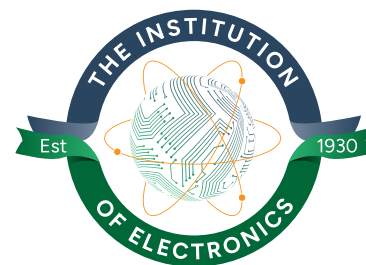


ELECTRON

THE QUARTERLY NEWSLETTER OF THE INSTITUTION OF ELECTRONICS



Autumn - December 2025

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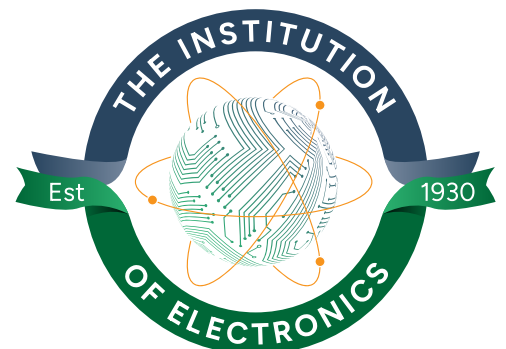
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ENGINEERING DESIGN SHOW 2025

ENGINEERING DESIGN SHOW

The Engineering Design Show, now in its thirteenth year, is one of the leading events in the UK for electronics professionals, as well as being the leading event dedicated specifically to engineering design.

Held at the Coventry Building Society Arena, adjacent to Coventry City Football Club, on 8th. and 9th. October, it featured around 200 exhibitors and brought together some 4,500 mechanical, electronic and embedded design professionals.

There were around 50 conference presentations spread across three streams sponsored by Eureka!, New Electronics and The Engineer, and two workshop theatres. Topics included:

- How GenAI is transforming Engineering Intelligence Posts (Emerson Test and Measurement)
- Breaking the Reactive Cycle: Strategic Approaches to Component Obsolescence Management (Bytesnap Design)
- How to design a Performance Optimised Power Module in a Week with the help of AI (Siemens)
- Don't forget Me: A Human-centred Approach to Simulation and Digital Twins (Loughborough University)
- Designing with Relays: Reducing Heat and extending Life of Electronics (OMRON)
- Designing for the Unknown: Lessons from Defence and Biomedical Sensor Development (Solstra)
- Meeting the 2024 Cyber Resilience Act: A 21-month Compliance Roadmap for Engineers (Digi International)
- Thermal Management Considerations in Product Design (Würth Electronics)
- Redefining Edge Intelligence: DEEPX's Breakthrough AI Semiconductors for a smarter, sustainable Future (DEEPX)

- IoT: From Design to Market (Würth Electronics)
- Human-centred AI: Transforming the Future of Engineering Design (Mark Allen Group and Edinburgh Napier University)
- Engineering and Medical Applications of Infrared Thermography (Nottingham Trent University)

Other attractions for 2025 were:

- Dynium Robot Tractor – an autonomous agricultural vehicle designed for precision tasks in orchards and polytunnels
- KUKA Robotics' Autonomous Mobile Robots – demonstrating next-generation automation, including fleet management software and no-code programming tools
- Next-gen Humanoid Robot – developed by Dennistries, founded by Nottingham Trent University student Joshua Dennis, providing a showcase for the evolution of student innovation to commercial success in the exhibition's dedicated Innovation Zone, notably featuring the newly-announced Next-Gen LEO
- Primary Engineer – an educational not-for-profit organisation founded in 2005 which aims to engage both primary and secondary school pupils and teachers with the vast and inspirational world of engineering and technology

With 2,141 schools, 6,630 teachers and 1,608 engineers participating in 2023-24, a recent initiative is the national STATWARS Climate Change Challenge in which children aged 8 to 14 tackle climate change using data they capture themselves and use the Primary Engineer carbon footprint calculator to calculate their own carbon footprint, then use this data to identify three changes they can make in their daily lives to help tackle climate change. Schools host in-class debates on their work and submit one team per class, with every pupil receiving a graded certificate and up to £5,000 worth of eco-prizes available to all schools that take part.

Nottingham Trent University Student Showcase

A prominent feature of this year's event, like last, was the Nottingham Trent University Student Showcase in which a new cohort of students were invited to exhibit their projects under the banner of ntu design industries. Below is a selection of just some of the projects that were showcased.

1. FLUX:

A prominent feature of this year's event, like last, was the Nottingham Trent University Student Showcase in which a new cohort of students were invited to exhibit their projects under the banner of ntu design industries. Below is a selection of just some of the projects that were showcased.

2. RHIZOME:

This project, by MSc Product Design student Rishabh Nayak, is a low-cost modular toolkit designed to help protesters maintain secure communication during blackouts. It includes The Projector – a discreet device that displays protest details on public walls to inform and mobilise communities ahead of the protest, and a Backpack that helps users create a Faraday Sleeve using foil and cling film, shielding phones from Stingray surveillance. During a protest colour-coded messages are transmitted between protesters and relay signals to nearby units enabling rapid, decentralised communication. By enabling secure, real-time coordination without reliance on digital networks, Rhizome empowers protesters to organise safely and effectively even under intense digital repression.

3. Alera:

This project, by student Callum Slattery, involves a compact, user-friendly device that allows individuals with nut allergies to test food for allergens prior to consumption. Using advanced electrochemical sensing and single-use test strips coated in aptamers, alera detects the presence of nut proteins in a small food sample. A simple LED interface provides a clear pass/fail result within minutes.

4. SIPPO:

SIPPO, by student Angela Yu, is an AI-powered kitchen appliance that allows families abroad to be reconnected through the shared act of cooking. Elderly parents in Hong Kong, for example, can record voice and video instructions which are turned into step-by-step hands-free recipes using gesture controls. After cooking users can snap a photo, print a personalised recipe card and share updates via a built-in family chat.



5. Focus:

Smartphone-related distractions are one of the biggest barriers to productivity and mental clarity in the modern workplace, especially for Gen Z and young professionals. While many people wish to reduce their screen time, current solutions often fall short in terms of usability, practicality and long-term effectiveness. Zak Boardman has therefore devised Focus, a mindful productivity companion which, unlike existing alternatives that rely on discipline from the user or full disconnection from the phone, strikes a balance between accessibility and boundaries, allowing for uninterrupted deep work while maintaining essential communication and core phone functionality. The device consists of two components, namely a weighted phone-charging base and a portable companion unit. The user places their phone in the base to begin a focused session while the companion unit allows filtered access to urgent notifications and core phone functions.

The inventor says: "Ultimately Focus is not about rejecting technology, but about reshaping how we interact with it – with clarity, control and intent".

6. Structra VSM:

Zaki Razak's project is a compact, modular trolley that reimagines vital signs and point-of-care trolley design in NHS wards. Replacing outdated systems, it integrates a mobile CRU tablet that wirelessly records patient data, scans barcodes and digitises notes to reduce errors and save time. Designed through user feedback, it features adjustable compartments, modular ports and dedicated holders to improve workflow, storage, hygiene and maintenance.

The inventor says: "Structura offers a future-ready, cost-effective solution for efficient and scalable care in modern healthcare environments".

MEDICAL UPDATE

Success for UK's First Neuralink Implant Surgery

A patient with motor neurone disease was able to control a computer merely by thought following the UK's first Neuralink implant surgery performed at University College London Hospitals' National Hospital for Neurology and Neurosurgery in October 2025.

The procedure is part of the GB-PRIME study which is evaluating the safety and functionality of Neuralink's robotically implanted brain-computer interface, or BCI.

The study follows Neuralink's clinical trials in the United States and Canada, where patients are using the NI Implant to control everyday devices such as computers, smartphones and robotic arms.

The study will involve up to seven participants who are unable to walk and whose ability to use computers, smartphones and tablets is significantly impaired or impossible due to their condition. It is currently being conducted at University College London Hospitals and the Newcastle Hospitals NHS Foundation Trust.

Harith Akram, Chief Investigator for the study, UCLH Consultant Neurosurgeon at NHNN, and Honorary Clinical Associate Professor at University College London, states:

"This treatment has the potential to help thousands of patients trapped in their own bodies, for whom we have previously been able to offer very little. I'm so proud of our talented team stretching the boundaries for patients with paralysis".

William Muirhead, Principal Investigator at UCLH and Consultant Neurosurgeon at NHNN, adds:

"It was remarkable to see Paul using his brain-computer interface on the very first day after surgery, he is now using it in his own home and working very hard every day to improve his calibration and control. Using digital devices can be very challenging for people living with paralysis so to see Paul's growing independence in directly controlling his computer is incredibly rewarding".

Reference: Hookway, P., Electronic Specifier, 28th. October



Low-cost Mobile Network supports Remote Robotic Surgery

Researchers at the University of Glasgow James Watt School of Engineering have built a 4G LTE network using inexpensive off-the-shelf components to connect a haptic controller to a robotic arm, allowing for near-instantaneous control with minimal delay between input and movement – a critical requirement for delicate applications such as surgery.



The team used the network to perform simulated dental examinations on a set of dentures, paving the way for the technology to be applied to operations on patients many miles away.

The system is based on the Open Radio Access Network, or O-RAN, which replaces proprietary hardware and software with open-source alternatives. A consumer-grade USB mobile internet dongle was reconfigured to create stable links between a haptic controller, robotic arm and computer acting as intelligent base station. Specialised software, known as xApps was used to monitor and optimise signal quality, data rates and latency in real-time. Laboratory tests achieved data transfer speeds of 10 Mbps with a response delay of less than a second, sufficient for precise control of a robotic arm. The network was also energy efficient with power consumption of 4.5 Watts, a full 90 per

cent less than traditional software-defined radio systems performing similar tasks.

First Author Dr. Saber Hassouna states:

"The testbed we've developed using commercially available hardware shows that O-RAN can be used to enable excellent performance in robotic teleoperation. For applications like dental procedures the robotic arm must move very smoothly which requires both high data throughput and low latency both of which we've been able to achieve for the first time with O-RAN".

Professor Qammer Abbasi, Head of the University of Glasgow's Sensing and Imaging Hub, adds:

"This is a very encouraging demonstration of the potential of O-RAN to enable fine-grained, near real-time control of a robotic arm. We are now working to extend this capability over longer distances which could eventually make complex remote tasks, including medical procedures, viable and affordable".

Reference: 'Glasgow Engineers develop Low-cost Mobile Network capable of supporting Remote Robotic Surgery', IoT Insider, 23rd. October.

Virtual Reality helps reduce Symptoms of Pain

A study led by the University of Exeter has compared the effects of immersive 360-degree nature films delivered by VR with those of conventional two-dimensional video in providing pain relief. Results showed that the VR was almost twice as effective at reducing pain symptoms.

Chronic pain, which typically lasts more than three months, is notoriously difficult to treat and in this experiment it was simulated in 29 healthy volunteers by administering electric shocks to the forearm. They then viewed two types of nature scene over a 50 minute period. Without any nature scene the participants developed a sensitivity to sharp pricking stimuli, mirroring the nerve pain experienced by people with chronic conditions. They were later immersed in a 45-minute 360-degree VR experience of Oregon waterfalls, and on another occasion to the same scene on a two-dimensional screen. Findings showed that the pain relief continued for at least five minutes after the VR experience had ended.



Dr. Sam Hughes, Senior Lecturer in Pain Neuroscience at the University of Exeter, states:

"We've seen a growing body of evidence show that exposure to nature can help reduce short-term, everyday pain, but there has been less research into how this might work for people living with chronic or longer-term pain. Also, not everyone is able to get out for walks in nature, particularly those living with long-term health conditions like chronic pain. Our study is the first to look at the effect of prolonged exposure to a virtual reality nature scene on symptoms seen during long-term pain sensitivity. Our results suggest that immersive nature experiences can reduce the development of this pain sensitivity through an enhanced sense of presence and through harnessing the brain's in-built pain suppression systems".

Dr. Sonia Medina of the University of Exeter Medical School and Translational Research Fellow with NIHR Exeter Biomedical Research Centre, who co-authored the study, adds:

"We think VR has a particularly strong effect on reducing experience of pain because it's so immersive. It really created that experience of being present in nature - and we found the pain-reducing effect was greatest in people for whom that perception was strongest. We hope our study leads to more research to investigate further how exposure to nature affects our pain responses, so we could one day see nature scenes incorporated into ways of reducing pain for people in settings like care homes or hospitals".

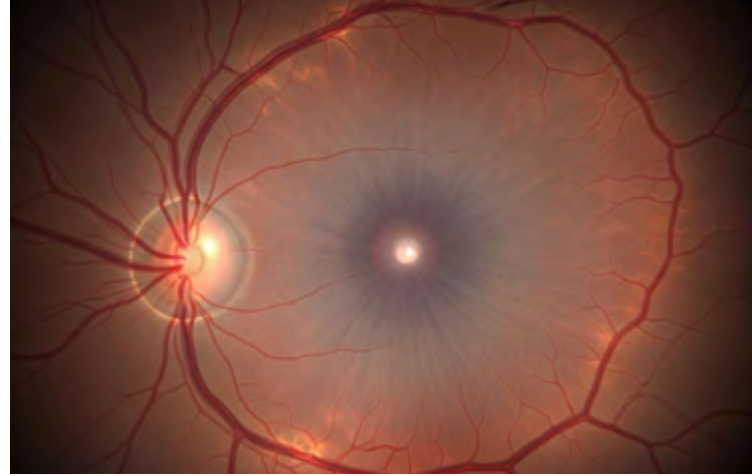
Reference: Miles, S., 'Nature VR can lessen Sensitivity to Pain', Electronic Specifier, 21st. September

Improving Retinal Scans with Quantum Computing

A European research consortium is exploring a new quantum imaging technique that aims to assist clinicians in detecting the earliest signs of eye disease.

The technique involves combining quantum physics with AI to push the boundaries of Optical Coherence Tomography that is used to examine the retina. Conventional OCT struggles to resolve details below 1 micron (about a hundredth of the width of a human hair), which is a problem because some of the earliest signs of disease begin with subtle changes in the retina's structure at this level. The new approach, however, uses quantum-entangled photons and advanced AI control to probe tissue structure, potentially reaching resolutions of 0.5 microns.

Entangled photons are pairs of quantum-linked light particles that can be used to illuminate the retina, potentially allowing for the imaging of sub-micron structures that traditional light sources miss. Current prototypes, however, work with single photons meaning that they scan much more slowly than



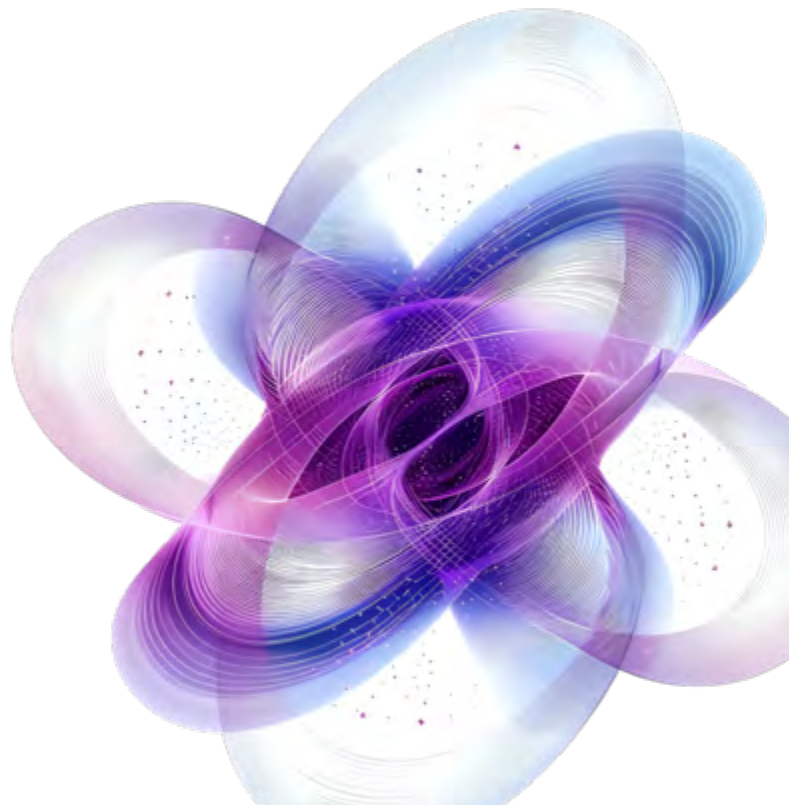
conventional OCT. The researchers are therefore deploying a Fourier domain detection method that aims to improve efficiency by removing moving parts.

In Spain and Germany research is being conducted in parallel to determine how machine learning can be applied to shape the quantum light itself. By imprinting orbital angular momentum (a corkscrew-like twist in the beam's shape) it is hoped to be able to sharpen edges and reduce interference.

