DETI DIGITAL ENGINEERING TECHNOLOGY & INNOVATION

WEST OF ENGLAND Combined Authority

ISSUE 2

DIGITAL NOW

DRIVING A DIGITAL REVOLUTION IN THE SOUTH-WEST

Boosting Digital Skills In the Workplace

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DIGITAL ENGINEERING TECHNOLOGY & INNOVATION

WEST OF ENGLAND Combined Authority

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Foreword

There is a climate and biodiversity emergency that requires leadership and action.

Thankfully, we in the West of England are getting on with the job of fighting the climate crisis and shifting towards a low-carbon economy which we know is so vital.

At the West of England Combined Authority, which I lead, we are passionate about harnessing the innovation and abundance of talent we have in our region to tackle this most urgent of challenges. The Digital Engineering Technology & Innovation programme is a key part of this commitment.

This key programme is building the technologies and digital skills we need to reach our net-zero ambitions

We have set out to inspire a generation of young people to pursue careers in future-proof sectors such the green economy. I'm pleased we've made such good progress already, with the programme boosting opportunities for so many youngsters throughout our region, helping create the innovators of the future.

This key programme is building the technologies and digital skills we need to reach our net-zero ambitions; when it comes to delivering the green economy of the future, we must ensure we have the green skills of the future. It's also demonstrating to the world that the West of England is the go-to place for digital and technological innovation and engineering knowhow.

In turn, this is creating more high-quality jobs for all residents, helping us to tackle the climate emergency alongside the jobs crisis at the same time. It also means our region can push the envelope of what's possible when it comes to finding new, sustainable ways of living.

I'm pleased to be able to share the progress we have made this last year, but my message is clear: let's build on the significant progress made so far, and together create an even better West of England region for all.

Dan Norris,
West of England Metro Mayor

WEST OF ENGLAND
Combined Authority

Introduction

The world is in a race to achieve net zero by 2050. To meet this, we need to invest in new ways to reduce and remove carbon emissions from what we produce and how we consume it.

The need to embrace digital technologies to help address the challenge has never been stronger. To answer the call, we need to rapidly accelerate innovation to drive decarbonisation, to ensure there is a future for all.

Everything we make needs to be completely re-designed and re-engineered. It provides us with the exciting opportunity to develop new, environmentally friendly products and ways of working that will support future generations sustainably, socially and economically. The South West has a proven history of being a leader in the development of next generation products with exciting innovators including Airbus, Rolls-Royce and GKN, who are part of the DETI consortium, making their homes here.

DETI is a crucial part of enabling a future where the South West is the place to design net zero products

There are few test-grounds to explore and test technologies and processes without disrupting current production line pressure and this is where the National Composites Centre comes in. The DETI partners have utilised its state-of-the-art facility in Bristol to create a 'learning factory' where concepts can be tested and trialled in as close to a production line environment as is physically possible. DETI's success lies in its ability to bring together academia, industry and world class R&D innovators to imagine a future and to build the capability that will be its bedrock in collaboration with the very companies who are looking to create a net zero future.

Because of the work undertaken within the DETI programme, the South West region was chosen by Government to become the UK's first industrial test bed for 5G. The programme has inspired future engineers through its outreach programme and the capabilities that the region now holds positions the South West to continue to be the innovation powerhouse it is known to be.

It is in the South West cluster of innovators that products that become household names are imagined and created. DETI is a crucial part of enabling a future where the South West is the place to design net zero products. Holding the product design and development capability will lead to high value, long term jobs both in the organisations that design the products, and the wider supply chain.

The first phase of DETI has developed a range of industrial test beds for accelerated innovation to prove out new digital technologies, tools, and processes. It has produced digital prototypes that de-risk technology implementation, demonstrate return on investment and increase agility. From redesigning sustainable products to using Artificial Intelligence to optimise engineering processes, the DETI consortium has developed new ways to enable industry to engineer better, sustainable products, faster.

Richard Oldfield, *Chief Executive Officer*, National Composites Centre

NATIONAL COMPOSITES CENTRE

deti.uk

Vision

To transform engineering for the digital era and inspire the next generation of engineers.

Purpose

To create a new, diverse engineering community and systems to investigate, develop and demonstrate the advanced digital technologies and skills needed for the sustainable products of the future.

About Digital Engineering Technology & Innovation (DETI)

The digital revolution is fundamentally changing the way engineers work, requiring new skills. There are few digital test-grounds to explore and test technologies used in design and manufacturing processes. This is where Digital Engineering Technology & Innovation (DETI) comes in.

DETI connects, accelerates and inspires the people and technologies that will lead into the next phase of clean and sustainable growth. It is supporting industry to reduce carbon emissions by helping companies to optimise design and manufacturing processes and produce better products that are more fuel efficient and have less waste – through undertaking research and innovation in our increasingly virtual world.

Encouraging diversity and inclusivity, DETI has developed a skills and workforce development programme to ensure the current and future workforce is digital-ready, inspiring future generations.

Research Highlights

Read about the research highlights from the second year of the DETI programme covering engineering leadership, digital workplace skills and inspiring the next generation of engineers.

For further information about a specific highlight or to access the technical information, email **deti@nccuk.com**

Driving engineering leadership

From redesigning sustainable products to using Artificial Intelligence to optimise engineering processes, the DETI consortium has developed new ways to enable industry to engineer better, sustainable products, faster.

Optimising satellite design with digital engineering

CHALLENGE

Digital engineering technologies and tools offer a new approach to the design process for complex, high value products from aerospace to automotive, defence and transport.

Offering opportunities to digitalise processes to reduce product development timelines and maintain engineering leadership, they provide the opportunity to review traditional design methods that require multiple design iterations and physical prototypes.

Satellite design has always been a lengthy and costly process. Traditional design methods require multiple design iterations and physical prototyping which can quickly become unaffordable for many companies. By using digital engineering there is a great opportunity to review and modify the traditional methods eliminating the need for individual build and test runs ultimately making the design process faster, more accessible and affordable.

RESULTS AND THE DIGITAL OPPORTUNITY

As part of its work with small to medium enterprises for DETI, CFMS has helped KISPE Space to examine and develop the methods using digital tools, applicable to the Open Source Satellite (OSSAT) structural design.

The aim of the project was to reduce a key driver in the cost of satellite production: the “touch time” or labour costs spent on designing, building and testing a satellite. KISPE Space is a programme execution and systems engineering company operating within the space sector.

KISPE Space’s vision is to use the same satellite structure on different missions and with different launch vehicles. The structure had to be optimised to avoid adding unnecessary mass to the satellite, which would increase the launch cost. With such a variety of often conflicting requirements, conventional design methods require physical prototypes and repeated design iterations. As a result, the traditional design process is lengthy, consumes materials and resources, and demands significant funding.

Case Study: KISPE Space

"CFMS generated a range of solutions using a generative design optimisation approach. This used digital engineering tools and methods to create multiple different designs, virtually tested against performance criteria."

To address the challenge, CFMS generated a range of solutions using a generative design optimisation approach. This used digital engineering tools and methods to create multiple designs, virtually tested against performance criteria. By automating this process using Multi-Objective Optimisation (MOO), coupled with high performance computing, an optimised satellite structure is created faster.

The process starts with the creation of an inventory of satellite components and their key parameters (size, mass etc).

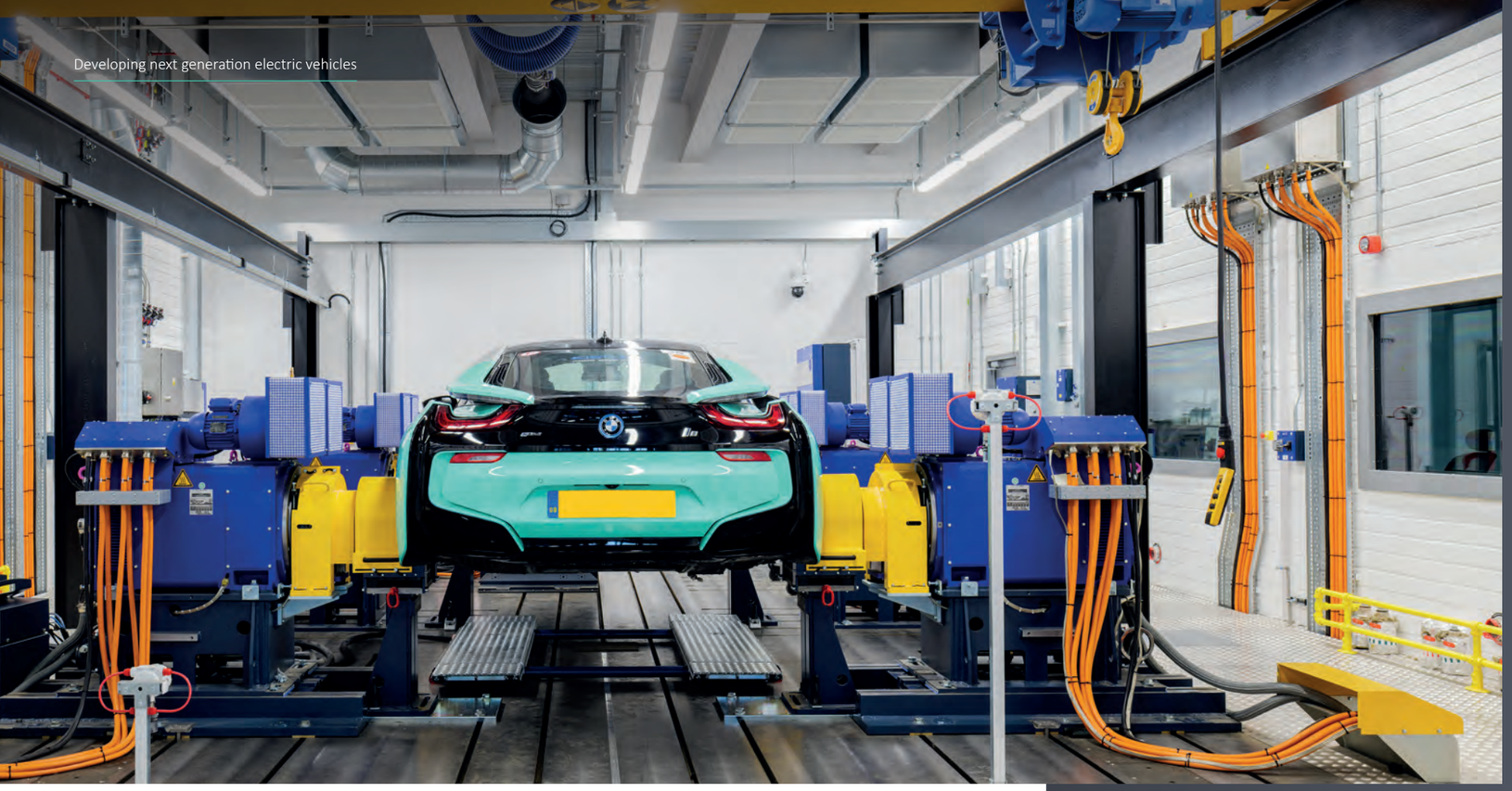
With these components, a model of the satellite is constructed in an automated way and with minimum input requirements from a human operator.

