BMT

Signal...

Digital Twins

News and opinions from industry experts

Ones to Watch

A round-up of recent news

US uses Digital Twin approach to extend US Army Service

A Black Hawk helicopter Digital Twin is to be built using 3D scanning and technology. **The Black Hawk entered military service 41 years ago** but has been out of production for nearly 15 years, leading to problems sourcing low volume parts quickly enough.

3D scans of the fuselage and components will be undertaken on an operational Black Hawk helicopter. The goal is to have a **fully digitised 3D CAD model** that can then be easier manufactured in low volumes – either by traditional methods or additive manufacturing.

Beyond resolving supply-chain issues, the Digital Twin will also **allow the US Army to improve maintenance** issues by creating training programs for its engineers in VR, without the need for a functioning aircraft.

Find out more

BAE Adopts Digital Twin Approach for Tempest Aircraft Design

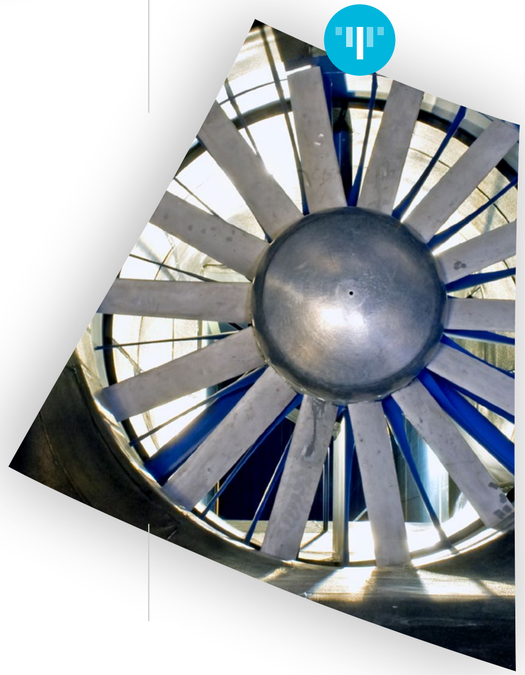
BAE Systems has used Digital Twin technology to design, test and fly new concepts for the **Tempest fighter jet.**

Conceptual shapes for the aircraft have been virtually designed and tested, using the **latest Digital Twin technologies**, with high-performance computers able to calculate the aerodynamic performance of different aircraft features and test pilots taking Tempest to the skies from a ground-based simulator.

Following digital testing, scale models were 3D printed and put through their paces to physically test the aerodynamic properties of the design under wind speeds of more than twice the speed of sound.

Data from these trials is now being used to refine and shape the final design of the UK's next combat aircraft, which **will be in service by 2035.**

Find out more



Coming up to the Anniversary of the National Digital Twin Hub – What have they achieved?

The Centre for Digital Built Britain's Digital Twin Hub (DT Hub) has signed up **more than 700 members** since it was launched in March.

The DT Hub is a web-enabled community to foster communication, connections and collaboration between Digital Twin practitioners within the built environment. The focus has been on the Digital Twin owners, both actual and potential, and on the suppliers of relevant products and services, as well as other key contributors, such as academics.

The community provides a space for conversation with varied online and offline discussions based around common themes, as well as regular webinars, workshops and other events to explore topics in more depth.

As part of this process, they launched the Information Management Framework Community, which aims to play a pivotal role in shaping the underpinning framework that will support the subsequent development and integration of emergent Digital Twins into a connected ecosystem.

The Gemini Programme has also been established, which aims to develop resources for the DT Hub community and expand the outreach of the Information Management Framework and of the programme itself. The Gemini Programme brings together people and organisations willing to contribute time and resources to develop materials for use by the DT Hub community.

Find out more

Team Defence Information Releases "Digital Twin Roadmap"

Team Defence Information, a collaborative association that informs defence information policy and pilots new ways of working, has launched its latest joint industry white paper, a roadmap for Defence Digital Twins.

