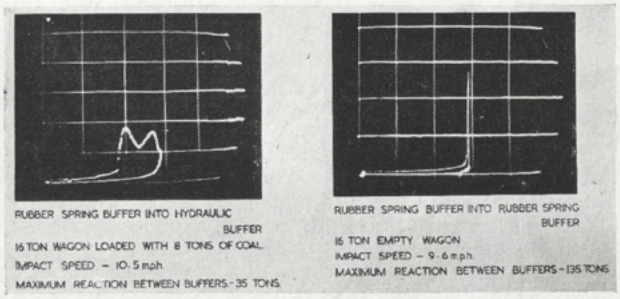


Figure 18.

Force-displacement diagrams of spring buffers and hydraulic buffers showing the superiority of the trace obtained from the hydraulic buffer.

As this College is pre-eminent in the field of Textile Technology it was thought that an application of electronics to textile technology and mechanical engineering might not be inappropriate. The Textile Division of the Railway Research Department, being interested in ropes used on the railway, asked for tests to be made of the tensions in ropes during service.

Strain gauges were fixed to a steel bar which was arranged by means of shackles to be a link in a rope, so that the tension in the rope could be measured. The strain gauges were energised by carrier wave and the output recorded on a chart recorder.

In a goods yard, some wagons were braked by this rope and the tensions recorded.

It was hoped that the addition of a nylon tail to a rope would remove the peak tension, and this is in fact what happened. The tension in the case without the tail was sufficient to break the rope, but in the case of the nylon tail, the tension build-up was slower and the peak tension less. The speeds of the wagon were approximately the same in each case, about 5 m.p.h.

As mentioned earlier in connection with rail end stress measurements, records were taken at various train speeds, and it therefore behoves one to measure the speed accurately. For this purpose two rail mounted photocells, a known distance apart, are employed (Figure 19). The first one starts an interval timer when the first train wheel interrupts the light beam, the second one stops the timer. By reference to a graph of time against speed for the known distance, speed can be found to a very high order of accuracy.

Figure 19.

Two rail mounted photo-cells set up a known distance apart for the measurement of speed of trains travelling on the line on which the cells are mounted.

When recording physical quantities with a cathode ray tube, it is often necessary to have an accurate time scale. This is done by recording flashes from a stroboscopic light source or the edge of the film outside the

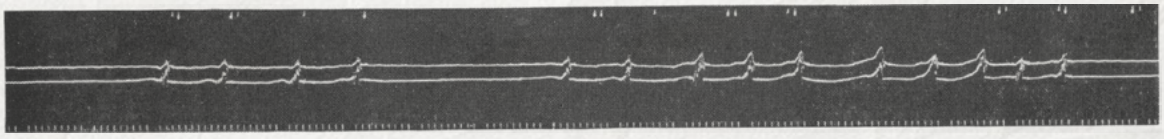


Figure 20.

Example of time marks on the edge of a film record. The marks are at one hundredth of a second intervals but every tenth mark is omitted with the exception of the hundredth. Thus seconds, tenths of seconds and hundredths of seconds are easily resolved.