This allows for a dramatic reduction of design time for any future mission requirements. The process of optimisation is conducted algorithmically by varying the geometry (thickness, positions) of the structural elements, the manufacturing methods and materials used to make the structure, and the overall layout of components within the satellite.

The vast array of models created were tested against key environmental conditions, such as vibration and the forces experienced during launch, restrictions applied to centre of gravity and total mass, etc. The end result was a structural design that achieved the mission requirements.

Partner

cfms



Developing next generation electric vehicles

CHALLENGE

To achieve net zero legislation, electric powered transport will reduce greenhouse gasses and air pollutants, enabling a cleaner, safer environment.

With the potential to reshape the transport sector, traditional diesel and petrol fuelled vehicles that use combustion engines will be replaced with electric vehicles.

The development of new tools and techniques is a vital component of product innovation for electric vehicle propulsion systems. With technologies changing faster than ever before, new exploratory research, tools, skills, and demonstrators are essential to facilitate transition and nurture innovation.

RESULTS AND THE DIGITAL OPPORTUNITY

The University of Bath, through the newly opened £70M Institute for Advanced Automotive Propulsion Systems (IAPPS), has produced a report that presents a number of case studies including an Electric Vehicle (EV) Powertrain analysis and an electro-thermal analysis of an EV battery pack.

A Powertrain consists of every component that is inside a car and generates power to the wheels, which enables it to move forward. It consists of a system that includes the engine, transmission, driveshaft, axles and differential.

Through a combination of research, simulation and experimental techniques, the first case study is based on a low-cost 48V EV powertrain for small electric vehicles, which can also have practical “real-world” applications in urban mobility solutions, including e-scooters, e-mopeds or even small e-motorcycles. The case study presents real drive cycle data, characterised component models and explains the model parameters for each of the major components in this system. It also determines the overall capability and efficacy of the EV powertrain when used in a realistic drive cycle context.

The second case study describes a modelling technique that has been used to rapidly and efficiently predict the thermal behaviour of an electric vehicle battery pack and evaluate the risk of possible fires or a ‘thermal runaway’. The case study explores the thermal runaway characteristics of typical Lithium Ion battery cells in a variety of geometric configurations using electro-thermal models. This is for the rapid assessment of not only the electrical and thermal behaviour of the cell in a context of a pack, but also different cooling regimes, understanding electrical and thermal stress on reliability, and ultimately providing a deeper understanding of the potential risk of an incident of failure leading to catastrophic damage to the battery pack as a whole.

Detailed reports and case studies are available from **www.iaaps.co.uk**

With technologies changing faster than ever before, new exploratory research, tools, skills, and demonstrators are essential

Partners

IAAPS ADVANCING PROPULSION

UNIVERSITY OF BATH

Optimising the design of a **composite hydrogen pressure vessel**

CHALLENGE

To gain competitive advantage in a global marketplace, it is crucial for companies to digitalise processes to reduce development timelines and maintain engineering leadership. For digital engineering, the use of Multi-Disciplinary Optimisation (MDO) techniques offer industry a new approach to product development, redesigning and remaking products with a focus on net-zero.

Product design is the process of identifying and defining a combination of features that satisfies a set of requirements. These requirements often include competing objectives and constraints, and address different aspects of the product and its parts. Traditional engineering tends to be sequential, but the complex nature of most products calls for a concurrent approach to be addressed which MDO can offer.

MDO is the process of finding the optimal solution to a set of design requirements that encompass multiple disciplines; from structures to manufacturing, operations, disposal, economic considerations, etc. The concept of MDO is particularly suited for products or systems made up of multiple coupled parts that cannot be designed and optimised in isolation.

RESULTS AND THE DIGITAL OPPORTUNITY

The advantage of MDO is that its goal is to address all design elements of a product at the same time, resulting in superior design, lower development costs, faster new product introduction, and the ability to refine specific features. It is a tool that could present a notable transformation in the competitive edge of British industry.

Case Study: Optimising the design of a composite hydrogen pressure vessel

As hydrogen has emerged as one of the most promising solutions for achieving net-zero carbon emissions by 2050, the design of pressure vessels for transport and storage has been drawing increasing interest within industry.

For this project, MDO has been applied to the design of a Type IV composite hydrogen pressure vessel, exploiting the benefits that digital design technologies can enable.

The design of composite pressure vessels is based on four main aspects: structural performance, manufacturing, weight, and cost. Among the constraints, the design must meet a minimum burst pressure, a minimum fatigue life, and a maximum permeance rate, typically prescribed by regulatory codes. Design objectives include maximising the hydrogen to tank weight ratio and minimising the cost to make the product competitive in the marketplace. The sustainability potential of materials and manufacturing processes used should also be considered early in the design process.

Following an aspect-based review of the system, setup of the pressure vessel MDO involved the identification of the analysis modules and software tools required to evaluate the product performance against constraints and objectives. A data structure matrix was used to map the relationship, or coupling, between the analysis modules and support the definition of a process flow for the optimisation of the pressure vessel.

A design space optimisation platform which enables the exploration of different design alternatives was used to conduct the MDO exercise. Previous research undertaken within the DETI programme involved the assessment of a range of commercial industry software available. HEEDS™ MDO, a design space exploration and optimisation software from the Simcenter™ portfolio produced by Siemens Digital Industries Software, was the platform selected for the implementation of this MDO process.

Fifty designs were evaluated in less than two hours and an optimal solution was discovered among twenty-three feasible designs. It is worth noting that a traditional design approach typically leads to a feasible design, which is not necessarily the optimum one. Further effort can be required to identify the optimum design. Finding the optimum design of a complex system such as a composite hydrogen pressure vessel was the goal of this proof-of-concept MDO study. Automating the design process identified the optimum design to be estimated at five times faster than a traditional approach. This achieved the goal and significantly reduced the risk of human error in the process of data transfer. With the UK looking to position itself as a hub for agile, high-tech manufacturing, MDO presents an enormous opportunity to substantially improve product design, development, and manufacturing time to market.

"Automating the design process identified the optimum design to be estimated at five times faster than a traditional approach."

The National Composites Centre (NCC) is advancing the knowledge required to establish a dynamic UK supply chain, investing in hydrogen pressure vessel research and development to seed manufacture in the UK. This progression in technology will help it to remain competitive in the future. It is also part of the High Value Manufacturing (HVM) cross-Catapult Hydrogen Innovation Initiative (HII). This collaboration brings together the strengths and capabilities of the Catapult innovation centres to support growth in the UK hydrogen supply chain, overcome technology and integration challenges, and to establish an effective UK hydrogen infrastructure.

Partners

NATIONAL COMPOSITES CENTRE

SIEMENS

Enabling the Digital Thread
in small engineering projects

CHALLENGE

The rapid uptake of digital engineering technology and capability has led to a heterogenous digital engineering landscape with no one organisation featuring the same IT infrastructure and architecture as another.

The result is digital engineering silos and constrained workflows that do not exploit the full capabilities digital engineering has to offer in terms of design and manufacturing optimisation, traceability of information, decision making, engineering process improvement and business intelligence.

How can we make use of the full potential of digital transformation and exploit this to our advantage in support of the next generation of products, to meet the pressing challenges of net zero and sustainability?

RESULTS AND THE DIGITAL OPPORTUNITY

For organisations to embrace digital transformation, they must manage and control the Digital Thread. Many large engineering organisations have adopted Product Lifecycle Management (PLM) systems to realise this goal. However, enabling the Digital Thread remains a particular technology gap for small engineering projects and organisations (circa less than fewer 20 engineers).

In these settings, it is often not practical to implement a full-scale PLM system due to the prohibitive cost, variety of digital toolsets employed, and the additional overheads and experience required to manage it. In addition, Digital Thread requirements of small engineering projects are often different to those required by long-term production-scale design projects, which must consider the entire product lifecycle.

CFMS have reviewed academic literature to determine a consistent definition of the term “Digital Thread”; “Data and/or information flow between systems and/or people that is systematic, consistent and auditable delivering the right information at the right time to the right people through the right mechanism.”