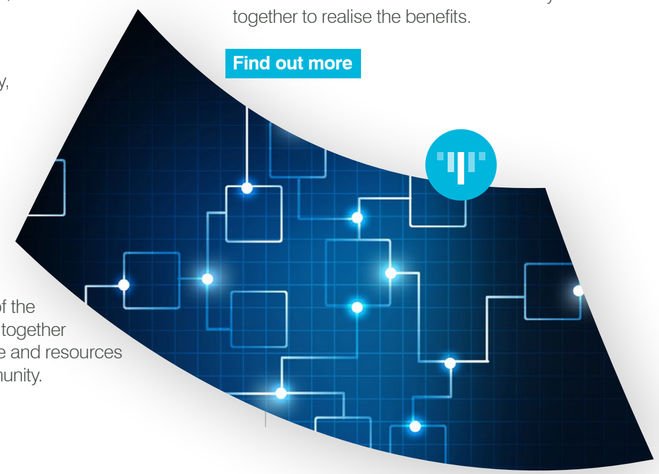
The Defence Digital Twin Road Map and Development Framework builds on the previous White Papers for Digital Twins and Information Architecture; it is also based on the MOD Digital Strategy for Defence - Delivering the Digital Backbone and unleashing the power of our data. The aim of the road map is to define the elements necessary to create an enduring framework for UK Defence that will support the adoption of Digital Twins as business-as-normal and form part of the wider digital enterprise. It identifies framework elements that can be either adopted or modified from existing industry good practice and those items that Defence needs to create.

The paper brings together the thoughts of leading industry experts from over 45 different companies to discuss the five main Digital Twin development workstreams of:

1. Governance and Lifecycle
2. Data and Infrastructure
3. Sense and Decision Making
4. Enablers
5. Change

The paper also makes some clear recommendations for the next steps and further work to bring to vision and promises of Digital Twins to Reality. A must read to understand how the MOD and Industry can work together to realise the benefits.

Find out more

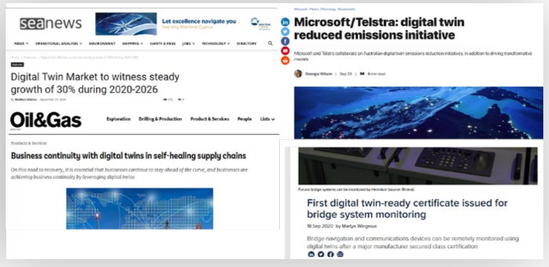


Introduction

Is Digital Twin just a buzzword?

The 'Digital Twin' is now a recognised core component of the Industry 4.0 journey, helping organisations understand their complex processes, resources and data to provide insight into their business and help optimise their operations.

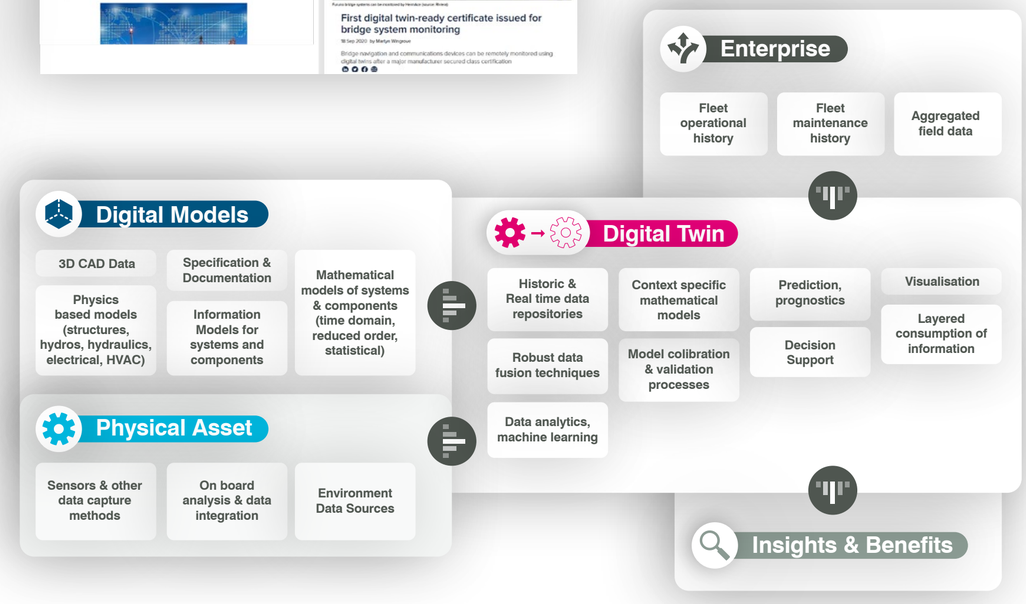
Despite this there are still multiple definitions and understandings of what a Digital Twin actually is. All this has led to a "mysticism" around the concept often overused as a technology buzzword, with over 19 million news articles featuring the term in 2020 alone (Source: Google News). Because of this the term is often misused and misunderstood, adding to the confusion. This edition of Signal aims to define the Digital Twin, explain key enabling aspects and explore the value that twins can bring.