The SEQUOIA consortium participants include Nicolaus Copernicus University of Poland, NKT Photonics of Denmark, the German National Metrology Institute, ICFO of Spain and ARDITEC of Italy. The Coordinator of SEQUOIA, Dr. Patrick Bowen Montague, comments:

"Our aim is to investigate whether quantum OCT can provide clinicians with information at smaller scales than today's systems. At this stage it's a feasibility study; we are testing the potential, not a finished product".

Reference: Wood, A., 'Quantum Imaging Research could improve Retinal Scans', Electronic Specifier, 19th. October



MORE QUANTUM DEVELOPMENTS

First Full-stack Silicon CMOS Quantum Computer

Quantum Motion has developed the industry's first full-stack quantum computer to be built using a standard silicon CMOS chip fabrication process, the same transistor technology used in conventional computers.



Deployed at the National Quantum Computing Centre (NQCC), this is the first full-stack quantum computer to use mass manufactured 300nm silicon CMOS wafer technology and the first silicon spin qubit computer to be installed under the NQCC's Quantum Computing Testbed Programme.

The system integrates the company's Quantum Processing Unit (QPU) with a user interface and control stack compatible with industry standard software frameworks such as Qiskit and Cirq, making it a full-stack solution. The system has a data centre friendly footprint of just three 19-server racks, housing the dilution refrigerator and integrated control electronics. It is based on a scalable tile

architecture which integrates all the required compute, readout, and control elements into a dense array that can be repeatedly printed onto a chip, enabling future expansion to millions of qubits per QPU. The system also represents a breakthrough in AI machine learning tuning, enabling more efficient operation and automated algorithms for control and calibration.

Reference: Colby, T., 'Quantum Motion's First Full-stack Silicon CMOS Quantum Computer', Electronic Specifier, 15th. September

Qubic to develop Advanced Quantum Amplifier Technology

Qubic, a quantum technology company pioneering advanced radar and cryogenic amplifiers, has been awarded a \$925,000 (CAD) grant from the Canadian government to support a \$2.5 million project to develop cryogenic amplifiers made from quantum materials. This will help overcome thermal barriers that are currently impeding the development of quantum computers.

Most quantum computers perform operations in a cryogenic environment. The heat generated by the system's electronics typically requires extra cooling, potentially disrupting the cryogenics used in quantum systems and limiting the number of qubits that can run together in a single cryogenic arrangement. Traditional amplifiers used in quantum systems are the primary source of this heat dissipation and as such represent a significant barrier to the development of fault-tolerant quantum systems.

The Qubic quantum amplifier reduces heat dissipation by a factor of 10,000, so removing this barrier to scaling quantum computers. It is expected to come to market in 2026 with the assistance of the University of Waterloo, the Institute for Quantum Computing, and the Quantum Nanofabrication and Characterisation Facility.

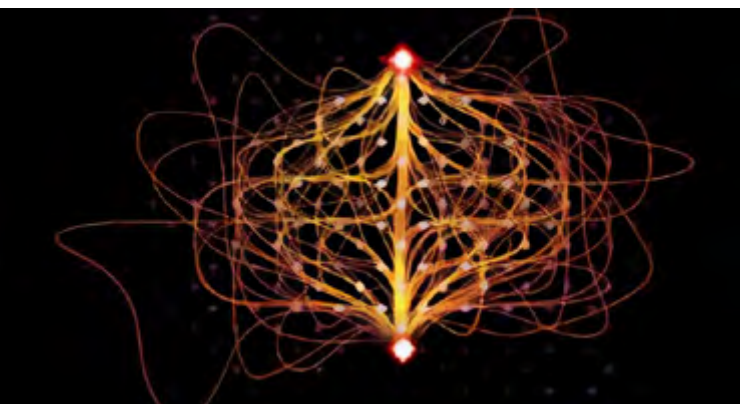
Article contributed by Qubic

Quantum Computing offers new Insight into understanding the Universe

A significant milestone in quantum research has been reached by using Google's quantum processor to simulate the interactions of fundamental particles.

Scientists modelled phenomena described by gauge theories to show how particles and the invisible 'strings' that link them behave, fluctuate and even break. The result is a new tool for exploring particle physics, quantum materials and potentially the underlying structure of space and time, and a new experimental platform to probe the deepest questions about the nature of the universe.

Michael Knap, Professor of Collective Quantum Dynamics at the TUM School of Natural Sciences, states:



"Our work shows how quantum computers can help us explore the fundamental rules that govern our universe. By simulating these interactions in the laboratory, we can test theories in ways not previously possible".

Pedram Roushan of Google Quantum AI adds:

"Using the quantum processor we examined the dynamics of a specific gauge theory and observed how particles and the invisible strings connecting them evolve over time".

Tyler Cochran, a graduate student at Princeton University and First Author of the study, further explains:

"By adjusting the effective parameters of the model, we could tune the behaviour of the strings. They can fluctuate strongly, become tightly confined or even break. The quantum processor data captures these hallmark behaviours, which have direct analogues in high-energy particle physics".

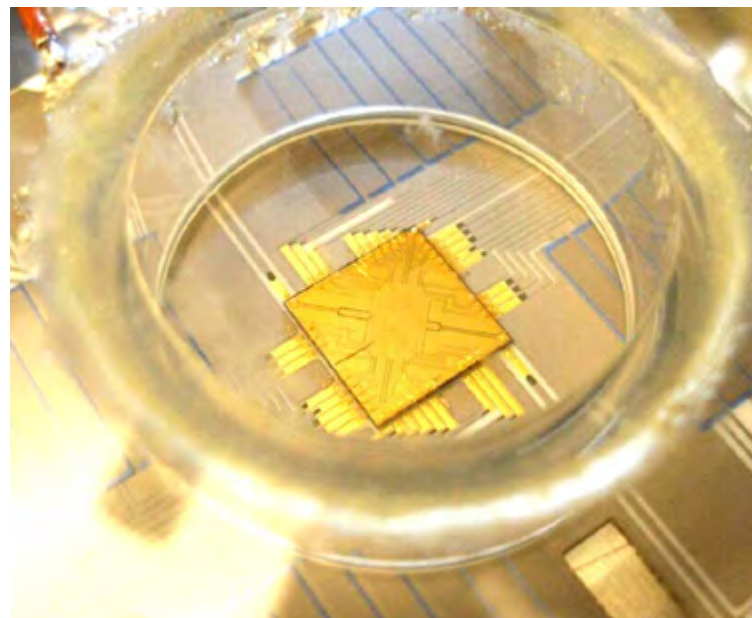
Reference: Hookway, P., 'Google's Quantum Computer offers new Window into the Universe', Electronic Specifier, 24th. October

Microwaves replace Lasers in Quantum Breakthrough

EleQtron, a spin-off from the University of Siegen, has replaced traditional laser-based control with microwaves, significantly reducing energy use and system complexity in quantum applications.

Direct Digital Synthesis (DDS) technology from Spectrum Instrumentation has been integrated into EleQtron's quantum systems enabling the precise control of trapped ion qubits using microwaves rather than lasers. This has led to much lower cooling requirements and power consumption than is the case with traditional laser-based systems. It has also greatly simplified hardware architecture.

Each of Spectrum's M4i.66xx series Arbitrary Waveform Generator cards can produce up to 20 independent sine wave carriers per channel using DDS enabling the fine-tuned manipulation of qubits, including amplitude, phase and frequency with timing resolution reduced to 6.4 nanoseconds.

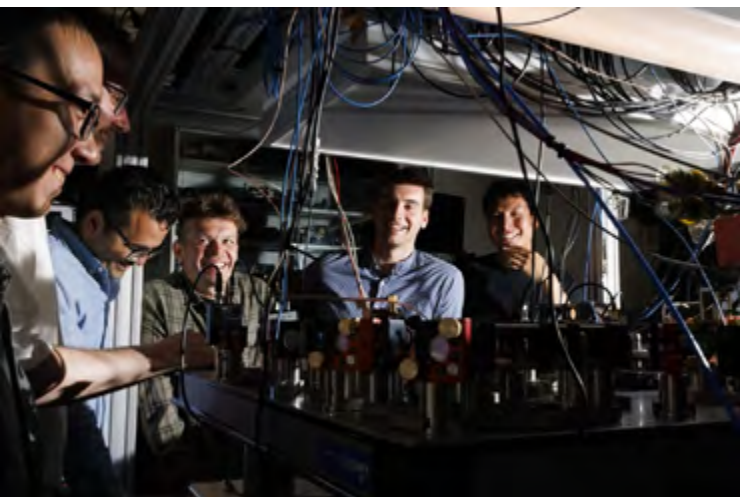


EleQtron's patented Magnetic Gradient Induced Coupling (MAGIC) quantum processors use ytterbium ions ($^{171}\text{Yb}^{+}$) confined in a Paul trap, which is a standard technique in ion-based quantum computing. Whilst conventional systems rely on high-precision lasers to target individual ions, here the same effect is achieved through microwave modulation operating at around 12.64 GHz. This brings into play the Zeeman Effect in which magnetic fields split atomic energy levels to distinguish between qubits by modulating the frequency in steps of 3 to 5 MHz.

Reference: 'German Startup EleQtron replaces Lasers with Microwaves in Energy-efficient Quantum Breakthrough', IoT Insider, 16th. October

First continuously operating Quantum Computer

Scientists at Harvard University have built the first ever quantum computer that can operate continuously without restarting. This is viewed as being a breakthrough since most quantum computers can only run for milliseconds and even the advanced machines have so far only operated for around 13 seconds.



A major problem in quantum is the so-called 'atomic loss', where qubits effectively escape from the system causing it to lose information and ultimately fail. In order to address this the Harvard team deployed two tools that can move atoms and subatomic particles, basically an "optical lattice conveyor belt" and a pair of "optical tweezers" which act so as to replenish qubits as they escape. Up to 300,000 atoms per second can be input to the machine, compensating for the 'atomic loss'.

Research Associate Tout T. Wang, who was involved in designing the machine, comments:

"There's now fundamentally nothing limiting how long our usual atom and quantum computers can run for. Even if atoms get lost with a small probability, we can bring fresh atoms in to replace them and not affect the quantum information being stored in the system".

Reference: 'Researchers develop continuously operating Quantum Computer', New Electronics, Vol.58, Issue 9, October 2025, p.7

Quantum Processor outperforms Supercomputers by 13,000 Times

A new algorithm known as Quantum Echoes, which ran on Google's Willow quantum chip, has allowed researchers to model the structure of physical systems ranging from molecules to magnetic materials and black holes.

This is the first time that a quantum computer has successfully executed an algorithm the results of which have been able to be independently verified and repeated - a major step towards the practical deployment of quantum hardware in scientific applications.

Quantum verification refers to the ability to reproduce a result on another quantum system of comparable capability, confirming that a computation is both correct and scalable. This has been a long-standing challenge owing to the fact that quantum states are fragile and error-prone.

The Willow chip has an architecture that significantly reduces quantum error rates and the Quantum Echoes technique has been likened to sending a signal to a quantum system then reversing it to capture a return 'echo'. This echo is enhanced by constructive interference between quantum waves, which provides an exceptionally sensitive measurement for more accurate and complex simulations.



In collaboration with the University of California, Berkeley, Google demonstrated how Quantum Echoes can be applied notably to chemical research by analysing the structure of two molecules containing 15 and 28 atoms respectively. The quantum-derived results matched those of Nuclear Magnetic Resonance (NMR) measurements as well as revealing additional information that is fundamentally inaccessible with traditional NMR. This proof-of-concept experiment therefore pointed to a tool that could reveal molecular and atomic-scale phenomena that is currently beyond the reach of existing instruments.

Ashok Ajoy, Assistant Professor of Chemistry at UC Berkeley, states:

"Google's Quantum Echoes algorithm showcases the potential for quantum computers to efficiently model and unravel these spins, possibly even

across long distances. As quantum computing continues to mature, such approaches could enhance NMR spectroscopy, adding to its powerful toolbox for drug discovery and the design of advanced materials”.

Reference: Hookway, P., 'Google brings Quantum Computing a Step closer to Reality', Electronic Specifier, 28th. October

Quantum-AI Data Centre arrives in New York

Oxford Quantum Circuits and Digital Realty have opened a pioneering AI data centre in New York's JFK10 facility, harnessing the power of NVIDIA's GH200 Grace Hopper Superchips.

This data centre marks a significant milestone as it allows Oxford Quantum Circuits' GENESIS quantum computer to integrate with the NVIDIA Superchips in New York's inaugural quantum computing system.

With Digital Realty's global platform, Platform DIGITAL®, the centre facilitates secure, interconnected Quantum AI infrastructure, unlocking considerable potential particularly across financial and security sectors.

Reference: 'Quantum-AI Data Centre: Revolutionising Enterprise Computing in New York', Data Centre Solutions, 30th. September

Controlling Robot Posture with Quantum Computing

An innovative method for controlling robot posture using quantum computing has been developed by Shibaura Institute of Technology, Waseda University and Fujitsu.

This facilitates the efficient and accurate calculation of inverse kinematics, i.e. determining joint angles from a target end-effector position for multi-joint robots by leveraging qubit-based position representation and quantum entanglement.

Verification using Fujitsu's quantum simulator achieved up to a 43 per cent error reduction with fewer calculations than current methods. The effectiveness of quantum entanglement was also confirmed through an experiment conducted on the 64-qubit quantum computer developed jointly by RIKEN and Fujitsu.

By expressing the orientation and position of each robot link as a qubit, and by replicating the structural influence of parent joint movements on child joints through quantum entanglement, the number of necessary calculations was substantially reduced.

In robot posture control, calculating inverse kinematics is crucial. For robots with multiple joints, the possible angle combinations are numerous, requiring iterative calculations to minimise the

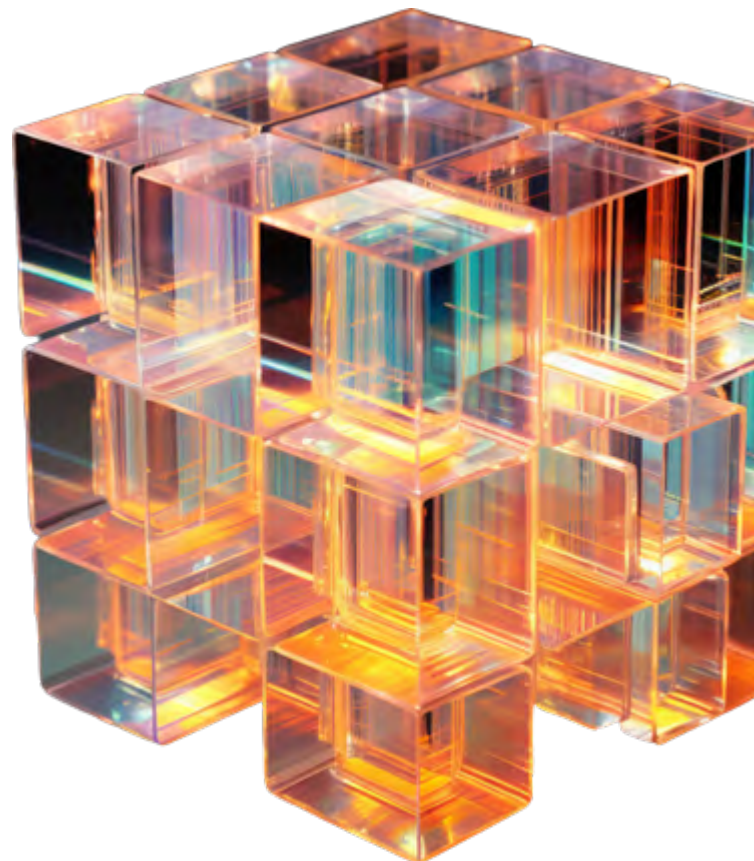
discrepancy from the target position, creating a high computational load. For a full-body multi-joint model with 17 joints, equivalent to the number of joints in the human body, the number of calculations required was too great to be able to be solved directly.

A common approach has been to perform motion calculations with an approximated seven joints, but this limits the smoothness of the movement. By leveraging the power of quantum computing, however, the orientation and position of each robot part, or link, are represented by qubits, and forward kinematics, i.e. calculation of end-effector position from joint angles, is performed using quantum circuits. Inverse kinematics calculations are undertaken using classical computers, such that efficient posture control is achieved using a hybrid quantum-classical combination.

By introducing quantum entanglement, the structure whereby the movement of parent joints naturally influences child joints is reproduced on the quantum circuit, which significantly improves the convergence speed and accuracy of inverse kinematics calculations. A trial calculation showed that motion calculations for a full-body multi-joint model with 17 joints could be executed in around half an hour.

The new method can express the posture of multi-joint robots with a small number of qubits, making it usable even in current noise intermediate-scale quantum computers.

Reference: Miles, S., 'Trio develop Quantum Computer-based Robot Posture Optimisation', Electronic Specifier, 26th. August



FURTHER DEVELOPMENTS IN ROBOTICS

UK's First Humanoid Industrial Robot

UK-based robotics and AI company Humanoid has launched HMND 01 Alpha, the company's first humanoid robot for industrial use. Taking just seven months to construct, it is said to be the fastest humanoid development cycle in history.