A summary of the Digital Threads that are commonly required to be managed for small engineering projects:

- **Document Management thread:** manages the operational history of the files used in everyday project work and allows the user to find files quickly
  - **Value:** Enhanced visibility and speed of accessing the correct documents
- **Unique document numbering thread:** the methodology of numbering with a unique identifier allows a thread to control the relationship between documents
  - **Value:** Ensures interoperability across multidisciplinary designs
- **Approval workflow thread:** manages the workflow in an approval process required to make changes to documents
  - **Value:** Streamlining of the process provides reliability and compliance
- **Version control thread:** manages the release of a new version once all the changes have been completed and approved
  - **Value:** Improvement in accuracy of operations and product quality
- **Configuration management thread:** manages the relationship between assemblies, parts, components, materials and other parameters
  - **Value:** Increases ease of use and reliability of design
- **Change management thread:** manage changes or iterations necessary as the project progresses
  - **Value:** Enhances product innovation and faster time to complete projects
- **Ownership thread:** manages the ownership of files, from who owns the files from creation to the ability to read but not change files
  - **Value:** Reduces compliance risks
- **Software and hardware components thread:** combines the information between the hardware and software components in projects allowing the designer, user, reviewer, full visibility of both parts of the project in synchronisation
  - **Value:** Enhances product innovation and faster time to complete the project
- **Issue control thread:** manages issues arising such as monitoring of bugs in software, incorrect part definition and corrections required, revision of software to fix problems, and any new features of requirements added
  - **Value:** Enhances product quality
- **Compliance control thread:** management of data to meet regulations
  - **Value:** Reduces compliance risks
- **Collaboration thread:** allows full collaboration between multiple members of a project team with full visibility of changes and ownership threads
  - **Value:** Increases communication and visibility to enable faster time to complete projects

Having determined the required threads that need to be managed for small engineering projects, a software system is required to manage the different formats that will need to be supported by the Digital Thread.

Detailed reports about the Digital Thread are available from **cfms.org.uk/article/digital-thread-a-digital-thread-definition**

Partners

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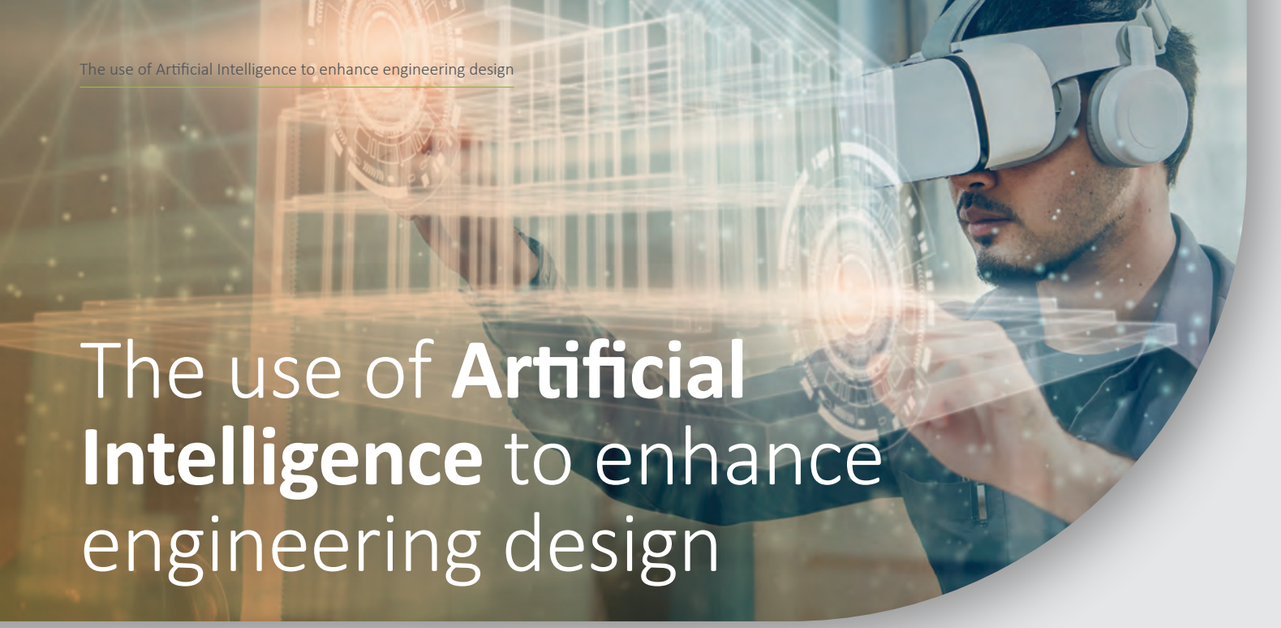
University of BRISTOL



The use of **Artificial Intelligence** to enhance engineering design

CHALLENGE

Artificial Intelligence (AI) is the fastest growing emerging technology. Undertaken by machines, AI performs tasks undertaken by humans.

AI is the simulation of human intelligence processes by machines, especially computer systems. It focuses on getting computers to do tasks that would normally require human intelligence. Machine Learning (ML) is where machines learn by taking in data, analysing it, taking action and learning from the results of that action. Data used for AI and ML applications and projects is available in many different forms, from multiple sources, real-time and historic, which can be used to make engineering predictions and gain improved insight.

How can we use AI/ML in engineering to enhance design and simulation to reduce the time, labour and cost of design and manufacturing processes?

How can we use this capability to our benefit to explore a wider range of design options for products and components, and discover patterns in data, speeding up decision making and freeing up engineers to focus on higher value tasks?

RESULTS AND THE DIGITAL OPPORTUNITY

The specific aim of this industrial project was to investigate the challenges associated with the use of advanced digital methods, in this case AI/ML techniques to understand their value and limitations in the automation of aircraft design challenges. The project focused on determining the level of confidence that could be placed in decision-making and guidance from using an AI system trained using a training data set.

The key findings determined that the approaches used, given sufficient data, provided a high level of confidence in being able to make engineering predictions from one type of data set to another. The approaches utilised are capable of improving the accuracy of existing computer simulation methods used in the design of high value products. With more reliable simulation, and improved ability to predict what a physical test may discover, this kind of approach may be able to reduce the amount of physical testing required by filling knowledge gaps or enriching a smaller physical dataset.

This technology therefore has the potential to create a significant cost saving in the development of new complex products through a reduction in the amount of physical testing required.

The results of this project provide further justification for the in-depth research and exploitation of AI/ML methods in digital engineering practice.

Detailed reports about the use of AI in the Digital Modelling Toolbox are available from **cfms.org.uk/article/digital-modelling-toolbox-a-generic-digital-toolbox**

Partner

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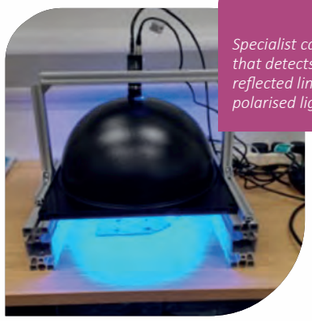
Automated detection to improve sustainability and reduce waste for composites

CHALLENGE

Composite materials contain unique properties that make them lightweight, strong, durable and adaptable. Products designed using these materials produce less waste, last longer, and help us tackle sustainability and net-zero challenges.

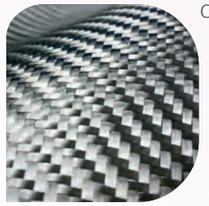
The dark, shiny nature of composite materials makes defects tricky to spot based on traditional camera technology. The current industry standard is to perform time consuming and eye straining manual inspections to ensure the safety of composite components, particularly those destined for applications in the aerospace industry. With testing and subsequent discarding of materials a key issue, new technology and innovation is needed to deliver improvements in industrial sustainability for composite materials.



Specialist camera that detects reflected linearly polarised light

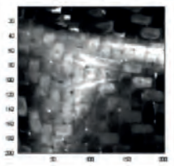
RESULTS AND THE DIGITAL OPPORTUNITY

The University of the West of England's Centre for Machine Vision have developed a new system that uses machine learning to automatically detect defects in raw and processed composite materials. This will reduce waste and cost for composite industries.

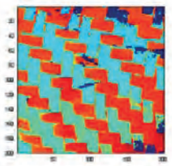


Composite material strength lies in the uniform pattern of either unidirectional or interwoven carbon fibres lying undisturbed in resin. But any composite component is only as strong as its weakest link, and weaknesses caused by fibre misalignment or gaps is a common problem in composite manufacture.

The system uses Polarisation Vision which consists of a specialised camera that detects when light becomes linearly polarised. Instead of blocking glare from reflected light like polarised sunglasses, the camera detects the reflected polarised light and, produces a "photo" of composite fibres – with each orientation of fibre shown in a different colour. These can be seen in the composite fibre orientation image below.



Traditional Light Intensity Image



Reflected Linearly Polarised Light

The images produced by the software highlight tiny, localised defects, but individual fibre orientation can also be calculated to give an overall report on a material's quality.

The system developed can provide consistent, rapid and detailed defect detection for composite manufacture, which standard manual inspection or traditional methods from machine vision would find difficult to achieve. Using a process whereby the machine learns from the data that it processes, feeding more data into the machine learning algorithm will enable it to identify the different types of defects, increasing the success in defect auto detection.

It will make the process of (re)designing and manufacturing sustainable products more cost effective, and faster for companies, maintaining competitive position for the region, and in the global marketplace. It will also reduce the volume of waste material for companies that use composites, helping to address sustainability and net zero.