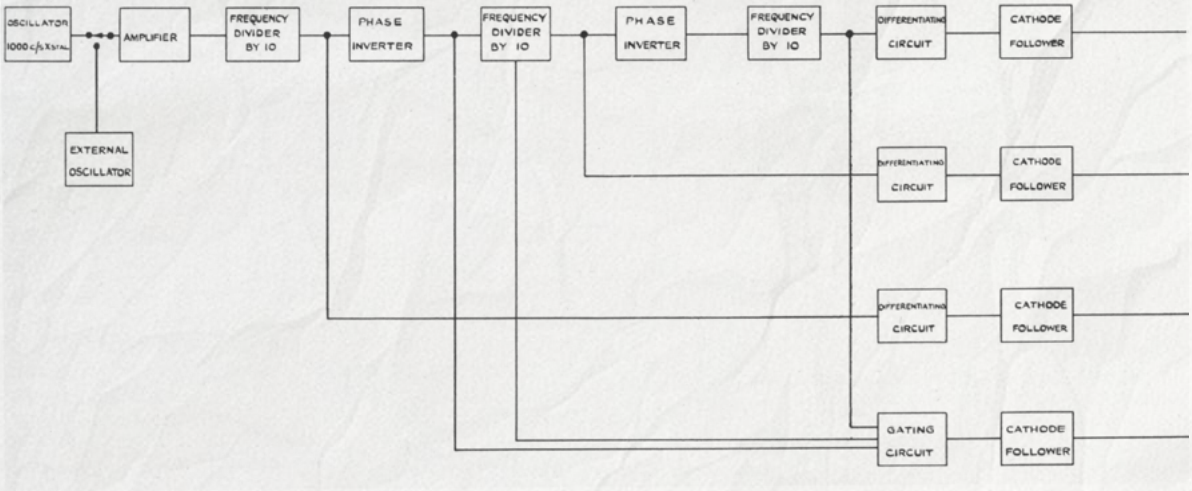


Figure 21.
Block diagram of pulse generator used to provide the triggering pulses for the stroboscopic light source, which produces the time marks shown in Figure 20.

perforations. Originally time marks were put on every hundredth of a second, but this becomes rather tedious if one has to count them all. The present method puts a mark on the edge of the film every hundredth of a second, omits one every tenth of a second, and puts it back every second, as can be seen from Figure 20. This was done by using a crystal source of 1,000 c.p.s., and frequency subdividing the output three times in decades, by means of standard dekatron circuits, giving outputs of 100, 10 and 1 c.p.s., and applying these signals to an appropriate gating circuit (see block diagram in Figure 21).

In order to obtain a complete picture of the dynamics of a wheel passing a given point, in addition to recording stress or displacement velocity or acceleration, one requires to know precisely the position of the wheel at a given moment. Our early attempts at this problem began with the use of a track switch, but this was soon shown to be inadequate. A crude but more accurate way to do it is to put a piece of insulated wire across the track and let the wheel break the insulation between the wire and the rail. This method, however, cannot be used on track circuited lengths. We now use a photo cell similar to the ones used for speed measurement, and arrange for a light flash, both when the light is obscured and when it is revealed. The two flashes are recorded on the opposite edge of the film to that used for time marks, and the mean position between the flashes corresponds to the axle being directly over the light beam. It is worthy of note that this method eliminates tangent errors which were present in earlier attempts. It is of interest to note that the ionisation time of the gas discharge tube is a significant factor in the accuracy attainable.

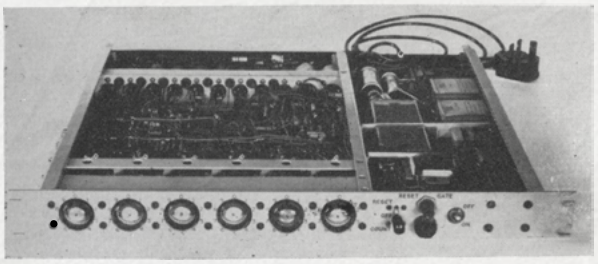


Figure 22.
A six-digit counter developed for statistical work, designed to occupy 1¾ inch module when mounted on a standard 19 inch Post Office rack.

The counter shown in Figure 22 has been developed for use where a number of variables are being counted at the same time. It is a standard dekatron counter, its unique quality being its size. It can be mounted on a 19-inch rack and it occupies 1¾ inch depth. Thus a number of these can be rack mounted and their readings photographed. Each one contains its own power pack.

In order to study the wear on a rail it is necessary to know the number of wheels passing over it. A rough estimate can be obtained knowing the number of trains and taking an average figure for the number of vehicles. For accurate work, however, it is necessary to actually count the number of wheels.

There are a variety of ways of doing this, but as the chosen site may be quite remote from electric mains, a battery operated apparatus is required, and one which is economical on current.

With this in mind an electro-magnetic axle counter has been developed. It comprises a permanent magnet clamped to the rail (Figure 23), with an air gap through which passes the flange of the wheel. When the flange

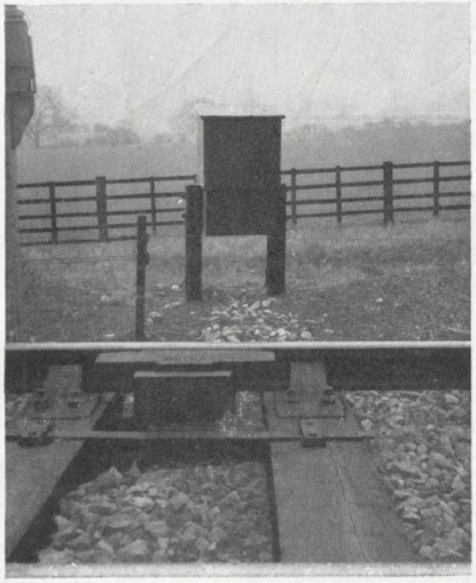


Figure 23.
An electro-magnetic axle counter on site. The permanent magnet is clamped to the rail and the counter and batteries are housed in the cupboard at the side of the track.

traverses the air gap, there is a change of magnetic flux, and an e.m.f. is developed in a coil wound round the permanent magnet; this operates a relay, the contacts of which close and operate an electro mechanical counter. The advantage of the system is that it only draws current when counting; the disadvantage is that it is dependent on the speed of the train, and the contacts require adjustment. This has been improved recently by using one stage of transistor amplification.