This unique robot can perform repetitive physically demanding tasks, for example in warehouses, logistical hubs and retail facilities. Working alongside people in environments designed for humans, it is claimed that it potentially increases throughput, reduces errors and improves working conditions without costly infrastructure investment.

The robot uses a proprietary combination of 360-degree simulation training and real-world data flywheels, which is claimed to deliver twice the development speed at half the cost of conventional methods.

It is 220 cm in height and is a robust wheeled robotic platform which can reach speeds of up to 7.2 kilometres per hour and carry bimanual payloads of up to 15kg. Its reach spans from the floor up to 2 metres with shelf depths of up to 60 cm and it has 29 active degrees of freedom, excluding end-effectors. It is powered by AI-driven end-to-end reasoning. A 12 degrees of freedom five-fingered hand or a single degree of freedom parallel gripper end-effector allows the robot to adapt to either dexterity or simple heavy handling or lifting. The head is fitted with 360-degree RGB cameras and two depth sensors for comprehensive perception.

HMND 01 Alpha is primarily designed for testing across industrial facilities, gathering insights as to which functions are market-ready, which need refinement and what new capabilities are required. The results should create a foundation for the Beta wheeled robot scheduled for launch in 2026. A bipedal Alpha is also being designed for pilot projects, testing and gathering real-world operational and safety data.

Reference: Austin-Morgan, T., Automation News, 13th. October



Introducing Rhagobot the Water-skimming Robot

Researchers at the University of California, Berkeley, Ajou University in South Korea and the Georgia Institute of Technology have developed a robot called Rhagobot that mimics the movement of Rhagovella, a small aquatic insect with fan-like feet that can navigate turbulent conditions with a high level of precision.

The feet of the Rhagovella unfold into fans when submerged, providing 'oars' that let the insect glide across water. No muscles are required as surface tension provides the means of propulsion. Once lifted from the water, the fans collapse, reducing drag and preparing the insect for the next stroke.



Engineers at Ajou University created artificial versions of the fans and attached them to the legs of an insect-sized robot. Electron microscopy showed that the natural fan is composed of flexible ribbon-like strips equipped with barbules, a little like feathers. When expanded underwater these barbules become stiff, allowing them to act as oars.

Je-sung Koh, Professor at Ajou University and Senior Author of the study, explains:

"Our robotic fans self-morph using nothing but water surface forces and flexible geometry, just like their biological counterparts. It is a form of mechanical embedded intelligence refined by nature through millions of years of evolution. In small-scale robotics, these kinds of efficient and unique mechanisms would be a key enabling technology for overcoming limits in miniaturisation of conventional robots".

Co-author Saad Bhamla, Professor at Georgia Tech, adds:

"We learned a rule from nature: the air-water surface can act as a battery. Surface tension powers the insect's collapsible fan, and the same design powers the robot fan".

Rhagobot's fans measure about 10x5 mm and are mounted on the ends of two 5cm-long robotic legs. It weighs 0.2 grams, can travel at around two body lengths per second and turn 90 degrees in less than half a second.

Reference: Hookway, P., 'Tiny Insect inspires agile Water-skimming Robot', Electronic Specifier, 28th. October



E-skin provides Robots with Human-like Touch

Robotic interaction is poised to be transformed following the development of an advanced next-generation electronic skin for robots.

Postdoctoral research associate in electronic skin Zhuo Chen, of Cambridge University, has used the optimisation of polymer composite formulations and advanced soft electronics fabrication to achieve spatial resolution that surpasses human skin and sensitivity.

Robot bodies and dexterity thus far have tended not to keep pace with the breakthroughs in AI that are transforming robotic abilities. Most conventional tactile sensors tend to be bulky, have low resolution and are limited to detecting normal forces. The capture of complex tactile information such as the direction and magnitude of forces with high resolution and accuracy has proved elusive. AI, however, is now allowing for the translation of raw sensor signals into meaningful tactile information. It is enabling learning-based adaptation that allows robots to refine their tactile capabilities in dynamic environments where surface properties are constantly changing. It also permits the e-skin to adapt to different locations on a robot and meet varied functional requirements.

The e-skin produces rich, multi-dimensional data, including pressure magnitude, direction and temperature which need to be rapidly interpreted for decision-making.

Potential applications include healthcare, where it can enhance the safety and precision of surgical tools by providing real-time force feedback, and in manufacturing where robots will be able to sense contact forces, surface texture, stiffness and friction with the ability to adjust their actions in real-time.

Zhuo Chen explains:

"Our e-skin uses a specially designed multiscale composite architecture that decouples forces in three dimensions. This enables accurate detection of normal and shear forces, allowing robots to sense sliding, texture, surface stiffness and temperature with greater precision.

We're exploring spiking neural networks and other neuromorphic approaches that mimic the way the human brain processes touch. This allows low-latency, energy-efficient processing suitable for embedded robotic systems".

Reference: Ford, J., 'E-skin to give Human-like Touch to Robots', The Engineer, September 2025, p.6

GROWING ULTRATHIN SEMICONDUCTORS DIRECTLY ON ELECTRONICS

Scientists at Rice University have created a new method of growing ultrathin semiconductors directly onto electronic components.

Chemical vapour deposition was used to grow tungsten diselenide, a 2D semiconductor, directly onto patterned gold electrodes. This was demonstrated by building a functional, proof-of-concept transistor.

Traditional fabrication techniques involve transferring fragile 2D films from one surface to another, but now the transfer process has been completely eliminated. Precursor materials have been optimised to lower the synthesis temperature of the 2D semiconductor such that it can be grown in a controlled directional manner. Advanced imaging and chemical analysis tools confirmed that the method preserves the integrity of the metal contacts, which are vulnerable to damage at high temperatures.

The method could help streamline the integration of two-dimensional materials into next-generation electronics, neuromorphic computing and other technologies that require ultrathin high-speed semiconductors, and as the electronics industry accelerates towards smaller, faster and more efficient components, integrating higher-performance, atomically thin materials such as

tungsten diselenide is growing in importance.

Sathvik Ajay Iyengar, First Author and doctoral student, explains:

"This is the first demonstration of a transfer-free method to grow 2D devices. This is a solid step toward reducing processing temperatures and making a transfer-free 2D semiconductor integration process possible."

A lot of our work in this project was focused on proving that the materials system is still intact. We are well-equipped here at Rice to study the chemistry that goes on in this process to a very fine degree. Seeing what happens at the interface between these materials was a great motivator."

Doctoral Alumnus student Lucas Sassi describes how the project was initiated by an accidental discovery:

"We received a sample from a collaborator that had gold markers patterned on it. During CVD growth, the 2D material unexpectedly formed predominantly on the gold surface. This surprising result sparked the idea that by deliberately patterning metal contacts, we might be able to guide the growth of 2D semiconductors directly across them".

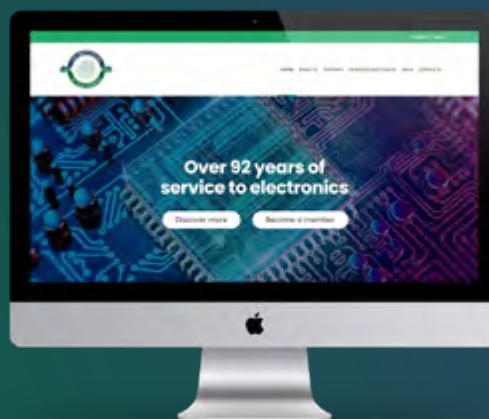
Reference: West, P., Electronic Specifier, 21st. August

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NEW METHODS FOR MAKING SMALLER MICROCHIPS

Researchers at Johns Hopkins University have discovered new materials and a new process for making smaller microchips by creating circuits that are so small that they are invisible to the naked eye.

During production, manufacturers coat silicon wafers with a radiation-sensitive material to create a very fine coating known as a 'resist'. When a beam of radiation is pointed at this a chemical reaction is triggered allowing details to be burnt into the wafer, so drawing patterns and circuitry. Unfortunately, however, the higher powered radiation beams required to carve out ever smaller details do not currently interact strongly enough with traditional resists.

At Johns Hopkins a new class of metal-organics has been used to create resists that can accommodate the higher-powered radiation process known as 'beyond extreme ultraviolet radiation', or B-EUV, which can potentially make details smaller than the current size of 10 nanometres. Metals such as zinc absorb the B-EUV light and generate electrons that cause the chemical transformations that are needed to imprint circuit patterns on an organic material known as imidazole.

This research marks one of the first times that scientists have been able to deposit imidazole-based metal-organic resists from solution at silicon-wafer scale, controlling their thickness with nanometre precision. The new methodology has been termed chemical liquid deposition (CLD) and it allows researchers to explore various combinations of metals and imidazoles. Experiments have now commenced with different combinations being used to create pairings designed specifically for B-EUV radiation.

Michael Tsapatsis, a Bloomberg Distinguished Professor of Chemical and Biomolecular Engineering at Johns Hopkins University, comments:

"By playing with the two components, metal and imidazole, you can change the efficiency of absorbing the light and the chemistry of the following reactions, and that opens us up to creating new metal-organic pairings. The exciting thing is there are at least ten different metals that can be used for this chemistry, and hundreds of organics.

Because different wavelengths have different interactions with different elements, a metal that is a loser in one wavelength can be a winner with the other. Zinc is not very good for extreme ultraviolet radiation, but it's one of the best for the B-EUV".

The Institution would like to thank Johns Hopkins University for this submission.



NEW HYBRID MEMORY BREAKTHROUGH FOR EDGE COMPUTING

A team of scientists at CEA-Leti in Grenoble has, with the assistance of several French research centres, developed a new hybrid memory technology that is expected to enable Edge devices to learn from real-world data without having to rely on energy-intensive cloud infrastructure.

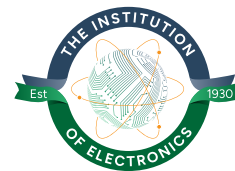
The breakthrough combines two previously incompatible memory approaches, namely ferroelectric capacitors and memresistors, into a single CMOS compatible architecture.

Until now, hardware designers have had to choose between memory types that optimised for inference or for training. Memresistors are energy-efficient for read operations and are good for inference, but lack the precision needed for training. Ferroelectric capacitors, on the other hand, perform fast and efficient updates, but destroy stored data once read, making them unsuitable for inference.

The new system supports both inference and training of artificial neural networks directly on-chip. Fabrication and testing was undertaken on an 18,432-device array using standard 130nm CMOS technology, demonstrating that a single memory unit could act either as a ferroelectric capacitor or as a memresistor depending on how it is electrically formed. This enables digital weight storage for training and analogue expression for inference within the same hardware.

The advance is anticipated to pave the way for more adaptive and energy-efficient edge systems from autonomous vehicles to medical sensors and industrial monitors, which require on-device learning to adapt to changing conditions.

Reference: Barnard, L., 'Grenoble Team overcomes Edge AI Hurdle with Dual-mode Memory Breakthrough', Electronic Specifier, 26th. September



NATIONAL ELECTRONICS COMPETITION

An exclusive competition for students of Arkwright affiliated Schools.

This competition will give the Institution the chance to champion the cause of young people pursuing electronics projects within the curriculum, extra-curricular and at home.

Applicants become student members of the Institution and will be invited to join the task-force that will plan the next phase of the Institution's development as an incubator for future leaders of the electronics industry.

LEARN MORE

CORNELL UNIVERSITY BUILDS MICROWAVE BRAIN ON A CHIP

Researchers at Cornell University have developed a low-power microwave chip, termed a 'microwave brain', which is the first processor to compute on both ultrafast data signals and wireless communication signals by harnessing the power of microwaves.

The processor is the first true microwave neural network and is fully integrated on a silicon microchip. It can perform real-time frequency domain computation for tasks such as radio signal decoding, radar target tracking and digital data processing using under 200 milliwatts of power.

It deploys interconnected modes produced in tuneable waveguides allowing it to recognise patterns and learn from data, but unlike traditional neural networks that rely on digital operations and step-

by-step instructions that are timed by a clock, this network uses analogue, non-linear behaviour in the microwave regime, allowing it to handle data streams in the tens of gigahertz, way beyond the capability of conventional digital chips.

Applications include identifying bit sequences and counting binary values in high-speed data, and in testing it achieved over 88 per cent accuracy in multiple classification tasks that involved wireless signal types. This is comparable to digital neural networks, but the power consumption and size were much lower. The chip's high sensitivity to inputs also makes it well-suited to hardware security applications such as sensing anomalies in wireless communications across multiple bands of microwave frequencies.

Doctoral student Bal Govind states:

"Because it's able to distort in a programmable way across a wide band of frequencies instantaneously, it can be repurposed for several computing tasks. It by-passes a number of signal processing steps that digital computers normally have to do."

"In traditional digital systems, as tasks get more complex, you need more circuitry, more power and more error correction to maintain accuracy. But with our probabilistic approach, we're able to maintain high accuracy on both simple and complex computations without that added overhead".

Reference: 'Researchers build "Microwave Brain" on a chip', New Electronics, Vol.58, Issue 8, September 2025, p.53



FIRST 1900MHZ 5G NETWORK FOR RAILWAYS

The world's first commercial 1900MHz (n101) 5G radio network has been announced by Nokia and Deutsche Bahn in conjunction with the 5G Standalone (SA) core, representing a significant breakthrough in railway technology.

The advancement will lay the foundation for the Future Railway Mobile Communication System (FRMCS), which aims to enhance railway operations through increased digitalisation, capacity and service reliability, marking a substantial leap from the traditional GSM-R system.

The deployment, conducted at Deutsche Bahn's digital railway test field in the Ore Mountains, features built-in failover mechanisms, self-healing capabilities and real-time monitoring. It will support the European FP2-MORANE-2 project that seeks to advance rail digitisation throughout Europe.

The agreement extends Deutsche Bahn's collaboration with Nokia's 5G SA core and 3700MHz (n78) radio network, presenting an augmented

solution that comprises of Nokia's 1900MHz (n101) 5G radio network equipment.

Reference: 'Nokia and Deutsche Bahn launch World's First 1900MHz 5G Network for Railways', Digitalisation World, 16th. September

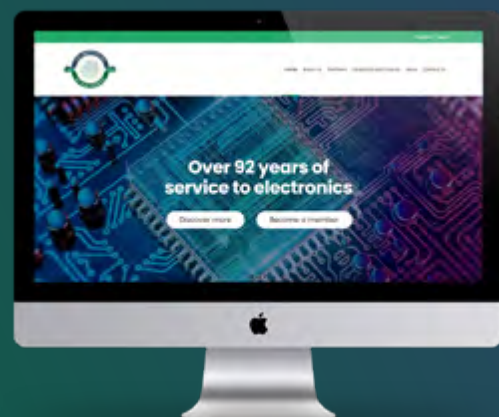


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FIRST 5G IOT SATELLITE LINK

Sateliot and Nordic have completed the first ever 5G IoT transmission between a standard commercial cellular IoT device and its Low Earth Orbit satellite constellation, demonstrating that existing cellular IoT devices can connect directly to satellites without any hardware modifications and so create true interoperability between terrestrial and non-terrestrial networks.

For telecom operators the breakthrough offers extended coverage beyond traditional infrastructure with seamless IoT connectivity anywhere in the world. Currently terrestrial networks only cover about 20 per cent of the Earth.

The development utilises Nordic Semiconductor's nRF9151 low-power cellular IoT module renowned for its efficiency and extended battery life, and complies with the 5G NB-IoT Release Standard. This standardisation ensures that telecom operators can

integrate satellite IoT into their existing infrastructure, extending network reach with without overhauling hardware or operations.

Oyvind Birkenes, Executive Vice President of the Long Range Business Unit at Nordic Semiconductor, comments:

"The lack of global and harmonised coverage has held back the IoT and M2M markets for years. With this breakthrough it's now possible to create low-power devices with satellite connectivity and accelerate deployments across key use cases".

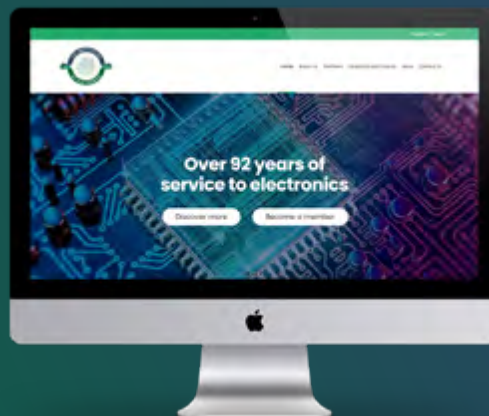
Reference: Nolan, S., 'Sateliot and Nordic achieve First 5G IoT Satellite Link', Telco Magazine, 11th. October

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SOLAR ENERGY FROM SPACE CUTS BATTERY STORAGE NEEDS

For the first time researchers from King's College London have assessed the potential impact that solar energy from space could have for Europe, with findings suggesting that it could cut battery storage needs by over two thirds.