To learn more about the automated detection system developed, email **deti@ncc.uk.com**

Partner

UWE Bristol University of the West of England

Transforming manufacturing using **Self-Adaptive Manufacturing Processes (SAMP)**

CHALLENGE

Manufacturing in the UK is seeing new and significant challenges, sustainability demands (captured by Net Zero initiatives), recovering from the COVID-19 pandemic, BREXIT, energy prices and the continuing rapidly evolving competitiveness from global markets.

Ultimately these challenges are applying new levels of pressure on the UK engineering and manufacturing sector, realised through ever increasing demands in the following areas:

- Cost per product challenges to remain competitive
- Efficiency of production to meet sustainability demands
  - Efficient energy use, efficient use of raw materials (no or low waste), efficient use of the workforce
- Demand for new novel/higher-performing products to remain ahead of competition

One of the ways to meet these demands is to develop higher-complexity manufacturing processes. With these types of processes becoming more prominent, ensuring manufacturing success is even more critical to avoid investment in producing parts that require rework or scrapping. In summary, there is a need to produce more right every-time manufacturing, on more challenging processes.

RESULTS AND THE DIGITAL OPPORTUNITY

What is SAMP?

Self-Adaptive Manufacturing Processes (SAMP) are processes that have been created to overcome manufacturing variation and deliver right every-time products. This is particularly pertinent to sustainability demands to reduce waste, energy and carbon emissions.

SAMP is a specific type of Digital Twin. The AMRC has completed significant work to clarify the definition of a digital twin: “A live digital coupling of the state of a physical asset or process to a virtual representation with a functional output."

How to enable SAMP

SAMP is enabled through the Digital Transformation of a given manufacturing process. For engineering and manufacturing, digitalisation means acquiring data from across the product development lifecycle, design to manufacture and through service to end of life, in order to make better product-related decisions and improvements and unlock new business-related opportunities. Digitalisation is now a viable route for a wide range of business improvements. Previously this wasn’t the case due to the expense and difficulty of deploying digital technologies. The growth of readily available digital technologies and an increase in collective understanding, and associated skills, means that these technologies can now be leveraged to achieve transformational changes in businesses.

To achieve SAMP, a traditional manufacturing process and its associated systems are:

1) Digitally modified to provide the ability to acquire quality controlling process data in real-time
2) Process data is used to assess whether the process is progressing/performing as it should be or not
3) If the assessment raises a concern that the process isn’t progressing/performing as it should then the manufacturing process, automatically and in near real time, is sent commands to change its behaviour to steer the process to a successful outcome

The Benefits of SAMP

The ultimate benefit of SAMP is to produce right first-time manufacturing, and has the associated gains:

- Lower cost of production due to less scrap and rework
- Efficient production to meet sustainability demands
- All energy, raw materials and workforce effort is directed towards making products that go out the door first time rather than on scrap parts that do not see service

Case Study: Applying SAMP to Liquid Resin Infusion (LRI)

Liquid Resin Infusion (LRI) is a high value process used to create composite components and parts used in aerospace, marine and automotive sectors. A composite resin is injected into the manufacturing mould of a product or part. The technique is highly dependent on the skill of the operator, is very manual, and often produces high volumes of waste components when developing new parts. An energy intensive process, failures are not only expensive in terms of material, time, and cost but also emit higher carbon emissions.

As industry grows its use of LRI, there is a need to improve the process to enable parts to be made ‘right first time’ and ‘right every time’. In turn, this lowers the cost and time of developing new components and reduces the environmental impact of composite production by generating less waste. Improvements to LRI composite manufacturing can be achieved through data analysis and automation of the LRI process by the application of digital and 5G technologies.

Further utilising SAMP will reduce risk and dependency on operator skill of the LRI manufacturing process, developing a system that can automate elements of the process. In turn, process time and cost associated with developing new components, as well as their environmental impact, are minimised, enabling a number of key benefits:

- The automation element enables benefits such as labour cost savings and reduced process risk, each moving the LRI process in the direction of ‘right first time’ manufacturing
- Insight into the LRI process is gained, resulting from the data collected and visualised. The enhanced data capture was leveraged for data driven decision making, which led to shortened timeframes to ‘cure’ the composite, resulting in a reduction in energy usage
- Overall cost savings and an improved environmental impact of the LRI composite manufacturing process

A detailed report about using and implementing SAMP in manufacturing environments is available from **deti@nccuk.com**

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Developing an **immersive operations environment** for manual tasks

CHALLENGE

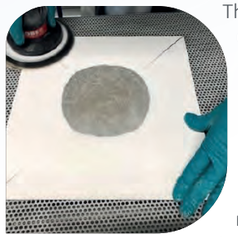
For companies that are starting out on their digital transformation journey, a lack of automation can appear a barrier. Integrating and automating technologies to undertake manual tasks and processes offers many benefits. Supporting manufacturing workforces to use advanced digital technologies in these scenarios enables agility, flexibility and a competitive lead.

Visualisation and immersive technologies provide new opportunities to present data on design and manufacturing processes, maintenance, and in training scenarios to users in manufacturing. They will enable industry to create better sustainable products in safer and more efficient environments, requiring less prototypes, developed in a shorter timescale, with reduced cost and waste.

RESULTS AND THE DIGITAL OPPORTUNITY

Visualisation technologies such as AR and VR, make it possible to realistically re-create natural or real environments that occur in industrial processes, such as those used in composites. The ability to move seamlessly from different ‘realities’ or technologies enables a design, build, maintain and decommission, end-to-end process.

- Augmented Reality (AR) is the integration of digital information with the user's real environment in real time. Unlike virtual reality, which creates a totally artificial environment, augmented reality uses the existing environment (the real world) and overlays new information on top of it
- Virtual reality (VR) is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment



The National Composites Centre (NCC) has produced systems to support operators who undertake manual, flexible tasks in the manufacture of composite parts. These systems focus on the physical process of layup, bagging and cure preparation for composites. This enables an increase in part consistency, a reduction in the volume of parts needing rework and the ability to predict failures earlier in the process, reducing the cost impact of errors.

The systems consist of:

- An Augmented Reality (AR) solution to inform, guide and provide feedback to an operator during manual manufacturing processes
- Artificial Intelligence (AI)- Machine Learning (ML) verification systems that validate and check the processes undertaken by the operator meet the required standards

The systems are setup as a deployable test bed and can demonstrate a range of use cases and specific customer case studies within composites manufacturing:

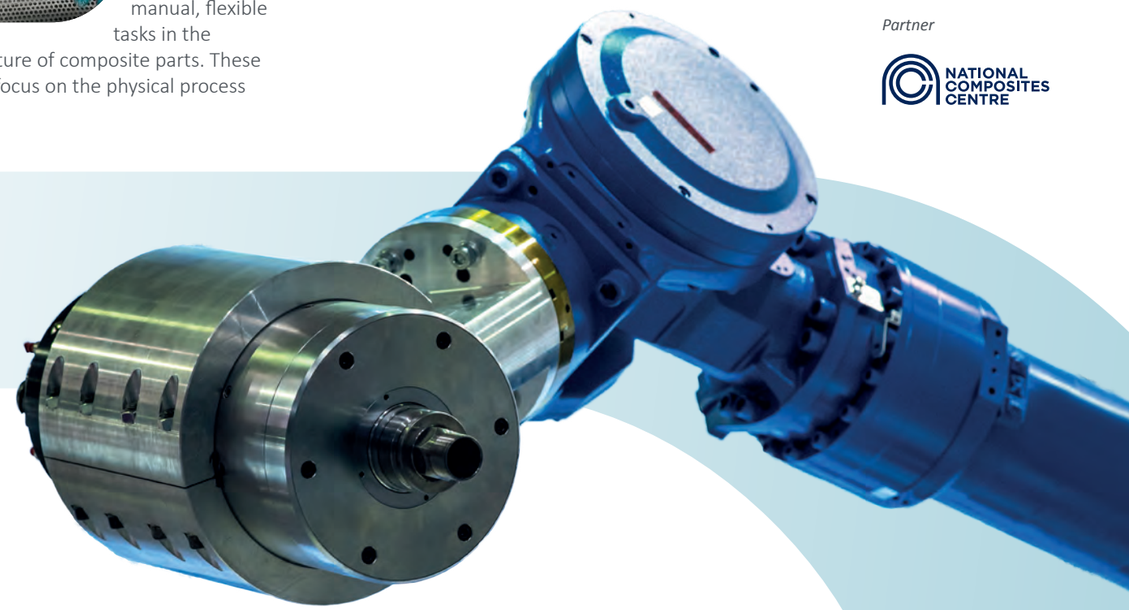
- A software framework hub manages operator guidance, verification and tool/part/device position referencing. It interacts with and gathers data from existing data sources using the latest Model Based Systems methodology

- Includes a built-in capability to deploy immersive output on to multiple device types like workbenches, wearable headsets and tablets
- Offers a verification capability to ensure the process operations are executed within the tolerance values required for task delivery
- Operator validation will oversee the starting and completion of tasks, to ensure the process operation is being followed
- Interacts with existing systems to gather data required to instruct and guide an operator during composite layup

Organisations interested in accessing the test bed can contact the NCC to arrange a demonstration; **deti@nccuk.com**

Partner

NATIONAL COMPOSITES CENTRE



Exploring how **servitisation** could unlock profits for **South West manufacturers**

CHALLENGE

Servitisation has huge profit potential for sectors like manufacturing. It can involve a transformation of the manufacturer from a business which is focused on building revenues around the production and sale of products, to one where a significant, sustainable revenue stream comes from services that focus on the outcome from the use of its products.