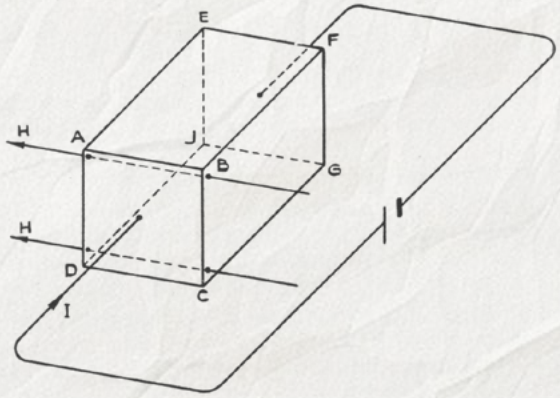


Figure 24.
Diagram illustrating the Hall Effect in a solid (see text).

Before discussing Automatic Train Control developments, it is essential to briefly describe the Hall effect, which is the basis of the new pick-up unit. Discovered in 1880 by Hall it is as follows: Imagine a rectangular shaped conductor (Figure 24) with a current passing through it across one pair of opposite faces. If a magnetic field is applied across it at right angles to the current, then an e.m.f. is produced in the third direction at right angles to both the current and the field. This e.m.f. in ordinary conductors is small and unimportant, but with the development of semi-conductors (particularly indium antimonide) this effect is much larger.

One of the pioneers in the development of these new substances has been the Services Electronics Research Laboratory, and we are very pleased to have the opportunity of publicly acknowledging their co-operation with British Railways in providing us with Hall Probes of indium antimonide for use in connection with the Automatic Train Control developments, a brief outline of which now follows.

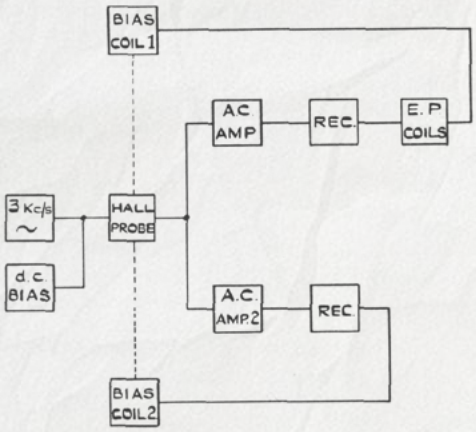
British Railways are justly proud of their record of passenger safety, for example, during the period 1943-54 inclusive, the risk of fatal accident to a passenger was 1 in 759,000,000 passenger miles. This degree of safety has not been achieved without a great deal of effort and expense, and currently considerable work is being done even to enhance it.

One cause of railway accidents is when a driver over-runs signals, and Automatic Train Control was first introduced by the Great Western Railway in 1906 to reduce the risk of this. The Great Western System depends upon a mechanical contact between the train and the track, and for this and other reasons it is not being generally adopted by the British Transport Commission in spite of the excellent safety record of the Great Western.

The British Transport Commission prefers a system which is operated by two magnets between the running rails, placed some 200 yards before each distant signal. When the signal is at caution, the train passes over a permanent magnet with South Pole uppermost, and by a system of relays, brakes are applied after a delay of about two seconds, and a horn sounded. If the signal is at clear, an electro-magnet immediately following the permanent magnet is energised, and this cancels the brake application and rings a bell. A driver's re-set handle allows him to cancel the brake application and regain control of his train, and, at the same time, gives him a visual reminder that he has cancelled the brake application.

Excellent though this system undoubtedly is from the point of view of the travelling public it has certain disadvantages from an engineering aspect. The chief criticism is perhaps that it contains moving parts (i.e. relays). These are subject to vibration and consequent wear on a locomotive and require considerable servicing.

Our aim in using semi-conductors has been to eliminate moving parts, and we have been most fortunate in this respect because of the generous electrical signal which can be obtained from a Hall Probe by running it over a track magnet, and by the development of the power transistor.