The study analysed the potential of a design by NASA for solar generation and considered how useful this type of energy could be when used in conjunction with European energy grids. It also provided a cost estimation for the use of this technology in the European market for the first time.

NASA's RD1, which was used for the study, is one of two designs for space-based solar panel power systems designed by NASA. The principle utilises the continuous collection of solar energy in space by placing large solar panels on satellites in orbit, and then transmitting the gathered energy to stations on Earth where it could be converted into electricity for subsequent delivery to the grid or to batteries for storage.

Professor Wei He, Lead Author and Senior Lecturer in the Department for Engineering at King's College London, states:

"For the first time we have shown the positive impact this technology could provide for Europe. Although the feasibility of this technology is still under review, our research highlights its vast economic and environmental potential if adopted.

Reaching net zero emissions by 2050 is going to require a significant shift to renewable energy, and this emerging technology could play a pivotal role in that transition".

Reference: Miles, S., 'Solar Panels in Space could cut Europe's renewable Energy needs by 80 per cent', Electronic Specifier, 26th. August



AI MODEL OPENS NEW POSSIBILITIES FOR MATERIAL DISCOVERY AND CLIMATE SOLUTIONS

Researchers at the VSC Viterbi School of Engineering have developed an AI model that can simulate the behaviour of billions of atoms simultaneously, creating new avenues for material discovery and climate solutions.

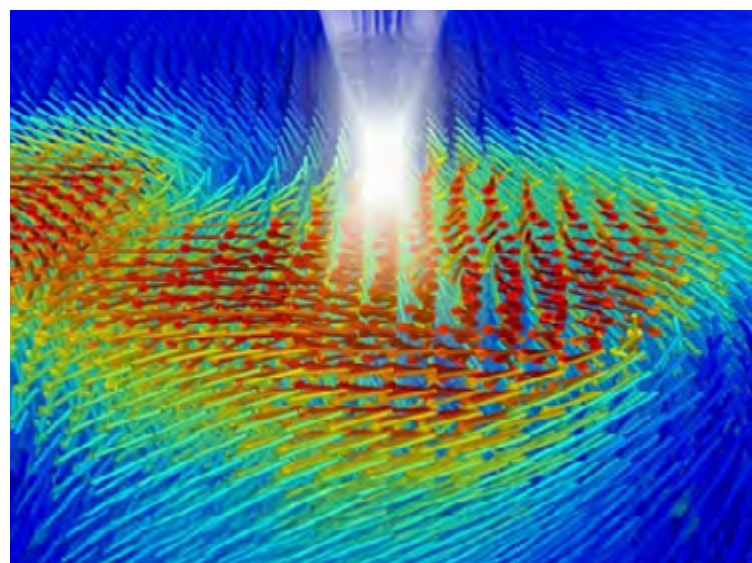
The model, known as Allegro-FM, demonstrated its potential by tackling one of the world's greatest challenges, namely reducing carbon emissions from concrete. Currently concrete production is estimated to account for some 8 per cent of global carbon dioxide emissions, but with Allegro-FM this could be turned around to the point where this figure actually becomes negative.

Allegro-FM is an AI-driven molecular simulation system that revealed that carbon dioxide that is released in concrete production can actually be reabsorbed and thus embedded in that same concrete.

By running simulations at atomic scale, Allegro-FM tested different concrete chemistries virtually prior to real-world trials, making for faster and cheaper experimentation. Where traditional molecular simulations handle only thousands or millions of atoms, Allegro-FM was found to offer 97.5 per cent

efficiency when simulating over four billion atoms on the Aurora supercomputer at Argonne National Laboratory. This is a system about a thousand times larger than those currently used.

Reference: West, P., 'AI Simulation Model points to Carbon-neutral Concrete', Electronic Specifier, 8th. September



NEW SCREEN HAS HUMAN EYE RESOLUTION

Researchers at Chalmers University of Technology, the University of Gothenburg and Uppsala University have developed a screen technology with the highest resolution to the human eye, potentially transforming virtual and augmented reality experiences.

The technology utilises nanoparticles, the size, arrangement and optical properties of which can be precisely tuned to scatter and reflect red, green and blue light. A weak electrical signal can be used to switch the particles off so turning the pixels black. The passive screen relies on ambient light as opposed to a built-in backlight.

The technology was demonstrated by recreating Gustav Klimt's painting *The Kiss* on an area of 1.4x1.9 mm, about one four-thousandth of the size of a smartphone display.

Reference: Barnard, L, 'Swedish Scientists develop Screen with Human-eye Resolution', *Electronic Specifier*, 24th. October

The 'retina-E-paper' is a reflective screen with pixels the measure just 560 nanometres. Each pixel roughly corresponds to a single photoreceptor in the human eye, giving the display a resolution of over 25,000 pixels per inch, which is way above that of today's consumer devices.



MORE DEVELOPMENTS IN OPTOELECTRONICS

Fibre Optic Cables to sense for Damage in Critical Infrastructure

A 5.1 million euro project is underway to ascertain whether fibre-optic cables can be used as sensors to detect hidden damage in critical infrastructure such as bridges, railways, tunnels and energy pipelines.

Known as the ECSTATIC project, it is being coordinated by Aston University with a Victorian railway viaduct being used as the first live test site. Laser light pulses are being directed through existing fibre optic cables with the aim of picking up subtle structural shifts, stresses and vibrations in real-time. This is seen as being a preferable alternative to deploying physical sensors across the entire transport and energy networks.

Ultra-precise laser pulses are sent through buried fibre optic cables. As trains pass above, the fibres subtly flex and vibrate, altering how the light behaves inside the cables. The phase and polarisation of the light change so as to create a 'fingerprint' of the forces acting inside the structure.

The changes are measured and interpreted using a special photonic chip and advanced AI signal processing that does not interrupt existing internet traffic or deployment of new fibre optic cables.

Professor David Webb, ECSTATIC project coordinator, states:

"Our aim is to create a global nervous system for critical infrastructure. We are hoping to turn existing fibre optic cables into a 24/7 early warning system, detecting the tiniest tremors or stress fractures before they become catastrophic. If successful, it will be the difference between fixing a fault and cleaning up a tragedy".

Reference: 'New European Photonics Project aims to prevent Bridge Collapses', Optical Connections, 8th. August

Lightmatter achieves 16-wavelength Bidirectional Link on Single-mode Optical Fibre

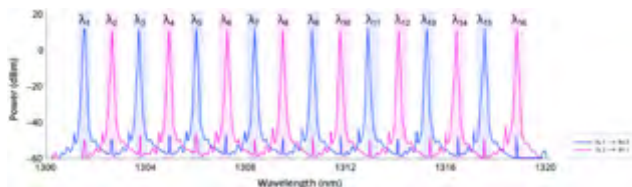
Lightmatter, a specialised photonic supercomputing developer, has developed a 16-wavelength bidirectional Dense Wavelength Division Multiplexing (DWDM) optical link that can operate on one strand of single-mode fibre, an advance that could enable the creation of next-generation AI data centres.

The achievement, which uses Lightmatter's Passage interconnect and Guide laser technologies, has been described as "a significant breakthrough that has shattered previous limitations on fibre bandwidth density and spectral utilisation" which "sets a new benchmark for high-performance resilient data centre interconnects".

The development is a response to the rise of complex trillion-parameter Mixture of Experts (MoE) models and the scaling of AI workloads which have become increasingly constrained by bandwidth and radix (I/O port count) limitations in data centre infrastructure.

Lightmatter's Passage technology can deliver 800 Gbps bidirectional bandwidth (400 Gbps transmit and 400 Gbps receive) per single-mode fibre for distances of several hundred metres, advancing chip I/O design by simultaneously increasing both radix and bandwidth per fibre relative to current co-packaged optics solutions.

Commercial bidirectional transmission on a single fibre has so far generally been limited to two wavelengths, with achieving 16 wavelengths requiring multiple or specialised fibres. Standard single-mode fibre, while offering high bandwidth potential, does not inherently maintain the polarisation state of the light, unlike the more costly polarisation-maintaining fibre. Now, by achieving polarisation sensitivity, Lightmatter has been able to use single-mode fibre for its bidirectional DWDM technology.



The technology incorporates a proprietary closed-loop digital stabilisation system that actively compensates for thermal drift, ensuring continuous, low-error transmission over wide temperature fluctuations. Architectural innovations make the Passage 3D CPO platform inherently polarisation insensitive, ensuring robust performance even when the fibres are being handled or subject to mechanical stress.

The combination of fibre bandwidth density, efficient spectral utilisation and robust performance are seen as making Lightmatter's Passage technology foundational to the transition from electrical to optical interconnects in AI data centres.

Nicholas Harris, Founder and CEO of Lightmatter, states:

"Data centres are the new unit of compute in the AI era, with the next 1000x performance gain coming largely from ultra-fast photonic interconnects. One 16-lambda bidirectional link is an architectural leap forward. Hyperscalers can achieve significantly higher bandwidth density with standard single-mode fibre, reducing both capital expenditure and operational complexity, while enabling higher 'radix' - more connections per XPU or switch".

Reference: Tyler, N., New Electronics, 19th. August

Holograms set to transform Smart Devices

Researchers from the School of Physics and Astronomy at the University of St. Andrews have created a new optoelectronic device from the combined use of Holographic Metasurfaces (HMs) and Organic Light Emitting Diodes (OLEDs) with the potential to transform smart devices, communications, gaming and entertainment.

Until now, holograms have been created using lasers, but at St. Andrews researchers have found that OLEDs and HMs are able to provide a simpler and more compact method that is potentially both cheaper and easier to apply, enabling hologram technology to be much more widely deployed.

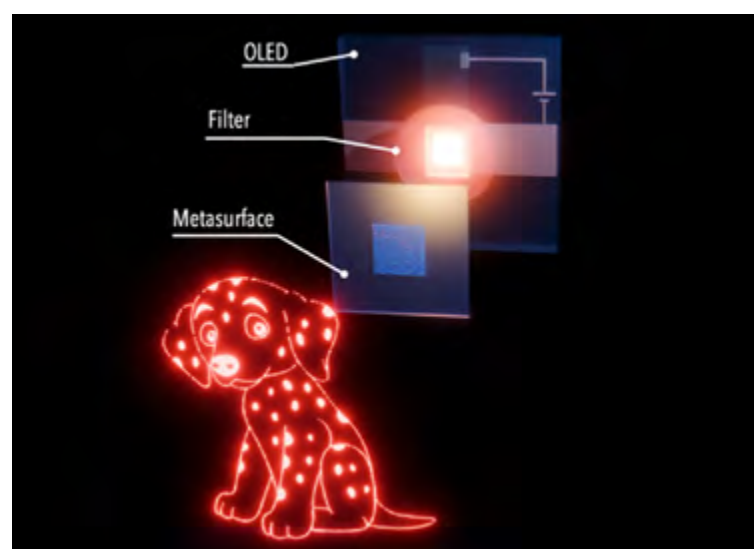
OLEDs are thin film devices that are widely used to produce the coloured pixels in mobile phone displays and some televisions. They are a flat, surface-emitting light source that can also be used in optical wireless communications, biophotonics and sensors, and are very useful in the design of miniaturised light-based platforms.

HMs are thin, flat arrays of tiny structures known as meta-atoms that are about a thousandth of the width of a strand of hair. They are designed to

manipulate the properties of light and can be used to produce holograms. They have applications in areas such as data storage, optical displays and high numerical aperture lenses such as those used in optical microscopy and sensing.

The researchers found that when each meta-atom is carefully shaped to control the properties of the beam of light that passes through it, it behaves as a pixel of the HM. When light passes through the HM, at each pixel, the properties of the light become slightly modified. This makes it possible to create a pre-designed image on the other side, utilising the principle of interference through which light waves create complex patterns when they interact.

So far scientists have only been able to make very simple shapes with OLEDs, limiting their usability, but with this advance miniaturised and highly integrated metasurface displays become possible.



Andrea Di Falco, Professor of Nano-photonics at the School of Physics and Astronomy, states:

"Holographic metasurfaces are one of the most versatile material platforms to control light. With this work we have removed one of the technological barriers that prevents the adoption of metamaterials in everyday applications. This breakthrough will enable a step change in the architecture of holographic displays for emerging applications, for example in virtual and augmented reality".

Professor Graham Turnbull, also of the School of Physics and Astronomy, adds:

"OLED displays normally need thousands of pixels to create a simple picture. This new approach allows a complete image to be projected from a single OLED pixel".

Reference: Wood, A., 'Breakthrough to bring Holograms closer to Everyday Use', Electronic Specifier, 27th. August

NEW AI TECHNIQUE ACCELERATES HEAT PROTECTION CALCULATIONS FOR FUSION VESSELS

A collaboration between Commonwealth Fusion Systems, the US Department of Energy's Princeton Plasma Physics Laboratory and Oak Ridge National Laboratory has created a new AI technique that speeds up calculations that are critical to protecting fusion vessels from the extreme heat generated by plasma.

The system, known as HEAT-ML, rapidly identifies 'magnetic shadows' within a fusion device, i.e. regions shielded from direct plasma heat. It is hoped that this will form the basis for future software that will accelerate the design of fusion systems and enable real-time decision making during operations.

In order to harness nuclear fusion, plasma has to be controlled at temperatures above that of the Sun's core, and it is a major challenge to predict how this heat will interact with the inner walls of the fusion vessel, known as a tokamak. Accurate and fast calculations of heat impact zones and protected regions are essential for the successful design and operation of such vessels.

HEAT-ML was developed to simulate a small section of SPARC, the tokamak currently being built by Commonwealth Fusion Systems in Massachusetts. This tokamak aims to produce more energy than it consumes, and requires a model showing precisely how plasma heat will affect the reactor's interior.

The team focused on a critical area of SPARC's exhaust system, namely fifteen tiles close to the bottom which are anticipated to experience the most intensive plasma heat load. In order to simulate the heat distribution, shadow masks, i.e. 3D maps showing where magnetic field lines shield components from direct plasma exposure, were created. These depend on the vessel's geometry and magnetic configuration.



EUROfusion, CC BY 4.0 <<https://creativecommons.org/licenses/by/4.0/>>, via Wikimedia Commons

Originally the open-source HEAT (Heat Flux Engineering Analysis Toolkit) handled these simulations, but the process was very computationally demanding with each HEAT simulation requiring half an hour or more for complex geometries. This was because it involved tracing magnetic field lines and calculating their intersections with intricate 3D surfaces.

HEAT-ML removes this bottleneck by using a deep neural network trained on around 1,000 HEAT-generated SPARC simulations. The AI learned to predict shadow masks within milliseconds, representing a dramatic improvement that now enables rapid exploration of design options.

Reference: Hookway, P., 'AI accelerates Heat Protection Calculations for Fusion Vessels', Electronic Specifier, 20th. October

WORLD'S FIRST AI-GENERATED POLITICIAN

The Institution of Electronics is naturally keen to promote the weird, wonderful, bizarre and unusual happenings in the world of electronics and this final article surely fits the bill.

The Government of Albania has reportedly appointed the world's first AI-made, that is to say not human, politician. It forms part of Prime Minister Edi Rama's vision of using AI as 'an effective anti-corruption tool' at his Socialist Party's assembly in Tirana where he informed ministers who would stay and who would go.

The new AI-generated minister, named Diella, which means 'sun' in Albanian, will be responsible for public procurement, that is to say making decisions on tenders. The result will be that responsibility for those tenders will now be taken out of the hands of existing ministries.

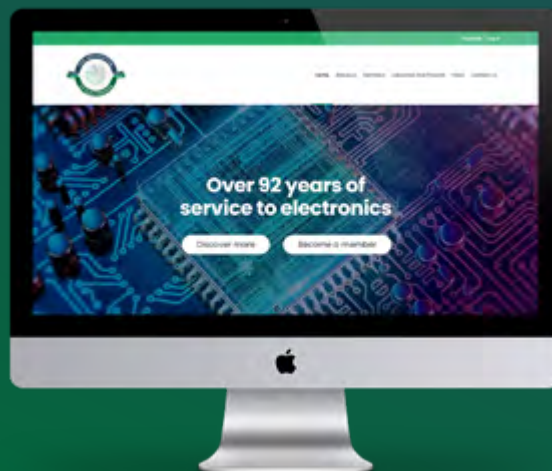
It is envisaged that Diella will not be corruptible and instead will be able to examine every tender in which the government makes contracts with private companies, and objectively assess each one. The move represents a countermeasure to the country's high level of corruption in which gangs seek to launder money from drugs and weapons trafficking under the guise of public tenders.

Reference: Gittins, C., 'Albania introduces First AI-made Minister', Electronic Specifier, 16th. September

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FROM THE ARCHIVES

Recent Electronic Developments in Card Accounting Machinery

by G. AITKEN*, A.M.Inst.E.

(A lecture delivered to our Northern Ireland members).