In the face of changes in consumer behaviour and an increasingly volatile socio-economic climate, the UK manufacturing industry has witnessed a rise in servitisation-based business models, with a 2020 report stating that 78% of manufacturers were either developing, or are already offering, services as an alternate revenue stream.

However, uptake in the UK is not as widespread as it could be, meaning viable opportunities to accelerate economic growth are not being grasped. In particular, servitisation could be key to unlocking regional growth, such as in the South West of England and Wales – an area rich in manufacturing sub-sectors including aerospace and defence.

RESULTS AND THE DIGITAL OPPORTUNITY

As part of DETI, Digital Catapult produced a report exploring the business case for servitisation to UK industry- particularly in the West of England- as well as unpicking the current challenges preventing manufacturers from reaping the benefits.

The report looks at how servitisation could play an important role in the post-COVID-19 regional economy, and how it has already shown potential for industries including aerospace, rail, heavy equipment and car rental.

Looking at a real-life example: an organisation called AE Aerospace in Birmingham – which specialises in the manufacture of precision machine components – has been assessing how a 'manufacturing-by-the-hour' service could help to differentiate from competitors.

Since AE's core activity revolves around traditional machining, they have integrated services on machine metal components into their offering. As a result of this new service, turnover has moved from £2.8m to £5m since 2016.

Elsewhere, the report examines skills gaps as a barrier to servitisation taking full-flight, looking at how manufacturers can look at upskilling existing employees – amongst whom a knowledge gap is likely to exist in the area of digital and programming skills, alongside hesitancy to work with unfamiliar technologies such as high-tech machines and automation.

Applying valuable learnings from the Advanced Services Group, the report looks at the benefits of targeted, regional interventions. Following servitisation successes in the West Midlands – a region with a proud industrial history – the South West of England and South Wales could stand to benefit significantly, given its specialism in transport and aerospace. Potential interventions examined in the report include the option of a 'best-practice', physical centre of excellence for servitisation.

The five key takeaways from the report:

1

Servitisation could play a significant role in propelling regional growth, with a notable presence from manufacturing and high value engineering businesses

2

Servitisation could help manufacturers build stronger long-term relationships with customers, from a one-time, completed transaction, to a series of regular interactions

3

Digitisation and IoT will play a significant role because servitisation of a product or service requires precise sensing of certain indices, including around usage and asset condition

4

Skills gaps are getting in the way, and are a major barrier to servitisation in the UK manufacturing sector. This is because the process of transforming to a product-service system requires both organisational and management capacities in a different manner to those required for product-oriented logic

5

Targeted, regional interventions could play a crucial role in helping organisations respond to increased societal appetite for services by adopting servitisation business models

Underpinning the report, a servitisation Proof of Concept (PoC) has also been produced to demonstrate the key digital components that can bring a servitisation business model to life. Through a rapid prototyping approach, the PoC demystifies the range of technology options available, by showcasing a best practice approach to developing 'connected' products.

It also explores the provision of the 'manufacturing cell' as a service. This will open up opportunities for new, servitisation-based digital business models, by providing visibility of carbon cost across the supply chain. In the long-term, this could mean a boiler manufacturer monitoring the energy efficiency of a boiler and providing this information, as well as any services linked to this, direct to the customer.

To access the servitisation PoC and discuss your requirements, email **deti@nccuk.com**

Partner

NATIONAL COMPOSITES CENTRE

CATAPULT Digital

THE ADVANCED SERVICES GROUP

Exploring the value proposition of digital engineering through industrial test beds

CHALLENGE

The need to embrace digital transformation to remain competitive and profitable is essential for growing businesses. The challenge is how to harness digital technologies to fuel innovation, agility and stimulate growth.

New business models, customers and markets offer growth and revenue opportunities. From IT to product development, design and manufacturing, digital technologies are the foundation to capitalising on the possibilities for the future.

Digital technologies will transform the way organisations and engineers operate to meet new product and market demands. Determining the best digital tools and technologies to invest in, through to exploiting value from the vast quantities of data generated through the product lifecycle, a greater exploration is needed by organisations.

RESULTS AND THE DIGITAL OPPORTUNITY

DETI has demonstrated digital engineering practice and concepts and developed a range of state-of-the-art physical and virtual industrial test beds. Open, secure access to these and DETI Partner test beds and industry relevant data and problem statements is available to organisations across the UK.

Targeted towards manufacturers, technology organisations and SME's, DETI test beds allow organisations to launch quick-fire digital projects to solve industry relevant use cases and learn about digital transformation, in a secure, industry-like physical environment, enabled and supported by DETI experts.

Organisations focused on product, process and technology development, can explore technologies to determine efficiencies, reduced risk, increased innovation opportunities, lower product development costs, and accelerated time to market.

Industrial test beds offer:

- Manufacturing and machine-led organisations the opportunity to explore the value proposition of digital transformation and technology without impacting production lines and business operations. They can be used to de-risk implementation, demonstrate ROI and increase business agility
- Digital technology providers the ability to access a platform to showcase, trial and develop their products and virtual services. Organisations can provide technology and hardware which can be integrated into the test bed and tested through industry use cases

Virtual access to DETI test beds allows for active engagement from a wider audience within an organisation and de-risks business adoption by improving cultural uptake, offering mechanisms for offsite training.

DETI has also produced a range of digital prototypes and proof-of-concepts already embedded in test beds that use Artificial Intelligence, Machine Learning, digital twin, and visualisation technologies, so companies are not starting from scratch.

Industrial test beds available through DETI and its partners include:

- **High Value Digital Design & Engineering (CFMS):** A recognised and trusted digital test bed for digital design and the exploration of high value engineering products and processes to improve industrial productivity
- **Smart Factory Operations (NCC):** A full scale industry relevant facility to evaluate digitally enabled operations use cases: Operations control centre, energy monitoring, predictive maintenance, asset and resource tracking and flow optimisation
- **I4.0 Manufacturing of Composites (NCC):** A series of full-scale physical composite manufacturing cells to evaluate use cases: sensors and data acquisitions, dashboarding and augmented applications and self-adaptive manufacturing process
- **Augmented Manual Operations (NCC):** Access to virtual reality and augmented reality systems to evaluate use cases: Immersive training scenarios, guided and verified hand lay-up of composites, digital work instructions
- **In Factory IoT (NCC):** Access to networking, IT and IoT infrastructure to evaluate architectures and deployment of IoT, 4G and 5G, cybersecurity and quantum key distribution solutions (hardware and software)
- **Quantum Key Distribution (QKD) (NCC & CFMS):** Access to a quantum-secure network and test bed to demonstrate and test secure, remote communications for design and manufacturing applications
- **Fully functional cellular technology facilities to bring solutions out of R&D for testing as an early real-world deployment at Digital Catapult (London and Brighton):** Open access and expert technical support to innovators wanting to test and develop 5G-enabled services and applications
- **Centre for Machine Vision (BRL, UWE):** expertise and facilities in innovative machine vision and state-of-the-art machine learning for demonstrating how automation can improve manufacturing processes, for prototyping and validating new innovations
- **Smart Internet Lab:** Based at the University of Bristol, it is one of the UK's most renowned Information and Communications Technology (ICT) research centres which addresses grand societal and industrial challenges across IoT, 5G & beyond, Future Transport Networks, Smart Cities, Autonomous Networks, Machine Learning, Artificial Intelligence, Network, Convergence, Mobile Edge Computing and Network Softwarization
- **A fully integrated R&I facility for advanced propulsion systems (University of Bath):** that can handle complete vehicles, individual systems or single components through bespoke cell configuration, utilising the latest measurement equipment designed to offer partners timely, consistent, accurate and repeatable data, analysis and results

To access the range of DETI and partner industrial test beds and discuss your requirements, email **deti@nccuk.com**

Partner

Adopting the **Internet of Things** to provide a top-class service for customers

IoT can be used to collect and aggregate data from sensors, improving traceability of assets and supply chains

CHALLENGE

Slowly but surely, manufacturing businesses are beginning to move away from product-only business models, exploring ways to unlock new revenue streams through servitisation.

The case for servitisation is significant, especially in regions where advanced manufacturing industries dominate like the West of England – as identified in a recent report by Digital Catapult.

Of the many advanced digital technology options available to facilitate the journey to servitisation-based business models, the Internet of Things (IoT) has clear potential.

Industry adoption of future IoT technologies will increase productivity, lower costs, improve product development and improve customer insights. IoT can be used to collect and aggregate data from sensors, improving traceability of assets and supply chains, and can even be used to retrofit legacy equipment.

However, while many manufacturers are aware of the importance of IoT for their businesses, many still struggle to identify use cases for IoT within their business, effectively monitor their assets, or understand the technical architecture required for meaningful adoption of IoT solutions.

RESULTS AND THE DIGITAL OPPORTUNITY

For DETI, Digital Catapult has produced two technical reports on the Internet of Things and how it can be used by manufacturers to create robust servitisation solutions.

IoT Monitoring Report: IoT monitoring accounts for more than one third of IoT use cases. Digital Catapult's **IoT Monitoring Report** explores the value of monitoring assets, including why data is such a crucial component of this.

Taking the reader through the journey of developing an IoT monitoring use case, it answers longstanding questions on how effectively asset monitoring can be achieved through the adoption of IoT. It summarises which components and technologies are necessary for achieving an IoT solution in general and provides guidance on best practices- helping the reader navigate the technology landscape.

IoT Architecture Report: IoT architectures are complex; and much of the current challenges relating to scalability; interoperability and security relate to poor architectural choices.