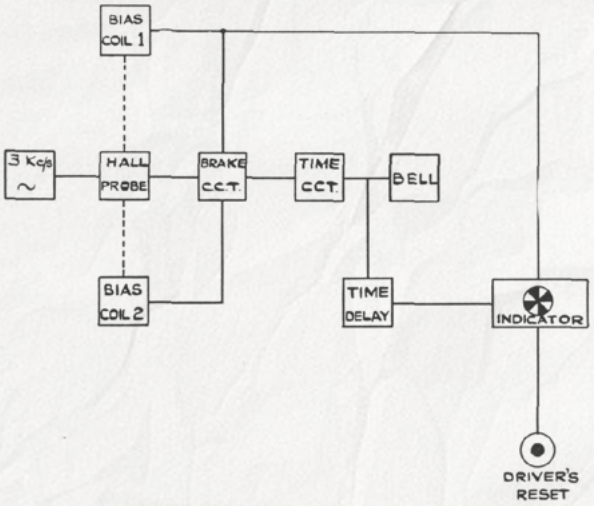


A.T.C. BRAKE DIAGRAM.

PATENT APPLIED FOR.

Figure 25.

Block diagram of Automatic Train Control Brake Circuit (see text).



A.T.C. COMPLETE DIAGRAM.

PATENT APPLIED FOR

Figure 26.

Block diagram of Complete Automatic Train Control Circuit (see text).

The easiest problem in Automatic Train Control is to put the brakes on and off and this is done by the A.T.C. brake circuit as follows (see Figure 25):

The Hall Probe is supplied with a square wave carrier frequency at 3,000 c.p.s. superimposed on a direct voltage, and the output is fed into two transistor amplifiers in push-pull. When the train is running normally the brakes are held off by current flowing in the electro-pneumatic (E.P.) coil. Current also flows in the bias coil 1 which is in series with the E.P. coil. In this condition amplifier 1 amplifies the alternating component and produces an output, whilst amplifier 2 is cut off by virtue of the direct voltage bias. The output from amplifier 1 is rectified and provides the direct current for the E.P. coil and bias coil 1. Bias coil 1 puts a magnetic field across the Hall Probe similar in direction to what would be produced by a North Pole from the track (but only about one-seventh or one-eighth strong).

When the locomotive passes over the South Pole of a permanent magnet, the magnetic field across the Hall Probe changes sign, and this reverses the phase of the output. This cuts off amplifier 1, stops direct current flowing in bias coil 1 and the E.P. coil, consequently after a delay the brakes go on. Amplifier 2 now functions and provides a rectified output into bias coil 2, which puts a magnetic bias on the Hall Probe in the opposite direction to that provided by bias coil 1.

If the signal is at clear, the locomotive passes over the energised electro-magnet North Pole uppermost, which restores the original phase of the Hall output, cutting off amplifier 2, re-setting amplifier 1 and holding off the brakes. As far as we can see this circuit *fails to safety.*

The complete A.T.C. circuit (Figure 26) has additional complication in the form of a bell circuit and driver's re-set control. When the train approaches a signal at caution the driver must be able to stop the automatic brake application and take over control himself. He does this by pressing a lever operated switch which puts a pulse of current into bias coil 1, acting in the same way as passing over a North Pole. This act also changes a visual indicator from all black to black and yellow, which is provided to remind the driver of what he has done. This indicator automatically returns to all black when the train passes over the next (South) track magnet. When the driver re-sets his equipment he also puts a pulse into a bell timing circuit which cancels the bell action which would otherwise occur.

It should be understood that this Automatic Train Control circuit is only at a development stage, and that a model for fitting to a diesel car is in preparation, so that a try-out on the track can be made.

Finally, thanks are due to the Director of Research for permission to give this lecture, and to the authors' colleagues in the Research Department for their help in this work.

Note: Tests of the Automatic Train Control circuit fitted to a diesel car have taken place since this lecture was delivered and have proved the circuit to be reliable.