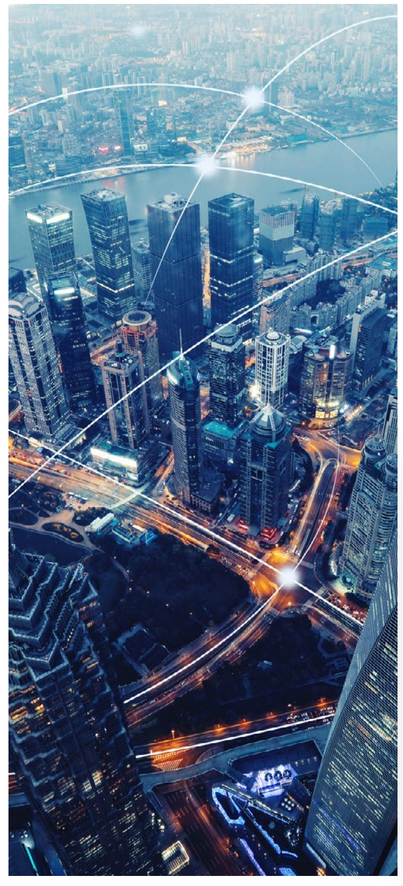


What is a Digital Twin?

We at BMT define a Digital Twin as "A virtual representation of physical assets, processes / people / places / systems / devices that when fed or provided with real-world data enables effective decision making to optimise the performance and utility of the system of interest". A collection of software models and simulations supplemented by data from live (or time delayed) measurements enable an informed decision-making process. Twins are, first and foremost, learning systems, driven by data that's collected from sensors in real time. An example component structure of a Digital Twin for a ship is provided below and shows how the digital models and documentation from the design process can be combined with physical asset data feeds to provide intelligent decision support, insights and benefits.

This is just one example of a twin, the item doesn't need to be a physical asset, it could be a process or even an event/organisation (as explored later on in this edition looking at applications of policing). In reality, the data feeds are not likely to be clean, therefore it is likely a data virtualisation or abstraction layer will be required which can pull together information from a range of different sources. With these multiple data streams feeding different parts of a twin, it is helpful to think of the twin as a number of twins - or threads - like a tapestry.



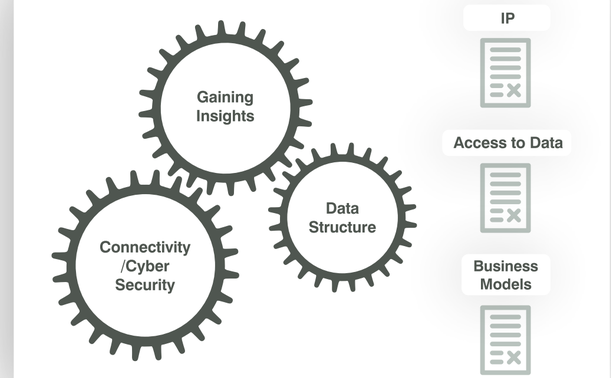


Why Now?

Although the concept of a Digital Twin is not new (the term was first used in 2002 and the original information concepts date back to the 1980s), there are several enabling factors that are coming together to accelerate the implementation of twins. The first of these is cheap, high bandwidth sensing availability; the Internet of Things is a key enabler for twins. The second is the abundance of cheap data storage and advances in data management. The third is the increased accessibility of the high-performance computing (HPC) required to manage the computing burden of a functioning twin. Finally, advances in integrated design and analysis environments are creating key digital threads at the start of the lifecycle, enabling the later creation of a twin.

Barriers to Development / Next Steps

The primary barriers to development that need to be overcome can be broadly split into two key areas, commercial and technical. From the commercial side the defence and security sector has traditionally contracted separately for design, build and maintenance contracts. These contracts are focussed on the provision of physical equipment and not on the provision of data and models. This approach typically results in the involvement of multiple prime contractors for each asset through life, and a correspondingly complex supply chain network. New commercial models will be required to enable access to data whilst also protecting Intellectual Property Rights. Work is also required on the overall business case; to really understand where true value can be gained. There should be just enough complexity in the twin to enable the key benefits, designing an economical system that meets the needs of the enterprise.