A general explanation of the operation of the curd accounting machines known as (1) the Horizontal Sorter, (2) the Wire Interpreter and (3) the Electronic Multiplier.

THE HORIZONTAL SORTER

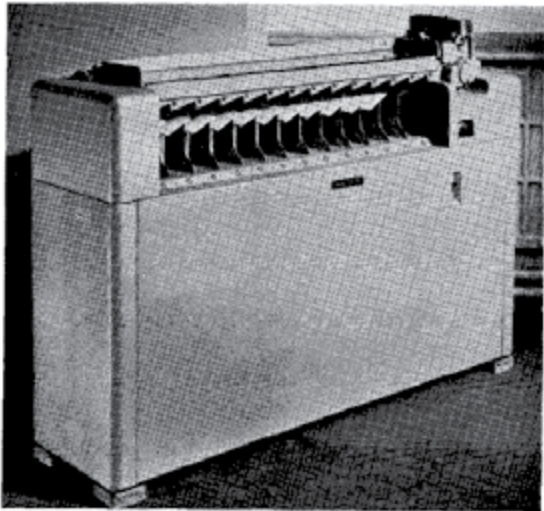


Fig. 1. The Horizontal Sorter.

This is often referred to as the basic machine of Hollerith, after Dr. Herman Hollerith who invented the system of punched card accounting, and as its name implies is used to either arrange cards in numerical order, thus sorting, or to locate a particular card from a pack. The speed of operation is 600 cards per minute.

On referring to the Hollerith card, Fig. 2, it is noted that it is numbered 0 to 9 reading from the top down and that, as well as these ten positions there are also, above the 0, two further digit positions which can be either X or Y, ten and eleven when dealing with pence, or eleven and twelve when dealing with months (in this instance the 0 position becomes ten). This gives in all twelve positions in which it would be possible to have a punched hole in the card.

in Fig. 1, that there is a total of thirteen positions. The extra position is for cards not punched in the particular column being read and these cards are termed rejects.

WAGES OR JOB CARD

YEAR	MONTH	DAY	CLASS	OF CARD	CLOCK NO.	DEPT. NO.	WORKS ORDER NO.	SHOP NO.	JOB NO.	PART NO.	NOM. A/C.	GROUP NO.	REC. NO.	OPEN NO.	QUANTITY SCRAP	REC. HOURS	QUANTITY GOOD	RATE	TOTAL EARNINGS	BONUS EARNINGS																			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	

"HOLLERITH" 4-85

THE BARK TABBING MACHINE CO., LTD., 11, PARK LANE, LONDON, W.1.

PRINTED IN ENGLAND PC4

Fig. 2. A Hollerith Card.

*The British Tabulating Machine Co. Ltd.

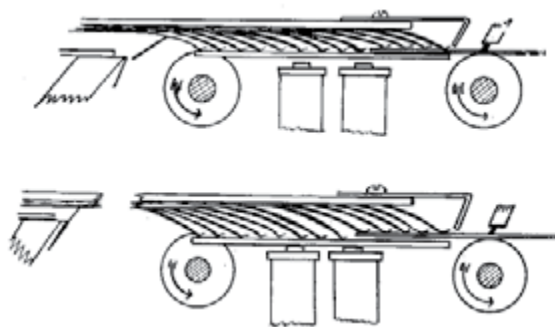


Fig. 3. Feed Mechanism of Sorter showing card entering and card "read."

Fig. 3 shows, as it were, the very heart of the machine. This is the sensing mechanism and it operates as follows:—

Assume first of all that the particular card passing through the machine is not punched, the sensing brush will not therefore complete a circuit and the card will pass under each chute blade until finally it enters the first or reject pocket.

Now let us take the case of a card punched with a figure four. As the card passes under the sensing brush, commencing at Y and continuing via X, 0, 1, 2 and 3 to four it is at the same time passing under the Y, X, 0, 1, 2 and 3 chute blades. When the brush senses the hole in the card this energises the electro-magnet. This then causes the remaining chute blades to fall down and the card must therefore travel over the four chute blades and thus into the four pocket.

It should be mentioned that this action is for one column of the card only, and will be noticed that there is a total of 80 columns. This is the arrangement for the standard machine, but machines have been arranged to choose a card punched with an eight digit figure in a single run.

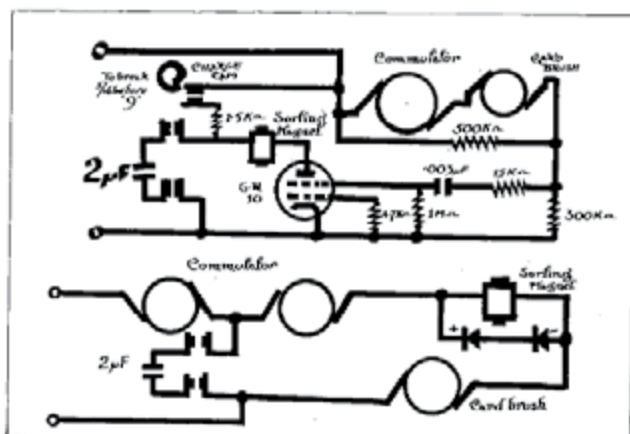


Fig. 4. Wiring Diagram of the Sorter.

Fig. 4 shows the wiring diagram for the first machines at 600 c.p.m. and, on machines built using this, trouble was experienced due to arcing at the sensing brush, and

this of course could not be tolerated in a machine which is expected to run continuously throughout the working day. It was therefore decided to fit a thyratron in the circuit.

The hole in the card is sensed at the card brush, and causes a positive potential to be applied to the grid, the valve now fires and discharges the 2 μ F condenser through the sorting magnet via the closed relay points, the valve extinguishes when the condenser discharges. The condenser is then recharged, before the next hole is read, by means of the Condenser Charge Cam.

This arrangement has proved entirely satisfactory and far exceeds the present requirements in that it can safely operate at 1,000 c.p.m.

At the moment the machine is being mechanically re-designed to enable it to operate at this speed and indeed we may be fast approaching the point when the machine may operate too fast. This can occur because the cards must be joggled, i.e. arranged evenly before being placed in the hopper, and if a machine was to operate at a speed much in excess of 1,000 c.p.m. it is feasible that it would empty the hopper before a new lot of cards could be put in.

THE WIRE INTERPRETER

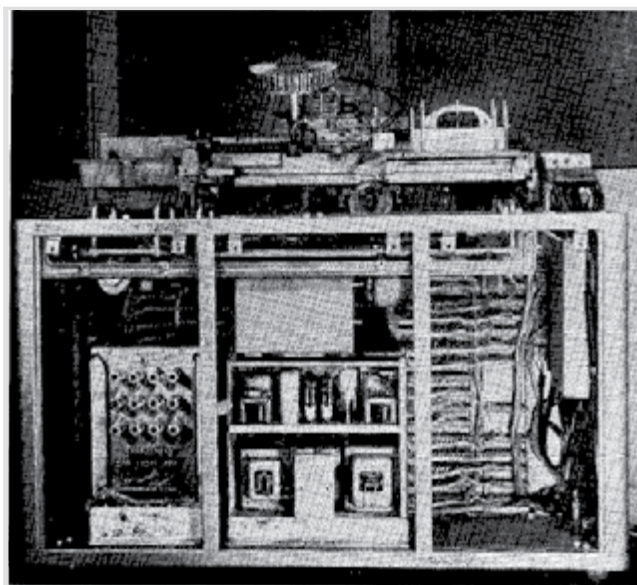


Fig. 5. Front view of the Wire Interpreter.

The Wire Interpreter interprets the punched holes in a card and prints this information along the top, thus rendering the coded information immediately available for filing and other purposes.

Referring to the Hollerith card it will be noted that the machine interprets alphabetical as well as numeric information. In each column the numerals are represented by one punched hole, whilst the alphabetical requires two punched holes, according to a predetermined code.

Fig. 5 shows the general layout of the machine with the card hopper (for new cards) to the right. The raised

portion in the centre contains the printing mechanism, from which the cards are ejected into a container at the left of the machine.

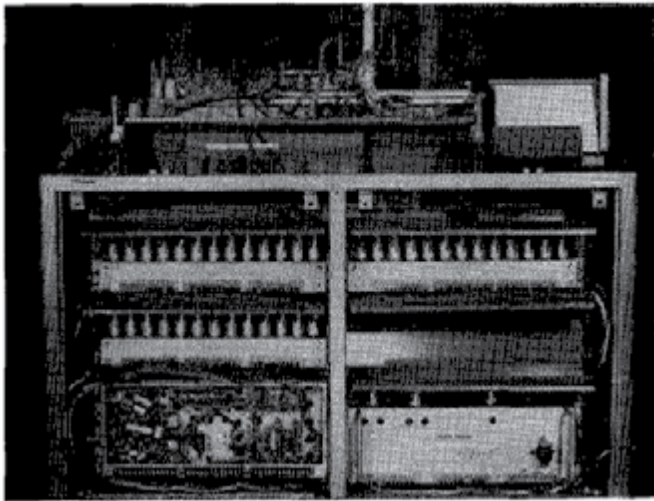


Fig. 6. Rear view of Wire Interpreter.

The card is fed into the machine face upwards and the punched holes are sensed by twelve brushes placed in the base of the machine. The brushes are connected to earth and when a hole is sensed this connects the grid of the associated Card Read thyatron to "earth" and causes it to fire; the grids are normally held at 100V negative.

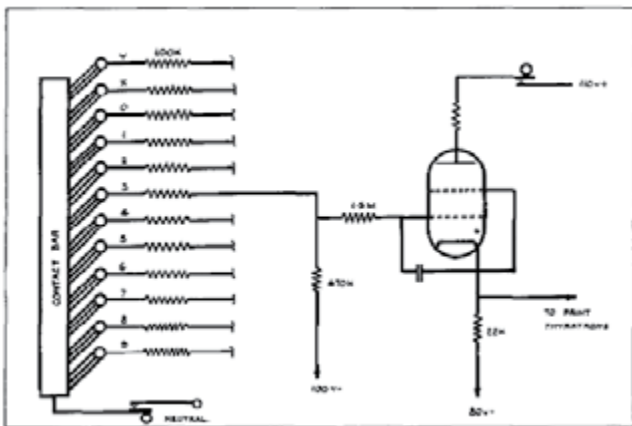


Fig. 7. Card Read Thyatrons.

These thyatrons are used as cathode-followers and their outputs (negative going positive) are taken to the grids of sign inverters and the character control thyatrons.

There are 40 character control valves, the outputs from which print the 26 letters of the alphabet, the figures 1 to 12 representing months and, in addition, two further valves for pence, i.e. 10d. and 11d.

If we take for example the figure three it will be found to appear in the following combinations:—

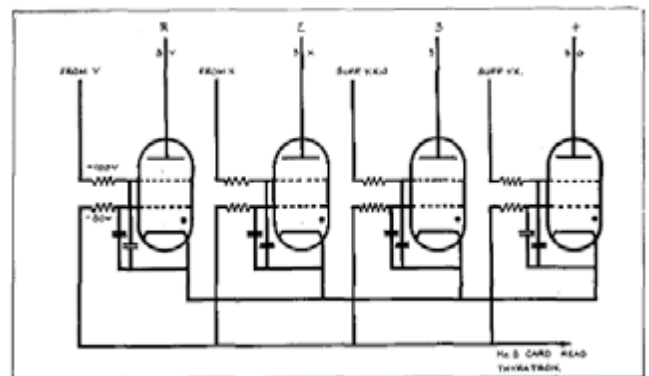


Fig. 8. Printing Thyatrons.

Holes Punched in Card	Printing
3	3
3 & X	E
3 & Y	R
3 & O	+

the character control thyatrons will therefore require to be specially conditioned. The two grids of the valves (2D21s) are used, one of these, of each of the 3, E, R and + thyatrons, is connected directly to the output of the Card Read Thyatron which, it may be remembered, will cause the grid to go positive when a 3 is sensed at the card reading brush. The other grids of the valves are under the control of sign inverters. It should of course be remembered that both grids of the valve must be at a positive potential before it will fire.

Consider a card punched with a 3 only, we must then suppress everything else except the 3 and this is achieved as follows:—

The 2nd grid of the E valve is connected to the X Card Read Output.

The 2nd grid of the R valve is connected to the Y Card Read Output.

Thus neither of these valves will fire since the 2nd grid will always be maintained at 100V negative.

The 2nd grid of the + valve is maintained at 80V negative and is connected to the output of a cathode follower which is only fired when a 0 is sensed at the card brushes.

The 2nd grid of the 3 valve is connected to a sign inverter and held at a positive potential, but the inverter will cause this to go negative if either an X, Y or an 0 is sensed.

We now have the condition that one of the grids of the R, E and + valves is held negative, thus suppressing these thyatrons, whilst both grids of the 3 valve are positive and it will therefore fire. The output of this valve is connected via rectifiers to the appropriate magnets of the print mechanism thus causing it to print the figure 3.

A close examination of the Hollerith Card will reveal that the letters and figures printed along the top are composed of dots arranged in the correct order. This is achieved by means of 35 wires arranged in 5 rows of seven and connected at one end to a print magnet armature.

When a print magnet is energised its armature depresses the marking wire on to a typewriter ribbon causing its cross section to make an impression on the card. A predetermined pattern can therefore be printed on the card, above any column, by operating simultaneously a particular combination of magnets.



Fig. 9. Print Head and Base

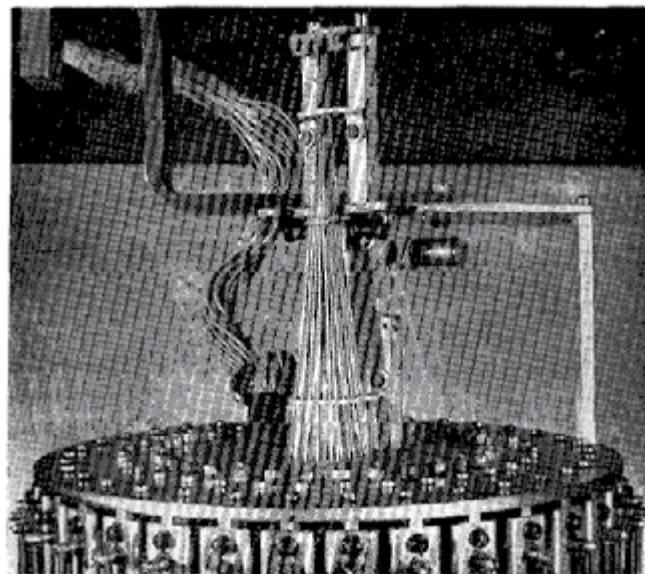


Fig. 11. The Print Head Wires.

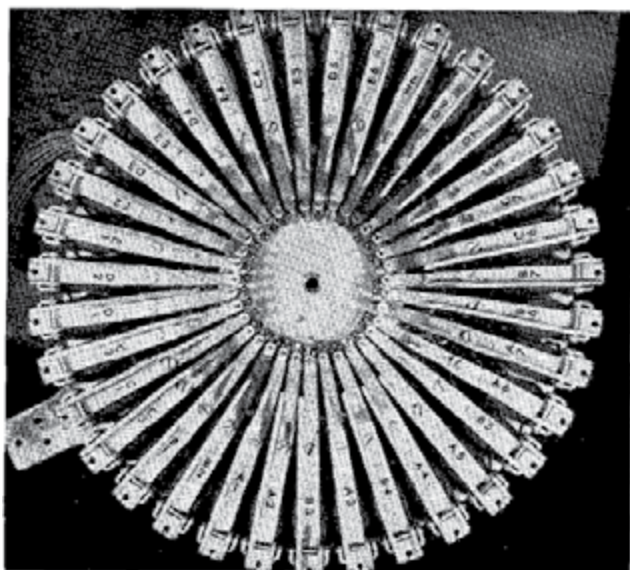


Fig. 10. A "close up" of the Print Head.

It may be of interest to note here, that by means of the control panel fitted to the machine, any letter or figure can be programme printed, without punching on the card, and that if the card does happen to be punched in a particular column the programme printing will suppress it.

A word is now due about the method of feeding the card through the machine. The card is taken from the bottom of the pack by a feed knife driven by an electric motor and then collected by a mechanism which, under the action of a spring, takes the card through the remainder of the machine, but is restrained by a latch type mechanism catching on a toothed rack. Therefore to cause the card to move the latch is lifted out of

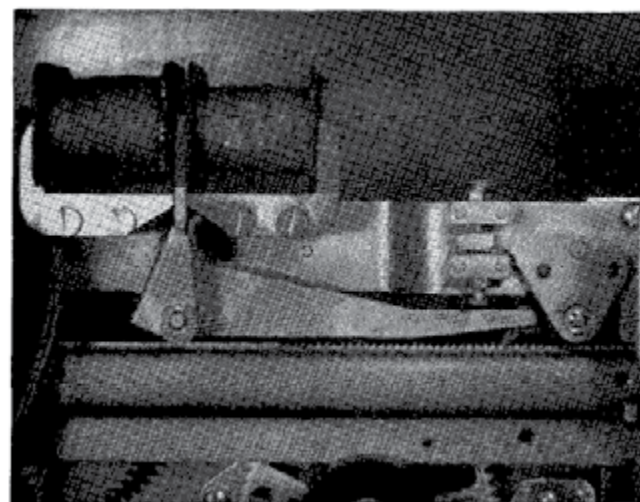


Fig. 12. The "Dog In" "Dog Out" Magnets,

the rack, and to stop the card the latch is returned. This latch is controlled by two electro magnets, one to cause it to lift out and the other to return it. The magnets are in turn controlled by two thyatron.