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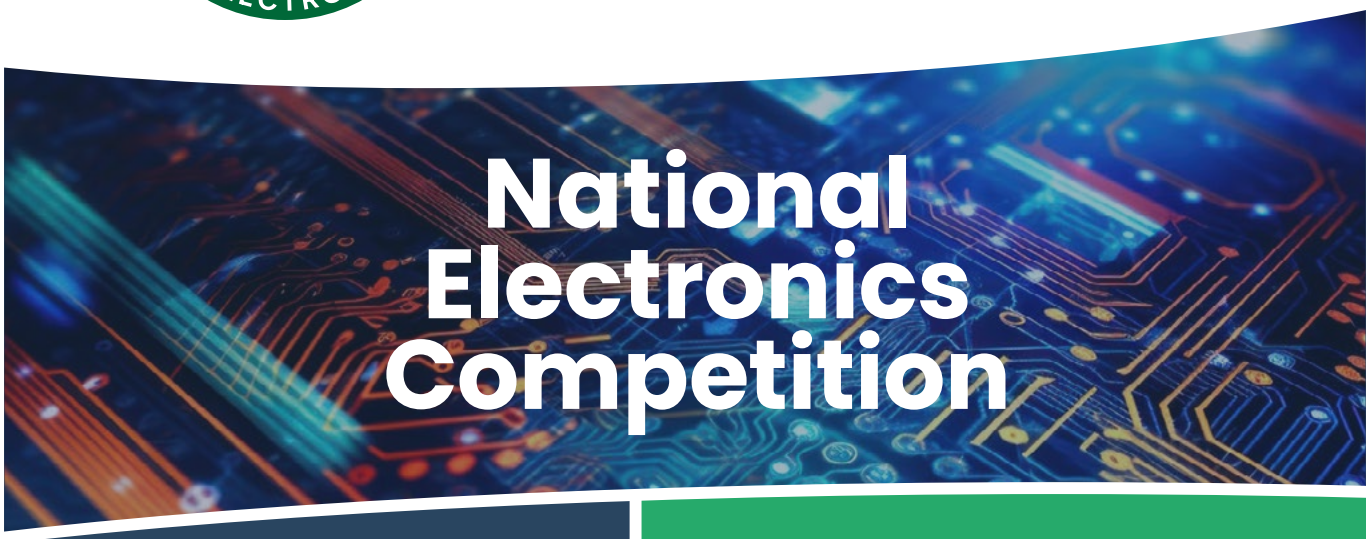

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What to do next?

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- Read the example technical paper
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- The project you submit can be anything, provided that electronics are integral to its successful function. We expect most applicants to use a project they have already completed or are working on at university, school (curricular or extra-curricular) or at home. There is no need to create a new project specifically for this competition. All projects must be complete and functioning when the technical paper and video are submitted
- An applicant can submit multiple projects - each one needs its own technical paper and video, but they must be submitted en masse in one email to the email address below.
- Applicants must report on their project using a simplified 'Technical Paper' format and a two-minute video

The 'technical paper':

- When Engineers, Scientists and Technologists submit their work to be published in a peer-reviewed journal or at an international conference, they must write a 'technical paper' to a rigid formatting specification. To give applicants an early experience of this, we require applications in such a format. An example technical paper is provided here. Our example is a paper 'converted' from the D&T project portfolio prepared by Arkwright Scholar Vaughan Jubb-Buckley as part of his school-based GCSE project.
- Submit your paper in exactly this format i.e. the same text font, size, style and colour, and the same main Headings (Sections 1 to 8). You can change subheadings and of course you must delete the example text and images and add your own (you do not need to add the same number of images as in the example. Use however many images suits your project the best). Use the same bracketed number format where you want to refer to a reference document (e.g. the example paper contains two references quoted in sections 2 and 3.2). Don't forget to change the footer. Maximum of 10 pages total please (yes we know the example paper is 12 pages long!)

The video:

- Produce a video (maximum two minutes) and post it to YouTube to: showcase, demonstrate and explain the main functional features and technical aspects of your project.
- Apart from its short duration we provide no other guidelines for the video—be creative!

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- Entries will be accepted from 1st July each year. The closing date is 31st August each year -late entries will not be accepted
- Results will be available mid October each year; Winners will receive their awards in November by arrangement with their school
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- In your email include: your technical paper(s) as an attachment to the standard specification, in an editable format (e.g. Microsoft Word); and a link to your YouTube video(s)
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GARDEN SHED RADIO

Garden shed radio – that was the name coined by a UK MP (Tony Benn) around 2002 when community radio was included in the Communications Bill put out for consultation by Parliament. That Bill became an Act of Parliament in 2003, over 20 years ago.

Many changes were desired by the authors of that Act, centered around the privatization of broadcasting – TV and radio – freeing the sector from the clutches of the BBC. Hence it included a third tier of broadcasting, at a "not for profit" level within the charity sector encouraging community groups and activities, at a local level.