The IoT Architecture Report details the sophisticated architectural components, technology and methodologies required for achieving an IoT solution. Discussing the open and proprietary technology choices available – taking sensors, edge compute, networking and cloud compute and service technologies into consideration – the report explores how IoT can serve an invaluable business purpose.

The report provides key information on where the key architectural decision points are, and the implications for return on investment, as well as looking at how IoT can be integrated into the fabric of organisational operations- empowering readers to start their IoT journeys.

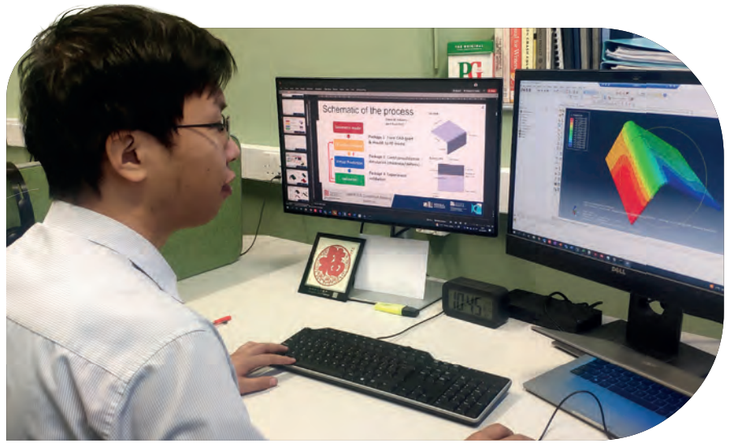
Access to the IoT Monitoring and IoT Architecture reports and environments is available from **deti@nccuk.com**

Partner

NATIONAL COMPOSITES CENTRE

CATAPULT Digital

Developing efficient modelling of manufacturing capabilities



The deployment of manufacturing simulation tools within composites is critical in reducing composite parts costs and in helping a greater range of industries access composites products and utilise their engineering benefits. Accuracy of the predictions and speed of the simulations are the two main challenges for greater use of simulations in the design and manufacturing cycle of a composite part.

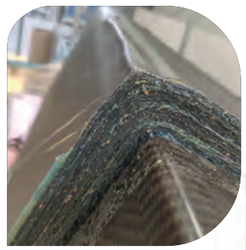
CHALLENGE

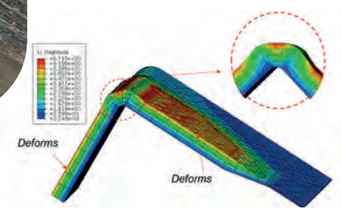
Currently, design and manufacturing of composite components is expensive and time consuming. A major impediment of current practices is that very few simulations are used in manufacturing cycles, with extensive physical trials still being the state-of-the-art.

RESULTS AND THE DIGITAL OPPORTUNITY

The Bristol Composites Institute at the University of Bristol has developed a simulation tool that provides uniquely fast, and accurate simulations for the manufacturing of composite components. The simulation tool is able to give an accurate prediction of the final thickness of the part and the formation of defects from the production process at a laboratory scale, effectively reducing waste, energy and carbon emissions.

An automated piece of software for the prediction of thickness and production-induced defects in composite parts has also been developed as part of the project. A physical demonstrator of industrial size and complexity was used to assess the accuracy of the software tool. Results highlighted the accuracy of the software tool in predicting the quality of the demonstrator part. An automated tool allowing for optimisation of the tooling for increased part quality has also been developed.





The simulation model process is entirely automated, which allows users with only a cursory knowledge of the complex mathematical models behind the software to be able to use it. A completely automated workflow for composite tooling design has also been developed.

The automated simulation tools developed are available for industry use from the University of Bristol and the National Composites Centre, which results in significant cost savings per part by suppressing one full design cycle.

To access the simulation tools and discuss your requirements, email **composites-institute@bristol.ac.uk** or **deti@ncc.uk.com**

Partner

University of BRISTOL

Enabling Quantum-secure 5G enabled Mobile Edge Computing (MEC) for manufacturing

CHALLENGE

With maturity of 5G technology and its commercial availability, 5G is becoming the connectivity technology of choice in the autonomous and smart manufacturing industry.

5G offers on-demand, high-bandwidth with low latency (minimal delays on a network or internet connection) connectivity for all connected devices, sensors and robotic apparatus in a manufacturing eco-system. This enables the realisation of advanced, intelligent, autonomous and predictive manufacturing control processes and workflows that are more efficient.

RESULTS AND THE DIGITAL OPPORTUNITY

Another technology often associated with 5G is Mobile Edge Computing (MEC). MEC provides limited but powerful computing power at the edge of the network close to end user devices for low latency computing tasks. This is an important technology for smart manufacturing, especially for time critical manufacturing processes. These processes require low-latency computing on real-time data to proactively react to different situations along the manufacturing line.

Modern analytics algorithms and processes in smart manufacturing such as those used at the National Composite Centre (NCC) are often very complex and computationally demanding as well as requiring processing of large data sets in real time. These requirements cannot be met by the limited computation power of MEC and as such the process has to be divided between MEC and a remote data centre with time sensitive processes. An example is an AI (Artificial Intelligence) Deep Neural Network Model where a machine is being trained to undertake thermal image analysis of material. This computationally intensive training can be done in a remote data centre while the operation of the trained model can be hosted at the edge to operate at low latency.

The interaction between MEC and the remote data centre require an exchange of sensitive data and manufacturing models. This requires a high level of security, especially for highly sensitive manufacturing process data (from a national security or IP (Intellectual Property) perspective).

To address this problem, the Smart Internet Lab at the University of Bristol has created and successfully demonstrated a 5G MEC that supports quantum security for secure communication with a remote data centre. Quantum security utilising the no cloning principle of quantum physics provides an ultra-secure solution for an unbreakable network communication cryptography.

A MEC has been implemented and integrated with the 5G test bed at the University of Bristol and the NCC 5G network and test bed. It can host AI and processing algorithms for low latency control of manufacturing robots at the NCC. It also connects to the 5G network at the NCC to collect data from manufacturing lines, their sensors and robotic facilities. The MEC network also integrates with quantum cryptography interfaces and quantum transponders. This enables quantum secure connectivity between the NCC 5G network and a remote data centre. The MEC utilises advanced algorithms that also partitions data flows based on their security requirement. It is able to transmit data with high security requirements over an optical network from the NCC to a remote data centre (in this case the University of Bristol 5G test bed) utilising quantum cryptography.

Demonstrated for the first time, quantum secure MEC is able to aggregate traffic from a private 5G manufacturing network and transmit to a remote data centre utilising quantum security.

To access the range of DETI and Partner industrial test beds and discuss your requirements, email **deti@nccuk.com**

Partner

University of BRISTOL

NATIONAL COMPOSITES CENTRE

Developing digital skills and capabilities

Boosting digital skills in the workplace

CHALLENGE

The UK is suffering a skills deficit when it comes to digital engineering, recognising the need for developing skills in the existing workforce and providing training for future entrants.

A range of virtual and online training and CPD courses are available to help manufacturing companies and individuals to bridge the current gap and visualise the possibilities of a future which has digital tools at its heart. Covering key topics and 'buzzword' areas for digital engineering, the courses demystify terms and provide learning that can easily be applied to businesses.

To express an interest or register to attend a course, scan the QR code.

RESULTS AND THE DIGITAL OPPORTUNITY

Big Data

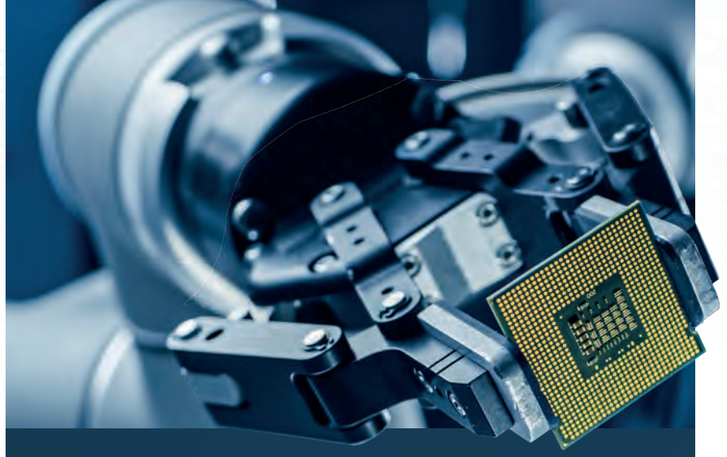
UWE Bristol University of the West of England

The Internet of Things (IoT) has seen an upsurge in the use of sensors, connected devices and a vast amount of data collection. Often this data is too large or complex to be processed by traditional software, referred to as Big Data. Harnessing Big Data in manufacturing enables the identification of really complex patterns and variables from sensors and human interactions that affect production. Analysing this can enable significant process improvements. This course both demystifies the term Big Data and gives learners the opportunity to understand how it can be used to improve business performance in their own organisation. Free to attend.

Introduction to Design for Composites

NATIONAL COMPOSITES CENTRE

Aimed at people new to or interested in working in the South West's high growth area of composites – a diverse range of advanced materials used by sectors including aerospace, automotive, construction and infrastructure, medical devices and energy. This course provides learners with an understanding of the key requirements needed in composites, and the tools and techniques needed to confidently develop robust concept designs.



Visualisation Technologies in Digital Design & Manufacture

UWE Bristol University of the West of England

The use of immersive technology can revolutionise how organisations design and develop products. This course focuses on Augmented and Virtual Reality (AR and VR) visualisation tools which allow engineers to enhance collaboration. AR and VR can enable optimised concept design, where a multi-disciplinary team can work at the same time, speeding up the process. It can be used to simulate, test and validate digital prototypes reducing cost and impact to the environment. It can also be used for training, service repair and remote assistance giving learners an experience far closer to industry than traditional classroom learning. Free to attend.