The first thyatron is fired via a cam-operated contact and relay point. The relay point indicates to the machine that the card is in the correct position for printing on the first column. When this valve fires it energises the latch-out magnet and after a delay of 5 milliseconds (due to the inertia of the moving parts) the rack begins to move. The action of the first valve firing causes the second valve to fire, and this valve operates the latch-in magnet but the latch will not be pulled in until the first valve has been extinguished. A condenser is connected across the anodes of the valves which, when the second valve fires, causes a reverse polarity to be connected across the first thyatron and

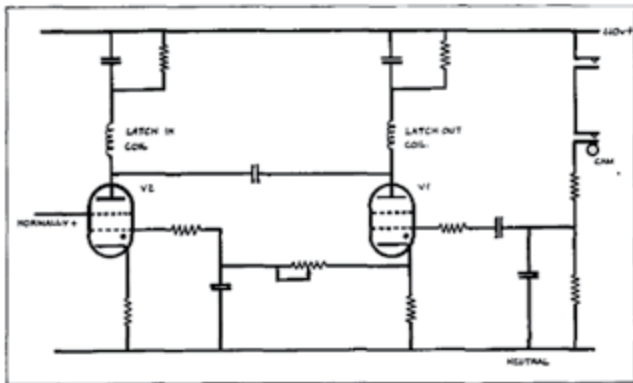


Fig. 13. Card Movement Control.

thus extinguishes it. When the previously mentioned cam again makes contact the first valve will again fire and the second will be extinguished by the condenser and this procedure continues until the end of the card when all 80 columns will have been interpreted.

It is interesting to note that the printing takes place during the 5 millisecond delay before rack movement.

When the card is not punched in certain columns the machine can be made to skip these quickly by plugging the control panel.

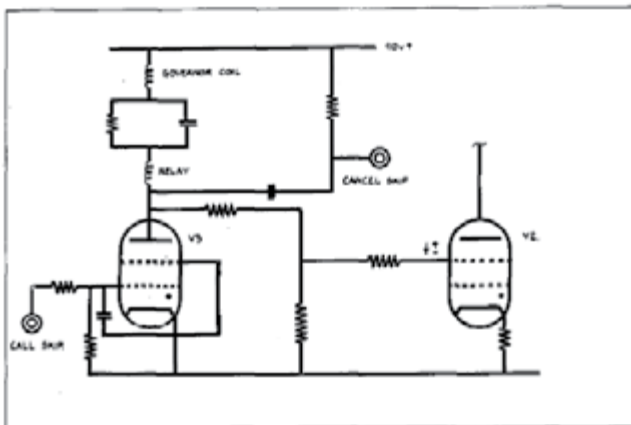


Fig. 14. The Skip Control.

The skipping is arranged by means of the thyatron V3. The 2nd grid of V2 is normally held at +30V, thus allowing it to conduct when its control grid is made positive. But the 2nd grid of V2 is connected to the anode of V3 and when this valve fires its anode voltage drops from 110V to approximately 10V, thus causing the potential at the grid of V2 to go negative and preventing it from conducting. This means that the latch is unable to mesh with the rack and the rack therefore travels out carrying the card with it.

The machine can be made to stop skipping by connecting the anode of V3 to earth through a condenser and the discharge from this condenser causes V3 to extinguish; this can be carried out from control panel plugging.

Before the machine was converted to electronic operation its speed was 10 cards per minute. This has now been increased to 20 cards per minute. A number of other advantages are also obtained but time does not permit a full explanation.

This concludes the description of this machine and, although not by any means complete, gives an idea of its capabilities.

THE ELECTRONIC MULTIPLIER

Now in the two machines already described the influence of electronics on the first was not to increase its speed but to improve its operation, whilst in the case of the interpreter electronics has doubled its speed, in addition to improving its operation. It will be noted that both machines have remained basically the same, the only alteration made to the interpreter was to replace high speed relays with thyatrons. But when we come to consider electronic calculators, and to compare them with their electro-mechanical counterparts, the increase in speed is almost unbelievable.

Take, for example, the speed of the relay operated multiplier, dealing with sterling amounts. This machine could deal with 700 cards per hour, for an 8 digit multiplier giving a 16 digit product, but the electronic multiplier can deal with 6,000 cards per hour for a 9 digit multiplier and a 14 digit multiplicand giving a 23 digit product.

It should be stressed here that the speed given for the electro-mechanical multiplier is the minimum speed, and that it could, of course, be increased if the number of digits in the multiplier or multiplicand were reduced. The speed for the electronic multiplier is constant, irrespective of the job in hand.

In order to achieve this increase in speed, it was necessary to use another system of notation. The idea of using the normal 0 to 9 as used in conventional arithmetic, as on electro-mechanical multipliers, has been dropped and in its place the Binary system is used.

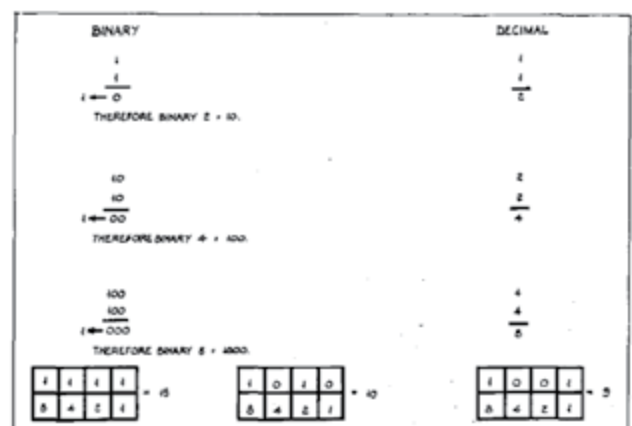


Fig. 15. Description of Binary "Introduction."

Before beginning a description of the principles and operation of the electronic multiplier, an explanation of the Binary system of notation, which bears a relation-

ship to these principles, will help to produce a better understanding of the functioning of the machine.

Binary notation is the notation of numbers in the scale of two, the carry, or point at which the same symbols are used over again, occurs after the tenth in decimals but after the second symbol in Binary.

If the figures $1 + 1$ are added in Binary, it will not give the answer 2 as a decimal, but 0 and carry 1, which would be written as 10. We thus see that whilst 1 represents 1, 10 represents 2.

Similarly, if $10 + 10$ are added in Binary, the answer will be 100, and this therefore represents the figure 4. Thus, each digit is twice as great as the one on its right.

Consider the Binary figure 1111, this then represents in order reading from the left the figures 8, 4, 2, 1 and, to find its equivalent in decimal, these figures are added giving 15.

Thus:—

$$\begin{array}{rcccc} 1 & 0 & 1 & 0 & \\ 8 & - & 2 & - & = 10 \\ 1 & 0 & 0 & 1 & \\ 8 & - & - & 1 & = 9 \end{array}$$

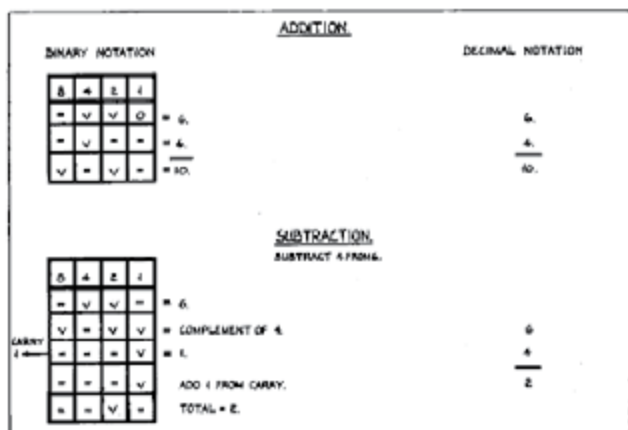


Fig. 16. Addition and Subtraction in Binary.

Addition

This is quite straight forward, simply add 1 to 1 and carry.

Subtraction

This may at first appear to be more difficult, but instead of subtracting, the machines find the complement of the subtrahend and add it. To find the complement of a figure in Binary simply means to subtract it from 15—thus the complement of 6 would be 9 and the complement of 4 would be 11.

Multiplication

The method by which multiplication is performed is that known as "Halving and Doubling," the multiplier is repeatedly halved until it reaches zero, while simultaneously the multiplicand is doubled. The multiplic-

and is automatically transferred to the product register each time the multiplier becomes an odd number.

MULTIPLICATION		
MULTIPlicAND (DOUBLED)	MULTIPLIER (HALVED)	PRODUCT ACCUMULATED
56.	23 ODD 1. TRANSFER.	56.
112.	11 " " "	168.
224.	5 " " "	392.
448.	2 EVEN 0. NO TRANSFER.	392.
896.	1 ODD 1. TRANSFER.	1288.
1792.	0 ZERO 0. NO TRANSFER.	1288 TOTAL.

Fig. 17. Multiplication of 56 by 23.

Consider an example:— $56 \times 23 = 1288$.

Multiplicand (doubled)	Multiplier (halved)	Product accumulated
56	23 since odd transfer	56
112	11 since odd transfer	168
224	5 since odd transfer	392
448	2 since even no transfer	392
896	1 since odd transfer	1288
1792	0 zero no transfer	1288
		Total

After each halving operation the remainders are dropped.

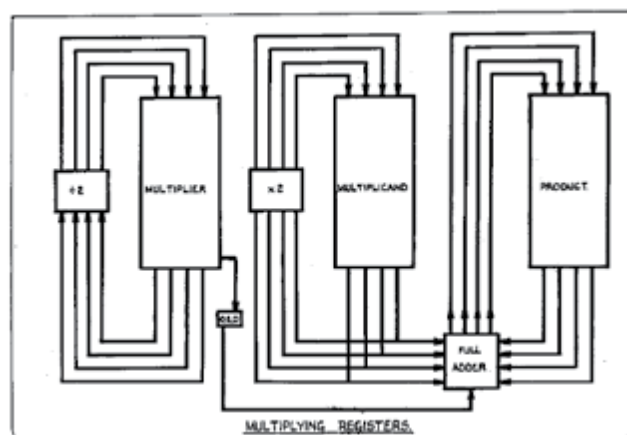


Fig. 18. The Five Main Components for Multiplication.

This shows the five main components necessary for multiplication:—

- (1) The Multiplier Register—this holds the figure to be halved.
- (2) The Multiplicand Register—this holds the figure to be doubled.
- (3) The Product Register—this accumulates the amounts it receives from the multiplicand register.
- (4) The Adder—this adds the amounts in the multiplicand to the product.
- (5) The Odd-Even Detector (OED)—this allows a transfer from the multiplicand to the product only when the multiplier is an odd number.

Doubling

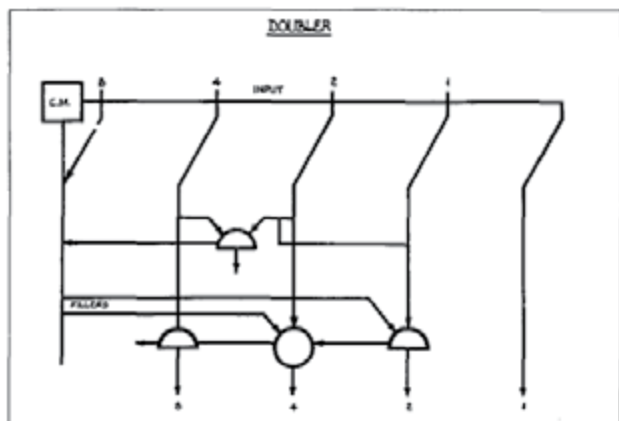


Fig. 19. Schematic arrangement for Doubling.

All that is required to double a number is to shift it one place to the left, the feed back loops of the multiplicand register are connected so that when doubling, the "1" feeds back to the "2," the "2" feeds back to the "4," the "4" to the "8," and the "8" to the Carry Memory buss bar. The 4, 2 and 1 lines are connected via the half adder to the C.M., since a combination of 4 and any other figure when doubled will require this circuit.

We have chosen the example No. 936 as this entails the use of the Carry Memory.

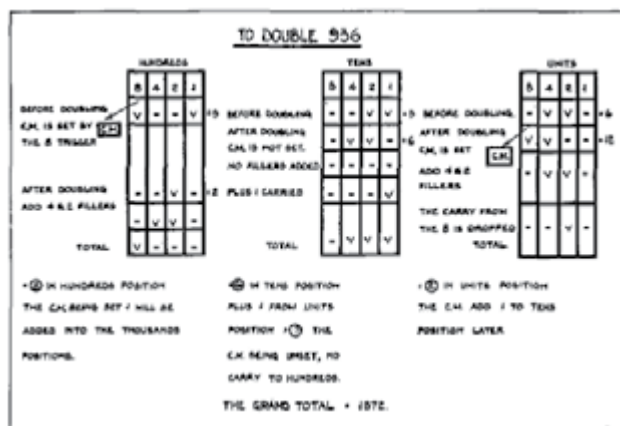


Fig. 20. Example of Doubling the number 936.

Halving

To halve the number in the multiplier register each Binary expressed denomination is shifted one position to the right, but as no decimal digit after halving can exceed 9, there will be no carry up the register, and therefore the "ten" detector and rationalising circuits are not needed. One bank of adders is necessary, however, because when a register position (other than the units position) holds a digit that is an odd number, a 5

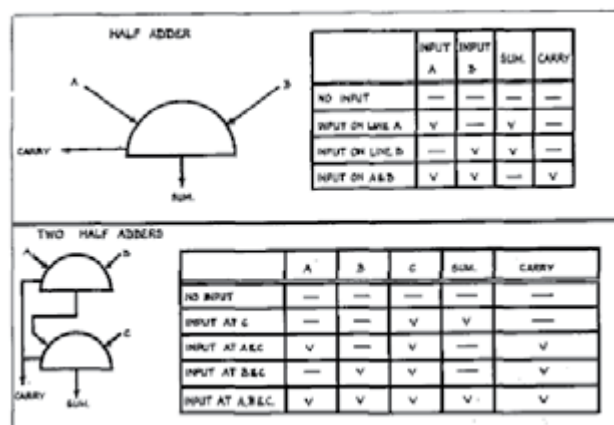


Fig. 21. Schematic arrangement of Halving and Numerical Example.

must be added into the register position below. This can best be shown by the example:—

$$50 \div 2 = 25.$$

Arrangement of Machine

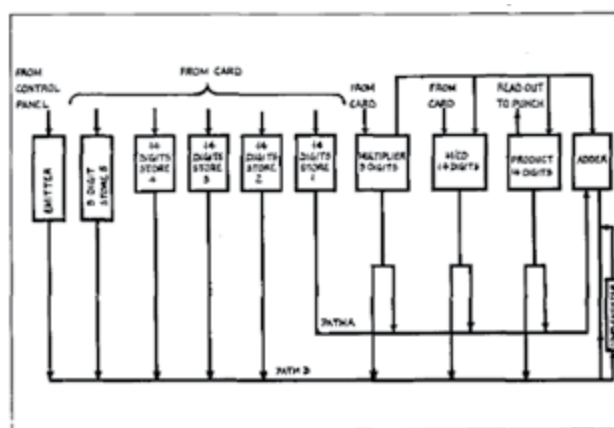


Fig. 22. Basic arrangement of Arithmetic Unit.

This shows the five stores, the three registers, the adder, the complementer and the emitter. The emitter can be used to insert a figure into any of the registers which would be common to a series of cards.

It will be noticed that there are two paths, A and B — this enables the machine to add together the quantities held in stores 2, 3, 4 and 5 to store 1, thus enabling the calculation of the type $(A + B) \times C$ to be carried out as it were in one run. The stores, with the exception of No. 1, can pass through the complementer.

Shifting Registers

One of the fundamentals of valve registers is that of being able to transfer (or shift) the digit in one position to the next position, and so on through all the stages of the register. The shifting registers are composed of a series of inter-connected triggers, one series for each register position.