Government approves but leaves it to individuals to implement – and in the case of local radio, to amateurs who largely had no experience of radio. I know that, I sat with them in working groups.

But did the Government foresee the digital revolution. I hope so, because that revolution had already started in the 1970s with the "silicon chip". That revolution led to signal processing that enabled modulation more advanced than AM (amplitude) or FM (frequency) making more efficient use of the spectrum. It led to audio compression saving bandwidth whilst retaining fidelity (mp3 and now AAC). It provided computers which enabled audio and video editing, plus automation of playout. It enabled remote control of equipment, telemetry of information, transfer of media files, and accessible storage of media. And this revolution took broadcasting out of the hands of the educated elite and dropped it into the hands of the amateur who did not have huge financial resources or vast infrastructure.

So in 2000 I sat with people who shared their capabilities and experiences and went away to implement local community radio. Now 25 years later there are 304 (May 2024) licensed community radio stations in the UK (mostly on FM). I went away and put a broadcasting antenna on a church tower, borrowed a basement room for a studio and sat with a few friends in front of a microphone with a simple amplifier, a CD player and cardboard box of CDs. We did that from 7 am to midnight, for 30 days, to establish and prove to Ofcom our capability. We did that on Wirral as a Christian and Community Radio station, called FLAME, and enjoyed it immensely. Our friends also enjoyed it and we were convinced that we could repeat the broadcasts, and learn to do it better. So we built our own studio in the beer cellar basement of an old night club, and for 7 years broadcast at Easter and in September for a month from a local radio tower, awaiting the opportunity to gain a full time licence.

From 2009 onwards we started broadcasting full-time on 1521 MHz (Radio Caroline's old pirate frequency ... who remembers that ?). We met the Ofcom key commitments for community radio programming (30% speech, 28% original, 25% new, 80% produced by the FLAME team). We met Ofcom's desire for "social gain" for our community in terms of

1. the provision of sound broadcasting services to individuals who are otherwise under-served
2. the facilitation of discussion and the expression of opinion
3. the provision of education or training to individuals not employed by the person providing the service
4. the better understanding of the particular community and the strengthening of the links within it

AND we enabled, and encouraged access and participation from the local community, and accountability to that community. We built our own broadcasting studio and recording room in a church hall and hung wires in trees to give a medium wave broadcasting antenna (we were not allowed panning permission for a permanent site and had to be well away from any houses).

Now in 2024, five transmission sites and three studios later we are still enjoying broadcasting. We have four computers working continuously. We prepare 70% of our broadcasting content, We have 0.7 Terabyte (347 Gbyte of programs and 70,000 tracks, 339 Gbyte of music) safely backed up, in a compressed format.. We operate around the clock. Our reach is worldwide. Most program preparation and broadcasting scheduling is "home working", as is our two hour breakfast-time show (not from the garden shed but from a comfy living room). We are staffed by volunteers many of whom have become enthusiastic broadcasters with friends who listen in. And all of this has been achieved at less than £5/hour (a £30,000/annum budget). When I was in University in the 1960s all of this was unthinkable.

Yes there is a need for innovation, for an artistic flair for broadcasting and for good business management skills, but there is also plenty of scope for local volunteers to share the fun. Skills are learnt on the job, and our text book is to observe other media practitioners.

In the early years we had to find our own transmission sites and operate our own transmission equipment but the digital revolution has enabled us to hand that over to service providers, at a modest fee. Hence we can concentrate on what we are good at, broadcasting. The first step of independence came around 10 years ago with internet radio. Another recent step is into digital radio (DAB ... digital audio broadcasting). So we have now left the analogue world well behind – to the delight of our listeners who now benefit from high fidelity crystal clear reception plus metadata that tells them what is being broadcast by whom.

Approximately 30% of our output is speech, in conversational form ... it is said that "the best radio is a conversation overhead on a bus". We are free to include controversial topics and overall try to be unbiased. And we include people's stories giving them time to express their views and describe their lives. That means that approximately 70% of our output is music – someone fittingly described radio as "the wallpaper" to me. In the UK, the use of music used to be licensed by PPL and by PRS but now "TheMusicLicence" covers playing of music for listeners through the radio and other digital devices.