Digital Learning Factories

WEST OF ENGLAND Combined Authority

SMEs in the West of England have the opportunity to develop their digital capability for free, as part of the West of England Combined Authority's Workforce for the Future programme. Five Digital Learning Factory training modules have been created by the National Composites Centre, GKN Aerospace and Bristol Robotics Laboratory (BRL) to give businesses and their employees the understanding and confidence to apply digital technologies in the workplace. The modules listed below combine practical, problem-solving exercises and critical reflection, which enable participants to use their new experience straight away.

- **An Introduction to Robotics –** an overview of types of robotics available as well as hands-on experience of robot programming and operating systems
- **Introduction to Smart Benches –** how to build your business case, transform a workstation into an interactive environment and integrate into your business
- **Creating an Internet of Things (IoT) Network –** understanding what an IoT is, how to efficiently set out your requirements and how physical networks are established
- **Data Collection and Display –** digital engineering relies on data collection, display and analysis to provide the input for decisions. This module will help you pick apart sources of data within a manufacturing environment, how they are measured and how they are displayed
- **Immersive Technologies –** this module will introduce current visualisation tools and methods available to enable you to understand the most appropriate tools to use in your business

European Union European Social Fund

Inspiring the **next generation of engineers**

Boosting digital engineering skills and inspiring the next generation of engineers

The West of England is a hub for innovative Science, Technology, Engineering and Mathematics (STEM) industries, but as with the rest of the UK, there is a huge skills and employment gap for future engineers.

Women make up just 12% of Engineers, and 26% of the UK Science, Technology, Engineering and Mathematics (STEM) workforce, despite making up 51% of our population. Similarly, people from Black, Asian and Minority Ethnic backgrounds make up 7% of engineers, despite being 13% of the UK population.

People from low socio-economic backgrounds or those with specific learning difficulties also find it harder to access engineering education.

Encouraging diversity and inclusivity, the DETI Skills Inspire programme engages children in primary and secondary education across the West of England, with a focus on disadvantaged areas. Using curriculum-linked engineering outreach and careers support, they connect children with real-life, diverse engineering role models, widening participation and aspirations for STEM careers.

UWE Bristol's School of Engineering, Design and Mathematics Department (EDM) are leading the Skills Development branch of DETI, establishing an engineering engagement hub for the West of England, based out of the new state-of-the-art Engineering building on Frenchay campus. Working in collaboration with key DETI partners and industry supporters, they are delivering Skills Development programmes that cover primary and secondary education, further and higher education institutions, and upskilling and reskilling the current and future workforce to ensure they are digital ready.

The following highlights present DETI Skills Inspire engagement activities in the region delivered throughout January 2021 to August 2022.

Partner

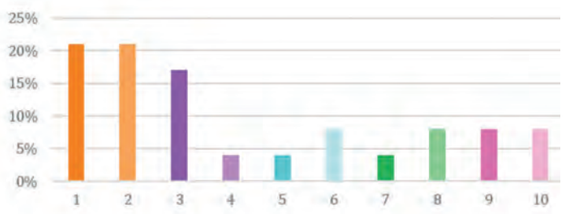
UWE Bristol | University of the West of England

DETI Skills Inspire summary

DETI Skills Inspire has delivered an impressive array of outputs and engagement activities with primary and secondary schools.

Since January 2021, the team have directly engaged 17,401 children aged 4-18, and 452 teachers from 218 schools and community groups in the West of England. This equates to an estimated total of 106,872 children reached. Along the way, children have been able to have conversations with real-life engineers through Q&A sessions, card games and skill shares. So far 456 engineers have shared their experiences, as well as at least 18 industry partners and 4 charities.

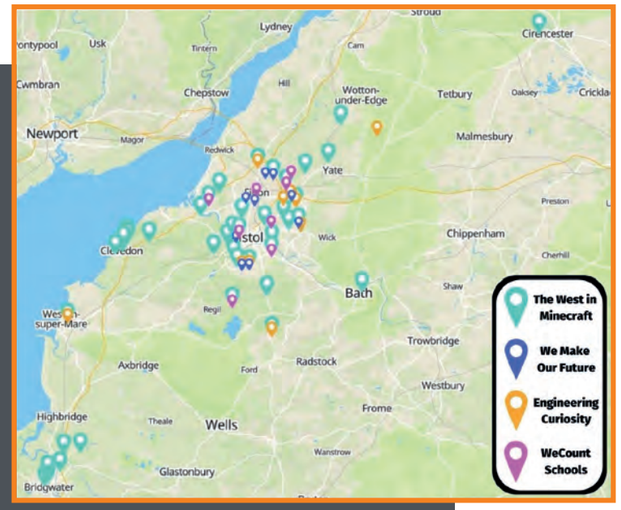
33% (5,787) of all direct engagements with children were delivered in-person via Inspire workshop sessions. These included: The West in Minecraft (delivered to 2,948 children), We Make Our Future (delivered to 766 children), Engineering Curiosity (delivered to 821 children), and WeCount Schools (delivered to 560 children). 29% (1,699) of all children engaged by Inspire workshop sessions came from areas within the most deprived 20% of the country.



Index of Multiple Deprivation (IMD) scores for schools and community groups engaged by Inspire

The DETI Skills Inspire programme has excelled over the past few years, adapting to changing rules and guidance. The team were able to enrich children and young people's cultural experiences, offering well attended online and offline events, with two online events reaching 9,000 children and young people.

The programme has also supported the Leaders Award, Great Science Share, Lego League, South West STEM Fest, and Bristol's Storytale Festival. DETI Skills Inspire is excelling in promoting engineering for sustainability among children, young people and adults from diverse backgrounds, not only in the West of England, but also nationally and across Europe.



Locations of schools and community groups engaged by Inspire activities. Note: where some schools have received multiple engagements, location colour indicates the most recent engagement type

Partners

UWE Bristol University of the West of England

Encouraging Engineering Curiosity

Research indicates that children need to see a wide variety of role models in order to enhance their identification with people in STEM (Fogg-Rogers & Hobbs, 2019). A critical DETI Skills Inspire resource has therefore been the development of new role modelling career cards for KS2 and KS3 children.

DETI Skills Inspire collaborated with **MyFutureMyChoice**, an education charity which promotes engagement and connection with STEM careers. The collaboration culminated in a card game "Engineering Curiosity" (in the style of Top Trumps) showcasing the wealth of different engineering roles and opportunities available. The cards show a great diversity and variety of engineers, with accompanying skills, background context, and colourful illustrations, and are available to download from the **Curiosity Connections website**.

Over half of the Engineering Curiosity cards are made up of women

The engineers depicted on the cards are based upon real engineers working in the West of England. To describe their job and determine their Top Trump scores, the engineers were interviewed about their route into engineering, as well as their skill set. A conscious effort was made to include more females and people from Black and Asian backgrounds, as they are underrepresented in the engineering field. The diversity of people, careers and workplaces is intended to challenge perceptions of engineers and the jobs available in STEM and show the children that people like them are part of engineering.

Each card is also accompanied by a short Tik-Tok style video, made by the engineers themselves, showing them at work or talking about their role. The videos are fun and light-hearted, intending to further cement the concept that engineers are real people and that they come from a wide range of relatable skills and backgrounds. The videos can be accessed through the DETI Inspire YouTube channel.

In addition to the card pack, a full set of lesson plans, assembly ideas and activities have been developed for use with KS1, KS2 and KS3 classes. The resources are designed to work best with live interaction and support from a STEM ambassador or student engineer, however they also include suggestions for online delivery.

Engineering Curiosity cards have been offered free to every school involved. 327 packs have been sent out to 79 different schools and community groups.

The cards and resources have also been used directly in DETI Skills Inspire outreach, these engagements equate to 821 children, across 25 classes in years 3-8.

Partners

UWE Bristol University of the West of England

my future my choice

The West in Minecraft

Pupils of Watermore Primary, South Gloucestershire, re-engineering their area in Minecraft, with Mayor Dan Norris. Photo courtesy of West of England Combined Authority

If you could completely re-design your city, your street, your home, what would you do differently?

Using the incredibly popular block-building video game 'Minecraft', DETI Skills Inspire have been exploring digital engineering in the West of England with local children.

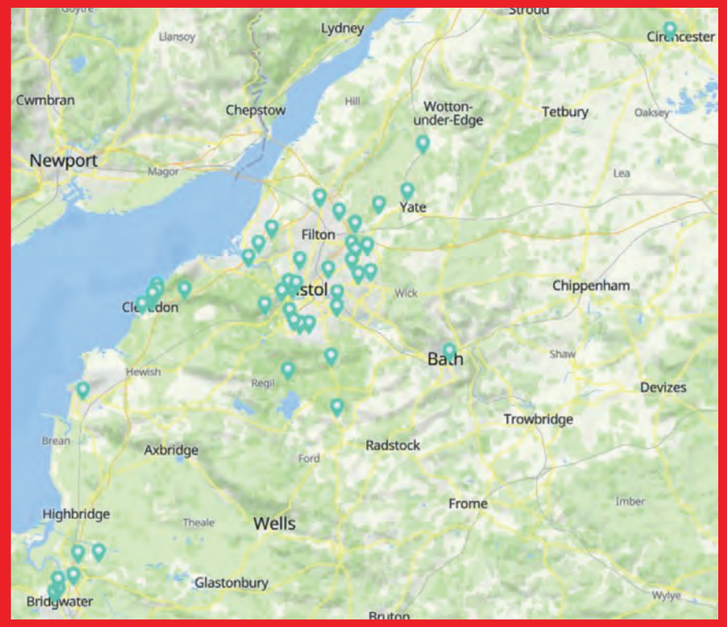
Minecraft is the second-best selling video game of all time and extremely popular with children. Players place and break blocks with a wide range of appearances and properties, to build a huge variety of constructions. It's easy to make changes to your builds and quickly visualise new ideas, much like computer-aided design (CAD) software used for digital engineering.