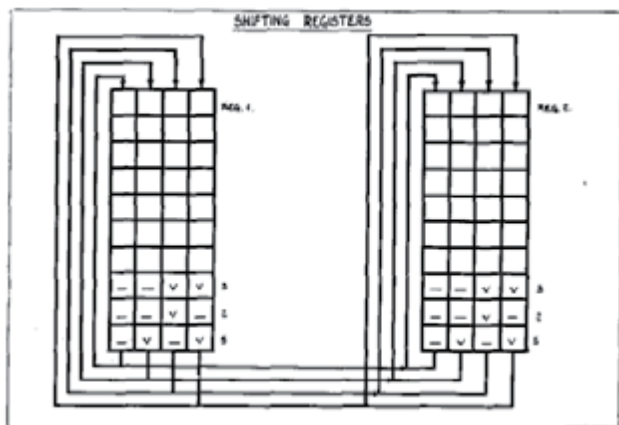


Fig. 23. Shifting Register Layout showing simple explanation of Shift.

The Multiplier, Multiplicand and Product Registers each possess this shifting quality, so that when a pulse is applied to all their triggers simultaneously, the pattern changes by being shifted at each pulse. If we consider the register shown, each square represents a trigger, the slide shows a capacity of eight digits, whereas on the machine it may be 9 or 14, it is assumed that the register holds the figure 325.

A single pulse applied to all the triggers simultaneously will result in the pattern shown on the centre register, and the number would now read 32. If, however, four connections were made from the bottom to the top of the register as shown, the units figure 5 would not have been lost, but would have been fed back into the top of the register. Thus, if the same number of pulses are applied as there are register positions, the figure 325 would move right round and return to its original position.

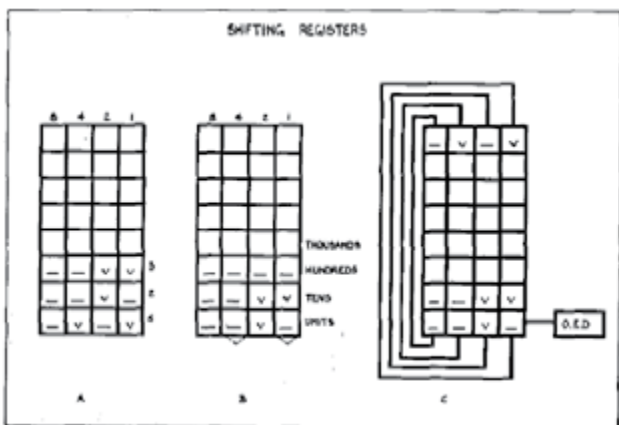


Fig. 24. Shifting Register Layout showing how figure can be retained.

To transfer a number from one register to another, all that needs to be done is to inter-connect the loops of both registers. Now, if both registers are pulsed ten times the number standing in register 1 (325) will be transferred to register 2 and still retained in register 1.

If the two registers are pulsed again ten times the number 325 will simply circulate round both of them, and therefore a device is needed to enable one number to be added to another. this device is called an "Adder."

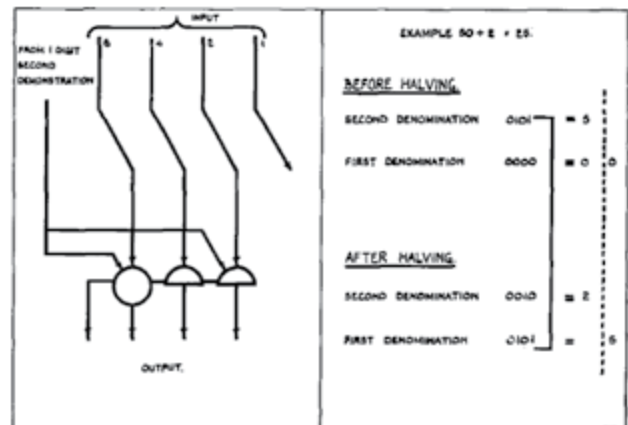


Fig. 25. Schematic arrangement of Half Adder and Full Adder

The adder comprises two elements called half-adders. It will be seen from the table that with no input to A or B, there will be no sum or carry, whereas an input on line A only will give a sum and no carry. Similarly, with an input on line B only. With an input on line A and B, there will be no sum, but there will be a carry.

Whilst a half-adder can deal with A and B, if two half-adders are connected together to give a complete adder, this will then deal with A + B + C. Reference to the table will show the output for all variations.

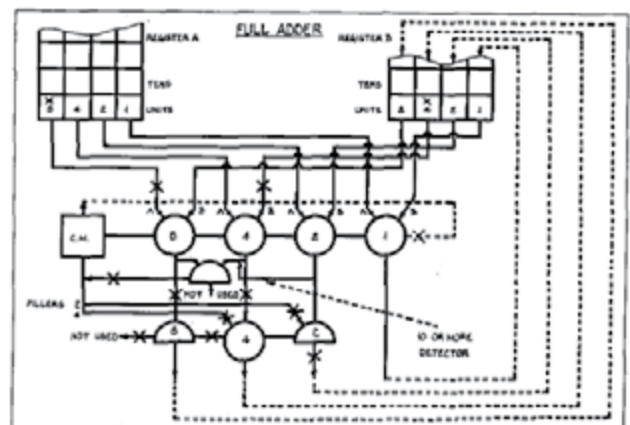


Fig. 26. Adder—Tadd Fig. in Reg. A to Fig. in Reg. B.

It will be seen that the method of connecting the full adders is to add the contents of register A to register B.

The A and B inputs to the four half-adders first receive the digits from the units position of the registers, sum them, and set a Carry if the sum exceeds 10. This carry is held in a Carry Memory which is shown in the diagram as the Box marked C.M.

The memory stores the carry from the position of the adding register to the next position—a grand carry which requires a time delay as against an incident carry that requires no delay.

The 10 or more detector is a half-adder connected to the 8, 4 and 2 sum lines, so that whenever the digits received at the A and B inputs contain an 8 and 2, an 8 and 4, or an 8, 4 and 2 (all of these combinations being ten or more), the carry buss bar is stimulated and this will set the Carry Memory.

It should be remembered here that the number in the register will not exceed nine, the units 8, 4, 2, 1 are arranged to give any figure between 0 and 9.

When a carry of 1 has been obtained it will be held until later when it will be added back into the 1 adder—the dotted line from the box C.M. The carry has a value of ten by stipulation, but it is known to have been stipulated by any number greater than ten, the exact value of which is not known. Therefore a means must be provided for adding back to the existing digit that unknown amount by which the carry exceeds 10.

This is achieved by inserting another bank of adders in the 8, 4 and 2 sum lines and whenever the carry buss bar is energised a 4 and 2 filler are entered into these adders which causes an addition of 6 to the total of the sum lines.

An example would demonstrate more clearly what takes place. Referring to the lines marked with an X in Fig. 26:—

Take $8 + 4 = 12$.

This sets the 8 + 4 adders which give out a sum on each line, these sums set the C.M. which gives out the 4 and 2 fillers—thus reading from the right, we have 2 followed by in the 4 position a sum on both inputs which creates a carry to the 8 position leaving zero at 4. The 8 position will therefore have two inputs which will create a carry which is not used and leaving a zero at 8.

The adders will therefore give out the figure 2 at the units position, but because the C.M. was set a 1 carry will be given out at the tens position—thus giving the correct answer of 12.

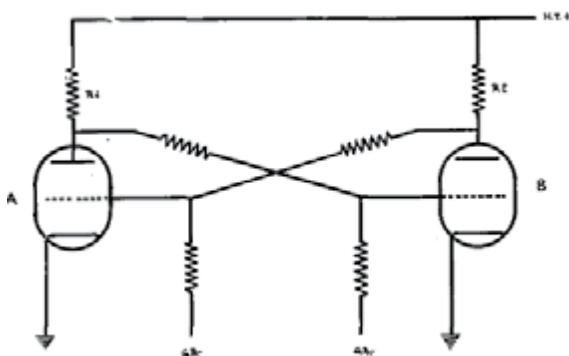


Fig. 27. The Eccles-Jordan Trigger.

This shows the well-known Eccles-Jordan Trigger,

quite often referred to as a flip-flop. This consists of two similar valves supplied with h.t. from a common source through anode resistors of the same value, and with the grid of one valve connected to the anode of the other. Negative bias is applied to the grids.

Such an arrangement has two stable states—if valve A is conducting, valve B is not, and vice versa.

When valve A is conducting its anode potential will be low, the grid of valve B will also be low, thus preventing it from conducting; its anode will therefore be at a high voltage and because of its cross connection to the grid of valve A this will tend to cause valve A to pass more current.

Consider now a negative pulse applied to both grids. As the grid of B is already negative, the pulse will have no direct effect on it, but the effect of making the grid of A negative will result in A reducing current flow, with a consequent rise in its anode voltage. This will cause a swing in the other direction, the grid of B will become positive because it is connected to the anode of A.

A will now be in the state that B was previously and will be cut off.

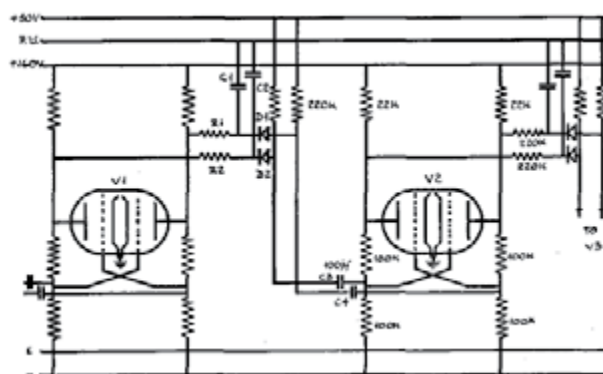


Fig. 28. The Shifting Register.

We shall now look at the circuit of the shifting register, and the slide shows two positions where V1, a double triode valve, represents one Eccles-Jordan Trigger, and was represented on the previous shifting register by one square. This then can hold one digit, representing either an 8, 4, 2 or 1, depending on its position in the register, and whether or not the trigger is set.

For the purpose of explanation, let us assume that V1 is set, i.e. it holds a digit. This then means that the right-hand portion of the valve is conducting and this of course prevents the left-hand side from conducting. With the trigger in this state, the right-hand anode of V1 will be at a low potential, whilst the left hand is at a high potential. Therefore, the left-hand side of the diodes D1 and D2 will also be respectively at a low and high potential. The actual values will be D2 at 135 volts and D1 at approximately 50 volts +.

Now bearing in mind that it is desired that V2 will assume the state of V1, and that we shall consider at the

Referring to the three lines at the top of the diagram, the upper is held at 50 volts + and the lower at 160 volts +. The centre line is the one along which the negative shifting pulses arrive. Therefore, when a negative pulse is applied to the condensers C1 and C2, it will not affect the diode D2, as this is biased off by the 135 volts positive potential, but the diode D1 is in the condition where it is ready to conduct as both ends are at 50 volts. Thus, a negative pulse will be reflected on the right-hand side of this diode and will be applied to the condenser C4, and on to the grid of the left-hand anode of V2. This negative pulse will tend to reduce the conduction of V2 and its anode potential will therefore rise and the potential of the point between the two 100k resistors will also rise. The right-hand grid of V2 will therefore go high, thus causing it to conduct slightly, and its anode will then go low as will the point between the two right-hand 100k resistors. The left-hand grid will therefore lower and so on. It will therefore be seen that the effect is cumulative and that the trigger V2 will assume the state of V1, in that its right-hand anode will be conducting, and the left-hand one cut off.

The circuit diagram shows a power supply with the following components and connections:

- Input:** Labeled "D = HIGH" and "I = LOW". It includes a 150V source and a 100V source.
- Rectification:** A full-wave bridge rectifier is used to convert the AC input into DC.
- Filtering:** A 500k resistor is connected in series with the rectifier output. This is followed by a 470uF electrolytic capacitor connected to ground, which acts as a filter.
- Regulation:** A 400k resistor is connected between the output of the filter capacitor and the base of a transistor (likely a 562V transistor). A 10k resistor is connected between the base and the emitter of the transistor.
- Output:** The output of the transistor is connected to a 500k resistor, which is then connected to the output terminal. The output is also connected to a 500k resistor to ground.
- Grounding:** The negative terminal of the 470uF capacitor and the emitter of the transistor are connected to a common ground.
- Labels:** The output is labeled "D = LOW" and "I = HIGH". The output terminal is labeled "CARRY" and "SOL".

Finally, I should like to explain the operation of the Half-adder. It should be remembered that the purpose of this device is to give a Sum output for an input of 1 digit, with no carry, and also to give, for two digits, a Carry output but no sum. Referring then, to the dia-

Let us assume then that we wish to add a digit on the A line to a zero on the B line. The adder should then give out a sum, but no carry. This means that a negative pulse is applied to the A line, which will cause the upper left-hand diode to conduct, thus the negative pulse will appear at the right-hand grid of the valve and prevent it from conducting, and the anode will therefore go high. Now at the same time, a positive pulse is applied to the B line and the lower right diode will therefore conduct and give a positive pulse to the left-hand grid, causing this anode to conduct and its potential will therefore go low. The negative potential is now transmitted to the grid of the single valve, preventing it from conducting and allowing its anode to remain at a high potential. We therefore have, on the output lines, a low on the carry which represents zero, and a high on the sum which indicates a digit.

The electronic multiplier just described was the first to be built by our Company, and does not include any division circuits, but since then two improved versions have been designed, the second of which is just going into production. This machine incorporates a high speed rotating drum storage device which replaces the capacitor stores on the earlier machines. In addition to these, an Electronic Computer is also manufactured, but of course a lecture of this type could not hope to cover all the electronic machines built by Hollerith.

In giving a description of the Multiplier, I have only chosen a few basic circuits, but we can look forward to future lectures which will cover the ground more fully.

VOLUNTEER OPPORTUNITY

Community Radio ... fun, yes, but also a learning experience. Flame CCR is a training centre, approved and supported by the Institution of Electronics. But what is the training gain? As well as the enjoyment of playing music, and playing with computers and technology, people also learn TO TALK.

Sitting in front of a microphone, only being able to imagine a listener or two, with music providing a timescale, focuses the mind in a challenging way. What to say, how to say it, on cue is surprisingly difficult. Developing a patter with other people is a challenge – it is said that “good radio is a conversation between two people overheard on a bus”. Presenters have to get used to the sound of their own voice, learn how to speak clearly in a flowing manner, and how to engage in conversation with other people – in an ordered manner not talking over each other (reading body language).

Based on our experience in bringing many new voices to air, we believe that radio does offer a training gain, to all ages. And in addition to being live, radio can also be recorded and professionally produced, and repeatable as podcasts. Give it a try there are hundreds of community radio stations across the UK looking for volunteers.

Contact us at flameccr@gmail.com and find out all about Flame, listen to us or delve through our podcasts on flameradio.org.

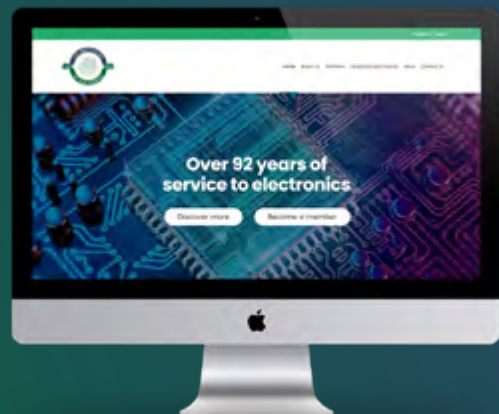


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They even have a handy reminder. Here are simple step-by-step instructions on how to download the easyfundraising Donation Reminder:



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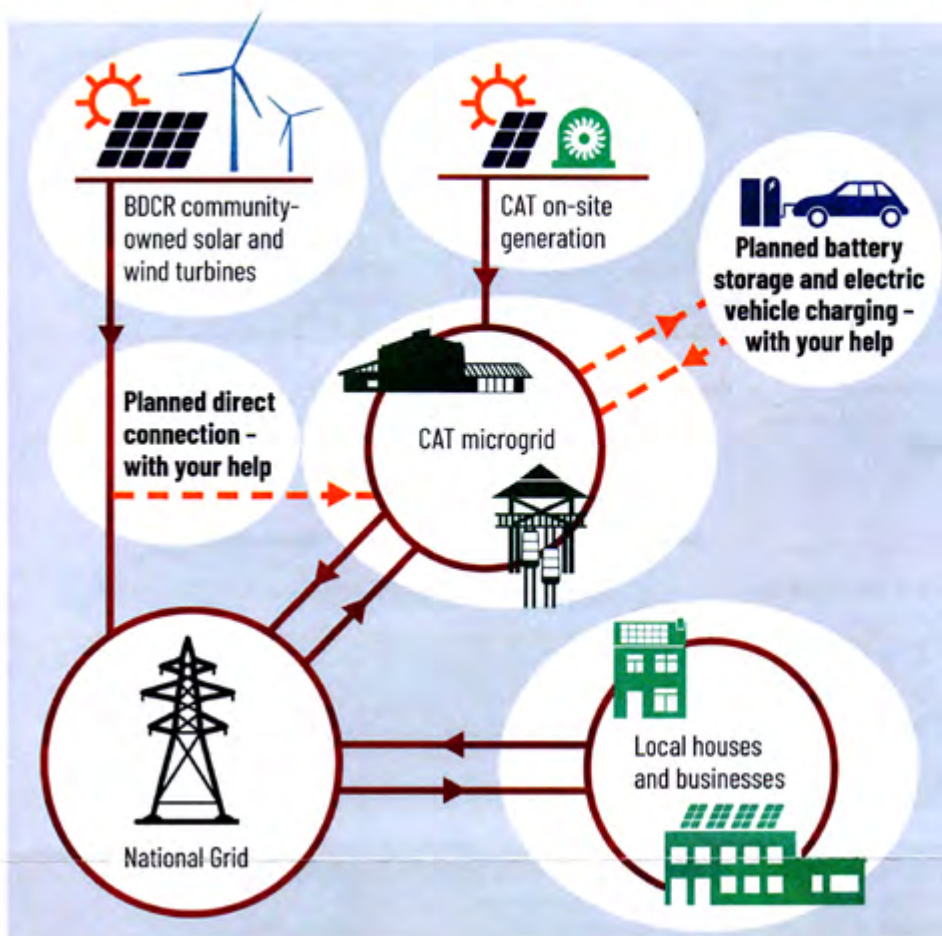
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The plan to power CAT using local renewables



Connecting CAT to cheap, local, community-owned, renewable energy is part of our strategic plan to develop our home in Mid Wales to reach more people and make an even bigger impact.