"TheMusicLicence" ensures that those who are involved in creating the music we all enjoy, are fairly paid for their hard work and talent. After business costs, all the music licence fees go back to PPL and PRS for Music who then process, allocate and distribute royalties to the music creators that they represent. (PPL represents the rights of over 130,000 performers and recording rightsholders while PRS for Music represents the rights of over 160,000 songwriters, composers

and music publishers). All broadcasters need this licence for each media they use, however where they "simulcast" (simultaneously broadcast) multiple transmissions of the same content concurrently via different media, allowing them to reach a wider audience, the extra licence is heavily discounted. Ofcom encourages community radio stations to seek advertising revenue, and allows them to cover up to half of their annual expenditure from advertising revenue. However PRS/PPL licence fees are proportional to advertising revenue. Another disadvantage of PRS/PPS is the need to provide monthly reports on music used on one chosen day in the month (unless agreement can be reached that a larger station is representative of the music played and PRS/PPL agrees to waive the "reporting requirement").

WE SAY THAT Flame CCR is "online" ... in detail that means Flame CCR webcasts via its service provider Canstream. Flame CCR can be accessed from a variety of online sources such as www.radioplayer.co.uk (or our www.flameradio.org website which gives direct access to Radioplayer via the LISTEN LIVE button). There are at least 10 other internet portals that carry Flame (such as www.tunein.com). Another easy way is via smart speaker saying "find Flame Christian and Community Radio" to AlexA or one of her friends. Our mobile phone APP takes listeners directly to Flame CCR. All of that is another dream realised, with the ability to listen to Flame CCR on a mobile phone whilst on the move.

A recent step of independence has come with Ofcom granting a small scale DAB licence (SSDAB) to major towns across the UK. SSDAB uses wide-bandwidth broadcast technology in Band III (174 – 240 MHz). So far 78 towns in the UK now have these broadcasts (and there are now 157 community radio stations with C-DSP licenses). SSDAB is considerably cheaper than the original high power regional DAB because the onset of DAB+ multiplexing enables a service provider to squeeze more channels into a multiplex. Being only city-wide, with a multiplicity of locations, it avoids the use of the few expensive regional broadcasting towers. It operates on tall buildings with low power (typically 100 watts) and limited range. Antenna need to be on tall buildings because the higher frequency of DAB, compared to FM, means blackspots and shadows. This can be annoying with sudden short dropouts when travelling through the area, and typically coverage is only for 25 miles which is shorter than some commuting distances. There is a hidden snag in the DAB+ multiplexing means that the old DAB radios need replacing, so look out for the "ready for DAB+" tick on the box when buying a new DAB radio.

Locally WE SAY THAT Flame CCR is "on DAB+" – in detail that means that Flame CCR is one channel (amongst 32) on the Liverpool 2 multiplex, broadcast by Liverpool DAB Ltd www.liverpoolDAB.com from St John's Beacon in Central Liverpool and also from Woolton. Flame

CCR has a community DSP (C-DSP) licence from Ofcom and serves Liverpool as a Christian and Community radio station. Coverage is Liverpool and most of Wirral (over 1.5 million people).

Whilst community radio is the "third tier" of broadcasting, it demands more than amateurs in their garden shed – it is in the open airwaves competing with the professionals, and listeners expect perfection. They contact us when we make mistakes, are not perfect quality or go off air. But technology is not perfect, it breaks down at the least convenient time. We learnt to provide automatic back-up systems, initially with simple recorded programs from a silence detector and mp3 player (with every 15 minutes the song "help, I need somebody, not just anybody, you know I need someone, help") (The Beatles 1965). Nowadays we avoid a single point of failure by having an additional route from our Liverpool home studio to our service provider who hosts specially created software that switches to alternate programs when the audio fails (and informs us, and switches back when the problem is solved). DAB and internet broadcasting also shine a sharp unforgiving light on our sound quality, so we are kept on our toes with quality control. Listeners expect a well-organized, and publicized, broadcasting schedule from an easy to access website – and keeping to schedule. And then they miss the programs and want "on-demand" so we have 7,700 hours of programs on FLAME's "LISTEN AGAIN", plus podcast of the controversial stuff.

We have ourselves become critics of the professionals and shout at the TV or radio when "Auntie" gets it wrong.

Community radio is local, and increases "localness" by featuring local news/ weather/ travel, supporting local charities and businesses, providing work experience opportunities for local schools and colleges, giving a window to local musicians and poets/authors, and providing local volunteering opportunities. It can cheaply advertise local businesses. This runs counter to the BBC (who have cut-back local radio) and to commercial radio stations (including the independents) who are facing take over pressures from national commercial radio.

So perhaps the government really was foresighted in riding the wave of digital technology, and countering the centralization pressures, and encouraging localness by enabling local community radio .... Or has it just been an accident ?