The West in Minecraft educational resource pack and workshop was developed in collaboration with the Science Hunters programme, through their engineering strand Building to Break Barriers, funded by the Royal Academy of Engineering Ingenious scheme.

The accompanying resource pack takes a digital, play-based approach to support children to develop their own ideas and problem-solving skills. It encourages them to engage with engineering as a creative and diverse subject that can impact the world around them. The lessons use the Minecraft world as the setting for children to explore, build, re-design and re-engineer the city around them.

Clifton Suspension Bridge

Bristol Harbour and the SS Great Britain



Location of schools and community groups who have so far taken part in The West in Minecraft

The team worked with engineers from Atkins, a member of the SNC-Lavalin Group, who were able to map Ordnance Survey data into Minecraft, resulting in accurate replicas of the cities of Bristol and Bath. The Minecraft world was then brought to life with landmarks in the West of England (Clifton Suspension Bridge, SS Great Britain, Bristol Temple Meads, and the Roman Baths), created by Science Hunters team member, Jonathan Kim.

Since its official launch in September 2021, The West in Minecraft has been delivered to 2,948 school-aged children, from years 3-10, either in a classroom or community setting. The reaction to The West in Minecraft has been hugely positive. Most children have already heard of or played Minecraft, but never used a world that digitally twins reality in the way that this session allows.

As part of the West of England's Climate Emergency Meeting in September 2021, the West of England Metro Mayor, Dan Norris, attended a Minecraft session at Watermore Primary School. Here he was able to talk to students about their ideas for sustainably developing their area.

Partner

Visualising sustainability and engineering solutions

In October 2021, DETI Skills Inspire partnered with I'm an Engineer to host the Youth Engineering for Environmental Sustainability Summit (YEESS), ahead of the UN climate change summit COP26 which took place in Glasgow November 2021.

The YEESS enabled young people (aged 16-18) from the West of England region to connect with local engineers and policymakers. This allowed them to explore how engineering can help tackle the Climate Emergency and discuss the interconnected solutions needed for future sustainability.

The summit focussed on three key themes from the West of England and Ecological Strategy and Action Plan, the Bristol Climate Action Plan and the West of England's goal to reach net zero by 2030: Transport, Energy and Waste.

Through a series of videos, created by engineers and activists, and live chats, students were encouraged to visualise what future climate solutions might look like.

From engineering innovation to societal change, they were able to discover what green jobs and career paths are available, and ask questions of West of England Mayor, Dan Norris (top right image), Bristol Mayor, Marvin Rees and Roy Kareen from the Centre for Sustainable Energy (right), Councillor Toby Savage of South Gloucestershire Council and Savita Custead – from Bristol Natural History Consortium' (above).

In total, 12 engineers engaged with 51 students from seven schools across the West of England during the three days of the online summit. A further 20 students from Orchard School attended a physical one-day version of the summit, held at We The Curious science centre.

The discussion toolkit and video resources are available as an educational resource pack for KS4 and KS5. To download, please visit Digital Trailblazers. The pack can be run independently by schools or community groups, or delivered by the DETI Skills Inspire team as a 2-hour workshop.

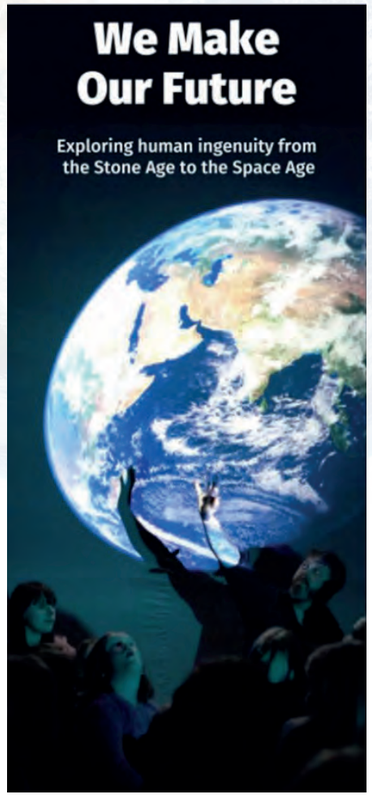
Partner

UWE Bristol University of the West of England

I'm an Engineer Get me out of here

We Make Our Future

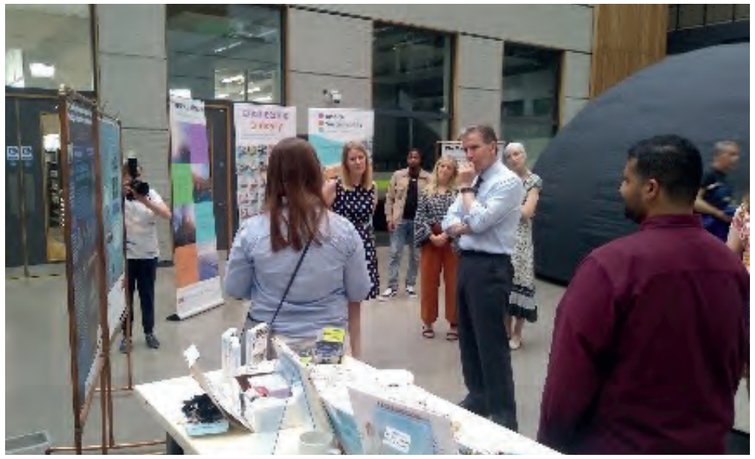
For COP26, the DETI Skills Inspire team, in collaboration with planetarium experts **Explorer Dome**, created a new experience to celebrate the ingenuity of human engineering.



It also addresses current issues around climate change, and introduces engineering as a relevant and attainable aspiration for all young people.

The new show, called 'We Make Our Future', was showcased in the Green Zone of COP26 Glasgow in November 2021. The show is presenter-led, interactive, educational and entertaining, to inspire the next generation of engineers. The experience highlights the urgent need for climate action along with the potential of green technology for economic and social progress.

Inside the mobile Explorer Dome, 360° digital projections allow audiences to visit engineering marvels from history and explore the pros and cons of technology in modern life. Design thinking offers hope to young children that humanity can solve global problems and bring about real change.



West of England Metro Mayor, Dan Norris, at the Green Skills event which showcased the Explorer Dome

Children are asked to use their imagination and creativity to come up with ideas and suggestions for sustainable solutions that address climate challenges.

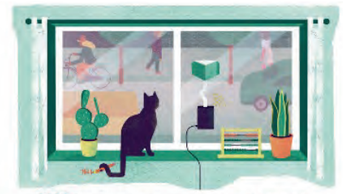
Between June 2021 and February 2022, We Make Our Future has been presented to 12 schools from the West of England – 8 in-person, plus a further four schools online. This equates to 1,458 children, from 49 classes, from years 3 through 7. More schools have booked shows to take place in 2022 & in 2023, and the show is also available as a paid for service through Explorer Dome. Thanks to a grant from the Royal Academy of Engineering Ingenious programme, the show has continued to be offered for free to schools in areas of high multiple deprivation.

Partners

UWE Bristol University of the West of England

EXPLORER DOME

WeCount Schools



Working in collaboration with EU citizen science project WeCount, DETI Skills Inspire co-produced an educational resource pack for KS2, KS3 and KS4.

The packs are themed around digital technologies (e.g., sensors) for urban mobility and how people move between locations. This looks at supporting children to learn about the challenges' cities face in relation to urban travel, air pollution and the steps they can take collectively to make their school streets, and cities, safer, healthier and happier. The resources contain all the teacher needs to deliver curriculum-linked lessons, covering maths, computing, science, and engineering. The resources sit alongside the other themed packs on Digital Trailblazers.

As part of the project, participating schools are equipped with low-cost traffic sensors to count cars, bikes, pedestrians, and heavy vehicles, as well as the speed of cars. Over time, "citizen scientists" can collect, analyse data, and observe trends on their roads.

Thanks to the collaboration with the WeCount project, the educational resource packs have reached a European audience. They have been shared amongst schools in Dublin, Ireland and Leuven, Belgium- four of WeCount's case study cities, and advertised on WeCount.

DETI has also developed primary and secondary WeCount-themed lesson plans for the British Science Association, which were featured in their annual resource packs for British Science Week 2022, with 70,944 downloads.

A similar pack of resources has also been developed for KS3 for The Scholar's Programme of The Brilliant Club. The Brilliant Club is a national charity working with PhD students to support less advantaged pupils to access the most competitive universities and succeed when they get there. They currently work with 15,000 schools, covering most of the UK.

Since deployment in 2021, nine schools (including Oasis Academies Brightstowe and Brislington which are in the 20% most deprived areas of the country) have been directly engaged with the educational resource pack via Inspire workshop sessions, representing 560 children

WeCount Schools being delivered to Year 6 pupils at Elm Park Primary

Thanks to the collaboration with the WeCount project, the educational resource packs have reached a European audience, while during British Science Week 2021, the packs were downloaded for use in schools over 70,000 times

Partner

UWE Bristol University of the West of England

WECOUNT

DIGITALNOW

Partners

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DIGITAL ENGINEERING TECHNOLOGY & INNOVATION

WEST OF ENGLAND
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