But we can't do it alone. Powering CAT on renewables takes a whole community.

By working in partnership with BDCR, Dulas Engineering and local people – and with your support – we can write the next chapter of CAT's story and take urgent action on the climate and biodiversity crisis.

"As part of our latest project to install 300kWp of ground-mounted solar generation, we are intending to 'private wire' approximately 40kWp straight to CAT. It will bypass the National Grid and enable CAT to purchase the electricity directly from BDCR.

This should hugely reduce CAT's future energy costs. We think this will be enough to power their entire eco centre for the summer months!

CAT has a long history of supporting community-owned energy projects, and I know this is something that fits their values perfectly. Thank you to everyone who gives CAT their support to help make this exciting project happen."



Tim Brewer
BDCR Ltd

"With more and more people using electric vehicles, being able to provide enough charging points is essential for CAT to welcome new visitors and guests.

The Dulas electric vehicle charger with battery storage will be an integral part of CAT's new on-site power plans. It is designed to maximise the power available for charging vehicles, while limiting the power drawn from the microgrid. By storing excess power generated, it can also be used to reduce the power drawn from the grid at peak times for other needs on site.

As a company that was born at CAT, we're delighted to be playing a part in securing its future and ensuring it can go on inspiring change."



Andy Skipton Carter
Dulas Ltd

THE FOUNDATION FOR SCIENCE AND TECHNOLOGY



The Foundation for Science and Technology

Are you part of a learned or professional society? Has your organisation considered joining the Foundation for Science and Technology? We provide a wide range of benefits for our member organisations. Read on to find out more about what we offer.

What is the Foundation for Science and Technology?

The Foundation for Science and Technology provides an impartial platform for debate of policy issues that have a science, research, technology or innovation element.

Established in 1977, the Foundation brings together Parliamentarians, civil servants, industrialists, researchers, learned societies, charities and others.

How does the Foundation help learned and professional societies?

The Foundation was originally established to support the work of learned and professional societies. Consequently, we have been advising such societies for almost 50 years. Today, we support over 90 learned and professional societies across a range of sectors, including engineering, mathematics, philosophy, transport, healthcare and more.

We assist learned and professional society members with a huge variety of governance, regulatory and policy-related topics. We receive regular enquiries from senior leaders, trustees and board members, as well as governance and policy managers. Common queries include how to obtain or amend a Royal Charter, charity registration and related matters, disciplinary issues, governance reviews and data protection questions. The Foundation's wealth of experience enables us to assist members with finding the right answer, developing a pragmatic and practical way forward, and – in the event we can't help – signposting to other relevant sources of advice.

What are the benefits for member societies?

Member organisations have access to 48 guidance notes produced by the Foundation, which are available in the members' area of our website. The guidance notes cover governance, legal and regulatory topics that are relevant to learned and professional societies, including charity and company law matters, Royal Charters, data protection, insurance, professional and ethical conduct, and more.

The Foundation's quarterly newsletter is sent to over 200 subscribers. It provides editorial content on administrative and governance matters, as well as updates on news, court and tribunal decisions, and reports that will be of interest and relevance to readers. Foundation newsletters from 2018 onwards are available on the website for download by members only.

Are other types of membership available?

Yes. Organisations can also become Associate members of the Foundation.

Associate membership is open to any organisation interested in the Foundation's work discussing issues of science, technology and innovation across Parliamentary, governmental, industry and research stakeholders.

Associate members receive invitations to attend all the dinner discussion events run by the Foundation free of charge. They also receive copies of the FST Journal, and are listed as supporters of the Foundation in the Journal and on all event programmes.

What else does the Foundation do?

The Foundation convenes discussion events and roundtables, publishes a journal and blog, and hosts a regular podcast.

The Foundation Future Leaders Programme supports the next generation of professionals from universities, industry and the civil service. The programme brings together around 30 mid-career professionals from the research community, industry, and the civil service and wider public sector. Over a 12-month period, the group interacts with senior figures from government, parliament, universities, large industry, SMEs, research charities and others. They also

develop an annual conference for a wider group of mid-career future leaders in science, technology, research and innovation.

Opportunities to collaborate

Collaboration rather than competition has been the rule of the Foundation's activities. Over the years we have partnered with a wide range of organisations, including ARC, the University of Edinburgh, the Geological Society, the Royal Society, the Royal Society of Chemistry and many others. We are always on the lookout for organisations to partner with, so if you're interested in collaborating with us by hosting or sponsoring an event, contributing to our journal or podcast, or working with us on another activity, we would love to hear from you.

How can I find out more?

Lori Frecker, Learned and Professional Societies Liaison Officer, is happy to answer any questions you may have. You can contact her by email: Lori.Frecker@foundation.org.uk

If you're interested in hosting or sponsoring a Foundation event, and other partnership opportunities, contact our Chief Executive, Gavin Costigan, to find out more and register your interest. (Gavin.Costigan@foundation.org.uk)

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MAKE ROBOTS, NOT EXCUSES

Your robotics journey starts here. The Institution of Electronics is working on bringing you a Custom Maker Space, perfect for bringing your robotics ideas to reality.

Ever dreamed of building your own robot but don't know where to start? Whether you're a curious teenager ready to dive into the world of technology or an adult looking to finally tackle those DIY robotics goals, the Maker Space is here to guide you every step of the way.



Unlike traditional tutorials that walk you through rigid, step-by-step projects, the Maker Space will instead teach you how to create robotics projects from scratch. From understanding how basic electronics work to programming Arduinos, each tutorial equips you with the knowledge to combine elements in your own unique way. This means no cookie-cutter solutions—just the tools and inspiration you need to bring your ideas to life. By focusing on creativity over hand-holding, the Maker Space ensures you're not just following instructions but truly innovating with every project.

Don't know where to start?

Don't worry! The Maker Space is designed to help

you take that first step into the exciting world of robotics. Whether you're a total beginner or someone looking to expand your skills, we've got the resources, inspiration, and support to get you started.

One of our most exciting features is the Ideas Portal, a creative hub powered by AI to help you dream up your next project. Simply input your skill level and interests, and the portal will generate tailored prompts and suggestions to spark your imagination. Whether you're into autonomous robots, AI-powered gadgets, or simple mechanical builds, the Ideas Portal ensures there's always something fresh and exciting to work on. The perfect tools for developing existing projects, repurposing spare parts, or for clearing that pesky imagination block.

Track Your Progress, One Step at a Time

Keeping track of your robotics projects has never been easier with our Project Tracker. This tool is designed to help you organize and document every stage of your build, from brainstorming to completion. Document your progress, budget, and jot down notes for each milestone, ensuring you never lose sight of your vision. The tracker also makes it easy to revisit old projects, refine your work, or share your journey with others.

Looking to make a submission to the National Electronics Competition? Use our Project Tracker to help you write your Technical Paper quickly and accurately, making sure you don't miss any details while simultaneously creating a professional technical paper.

Our platform offers everything you need to bring your ideas to life: step-by-step tutorials, inspiring project ideas, and tools to track your progress. With resources tailored for beginners and a supportive community, there's no better place to start your robotics journey. Let's turn your imagination into innovation—join us at the Maker Space today!

DRONE TECHNOLOGY IN ARLOESI DOLGELLAU



Arloesi Dolgellau, the community Maker Space and education hub based in Dolgellau in the Snowdonia National Park, is working with M-SParc—North Wales' Science Park— to develop a drone foundation course. This course will equip young people with digital and engineering skills in relation to drone technology and be a feeder into wider STEM related learning.

Arloesi Dolgellau is leading in this effort to establish a drone foundation course as part of its education offer to the local community. While the syllabus for this course is still in development it will comprise of a number of strands:

- a drone programming curriculum for primary and secondary school students (using Python and Tello drones)
- Drone coding camps and 3D printing workshops to build custom drone parts
- A local drone innovation challenge to encourage student-led experiments in delivery logistics, mapping and monitoring.

The vision is to establish a community drone lab within the Arloesi Dolgellau Maker Space and share this experience across the wider Ffiws network.

The course is only part of Arloesi Dolgellau's aspiration to explore wider applications of drone technology in a rural context. One area of interest is the use of drones to improve productivity and environmental data collection for local farming and horticulture. This could mean using drones for multispectral imaging of crop health in local farms and in Arloesi Dolgellau's own "Intelligent Garden," monitoring soil moisture and nutrient levels through drone-assisted sensor calibration and exploring real-time drone data streams for training datasets in AI-assisted agriculture.

As this project develops, Arloesi Dolgellau has

been continuing to embed electronics education in its engagement with the local community. With volunteer support, two "Smart Tech" workshops were held over the summer, with the start of the new academic year, the aim is to have a monthly workshop rolling out a syllabus designed by volunteer Chris Owens. This syllabus aims to encourage learning and exploration around smart technology, specifically sensors, microcomputers and controllers, and new innovations in computing. Participants in these workshops are being offered the opportunity to join the Institution of Electronics as student members. The modules will cover a range of target audiences, and we hope to be able to offer some of the workshops within the local schools.



As well as creating the community drone lab we are to continue our partnerships with Smart Towns Cymru and Menter Môn. Get in touch if you would like to know more about the project or get involved.

WHY CHIPLETS ARE THE FUTURE OF SILICON DESIGN

As Moore's Law slows, traditional monolithic chips are encountering significant limitations—physically, economically, and thermally.

Larger die sizes result in reduced yields and increased costs, while placing logic, memory, and analog circuits onto a single process node compromise both performance and efficiency. This is why the industry is shifting towards chiplets: compact, function-specific dies that are integrated within a single package. This approach represents a more intelligent method for constructing systems.

Chiplets let us mix and match technologies. Looking for a state-of-the-art 3 nm CPU core? Combine it with a 22 nm analog I/O block or a specialized HBM memory stack—each designed on the most suitable node. This heterogeneous integration enhances performance per watt and significantly reduces costs by improving yield: smaller dies are inherently less susceptible to being rendered unusable by a single defect.

Key facilitators such as 2.5D/3D packaging and the UCle (Universal Chiplet Interconnect Express) standard enable this innovation.

UCle offers a low-latency, high-bandwidth, vendor-neutral interface between chiplets, like what PCIe provided for circuit boards. With silicon interposers and micro-bumps, die-to-die communication is now approaching on-die speeds—essential for AI and HPC workloads where data movement is a major factor in power consumption. However, challenges persist.

Thermal hotspots can develop when high-power chiplets are placed adjacent to sensitive analog blocks. Maintaining signal integrity across interconnects necessitates the co-design of circuits, layouts, and packaging.

Additionally, EDA tools are still evolving to support multi-die system optimization. Nevertheless, the benefits are evident. AMD's EPYC CPUs, Intel's Ponte Vecchio GPUs, and next-generation automotive SoCs all leverage chiplets to enhance performance without the need to redesign entire dies. In edge devices, chiplets facilitate compact, power-efficient integration of AI accelerators, RF, and sensors—increasingly important, on device intelligence.

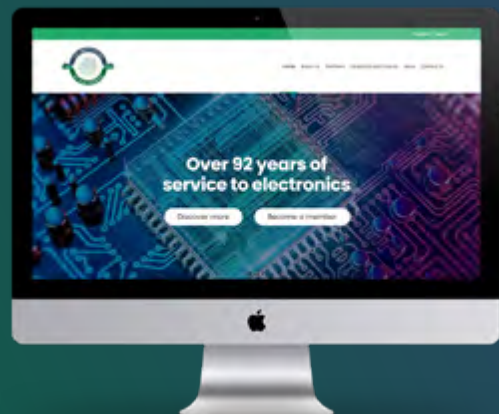
References: V. Gujar, "Chiplet Technology: Revolutionizing Semiconductor Design," IEEE Access, 2024. / UCle Consortium, "The UCle Chiplet Interconnect Standard," 2024.

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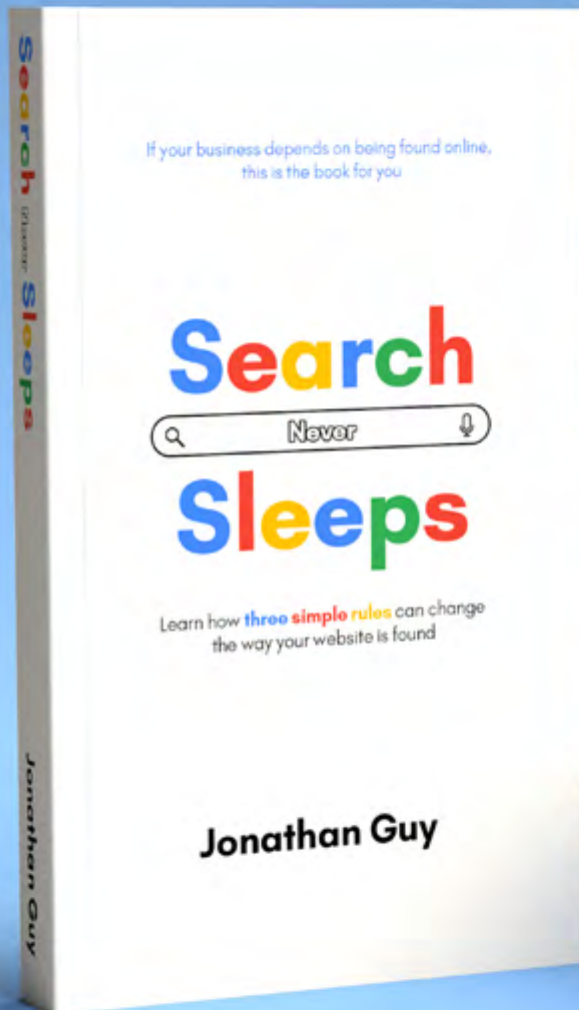
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Featuring real-life examples, key takeaways, clear case studies, simple diagrams, and a whole host of useful tips that anyone can put into practice, Search Never Sleeps artfully covers the SEO essentials as well as more complex topics for advanced SEO technicians.

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Jonathan Guy is the Founder and MD of award-winning digital marketing agency, Aqueous Digital.



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A Data-led Transformation

LET'S SET THE SCENE

The client decided to proceed with their ERP transformation programme without using Insight, and instead used an excel spreadsheet 'tracker'.

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SO, WHAT DID WE DO?

Within two weeks of the no-go decision, Insight was brought in to replace the impact tracker excel spreadsheet.

Leveraging the tool for a real time view of progress reporting, the change team were able to drive accountability and ownership of actions into the business.

WHAT WERE THE RESULTS?

The business was able to deliver a successful go-live within six months. Insight was carried forward into the next phase of the global rollout, and the leadership team also earmarked three additional programmes to be brought into the tool in order to leverage a data-led view of the bigger change portfolio across the wider business.

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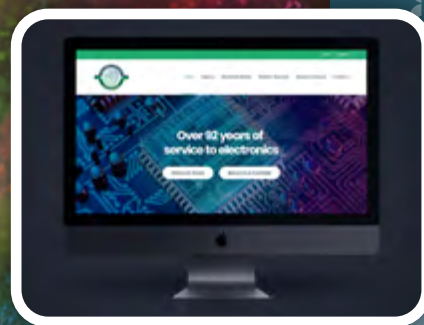
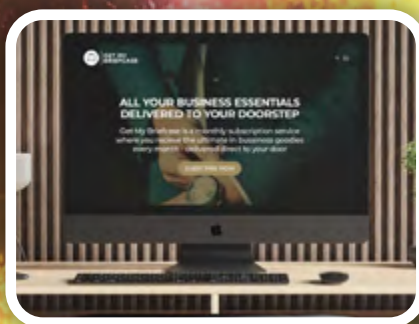
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- Members are invited to "Coffee and Chat", our regular virtual opportunity to chat with one another, regarding issues currently affecting them and "Networking" with like-minded, experienced, people.
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