Article written by Norman Polden, C.Eng, FIEE – station manager of Flame Christian & Community Radio 30/5/24

More details on Flame website https://flameradio.org/

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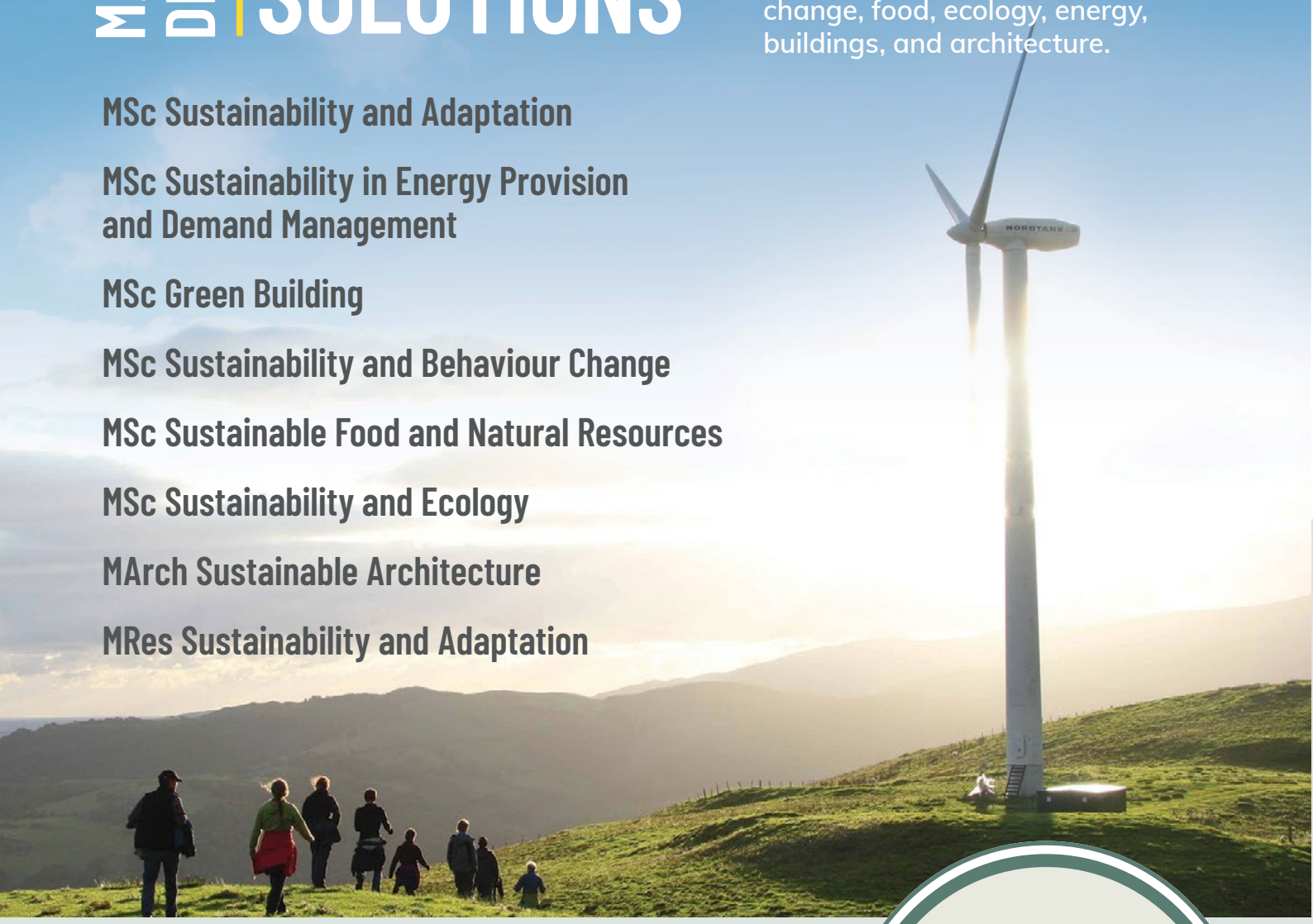

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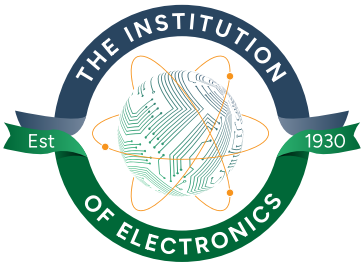

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