From the technical side, the next key steps include moving from systems level twins, as already in use by equipment manufacturers such as Rolls Royce (Ref) to a more complex system of systems or platform level twin combining the different digital threads. This increase in complexity will create challenges for connectivity/ cyber security, data structure/management as well as enabling insights from multiple data inputs.

To draw on these points, we will explore the following areas of development in more depth in this issue of Signal:

- Secure by Design – How to build in cyber security from the system design
- Data Governance – The importance of high-quality data
- Asset Management – How can a Digital Twin be a key enabling tool for asset management methodologies.

Many of the next steps to develop the concept of Digital Twins in the Defence Sector are now also defined in the Team Defence Information Digital Twin Roadmap, a document that BMT has helped to produce alongside a wide range of industry partners and UK defence stakeholders.

Asset Management

Asset Management: Enabled by Digital Twins

You may have also heard the term "asset management" alongside discussions on Digital Twins. Senior Consultant Michael Jones explains the difference between the concepts and how one enables the other.

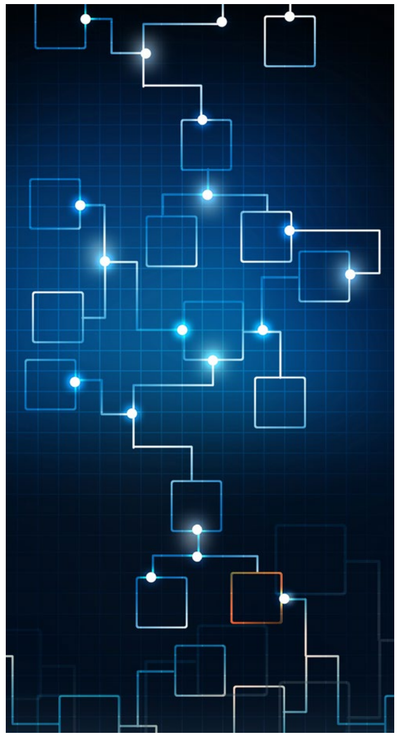
Asset management is the co-ordinated activity of an organisation to realise value from its assets. Its fundamental elements are Value, Leadership, Assurance and Alignment. The practice of asset management brings together all elements of an organisation with a single language, line of sight and culture, to enable a collective decision-making process. If we use a simplified example of a water company which has a damaged section of underground pipe; instead of just using the cheapest repair solution in the short term, an asset management approach considers the wider risks and long-term implications in order to make the right decision to optimise value for all stakeholders (i.e., the company and its customers).

Good decisions are based on relevant and accurate data, and that is where Digital Twins come in as an enabling tool. The information provided by both the real-life data feed and collective documentation storage of a Digital Twin feeds asset management decision making. They enable each other: with Digital Twins, asset management has the information it needs in a structured, scalable architecture; the full benefits and potential of Digital Twins are realised when used as part of an asset management approach.

People create good cultures; people push the boundaries; people do asset management.

Asset management is not a process but a methodology, the scope of asset management can be defined by 39 subjects (see www.theIAM.org knowledge/asset-management-an-anatomy). In a recent paper (full paper https://lnkd.in/dCyEdbc), industry leaders came together under a Team Defence Information (TDI) project to examine UK Defence Engineering Support functions considering asset management philosophies and benefits. It provided a high-level view of coverage across the 39 subjects. It also indicated the benefits Engineering Support could gain by adopting asset management practices demonstrated by case studies and in line with the international standard for asset management, ISO 55000.

There are still several challenges that need to be overcome for the widespread application of the methodology which are detailed in the TDI paper. However, with a new defence focused working group, progress is being made with further engagement planned across MOD, industry and internationally to understand the landscape and opportunities for asset management in defence.



Cyber Digital Twins

Secure by Design

Digital Twins can be an incredible decision support tool, collecting a wide range of information in one place. However, as with every digital support tool there is a potential cyber security risk that needs to be managed.

Digital Twins carry a risk that they will increase the attack surface of the physical systems by providing a new opportunity to gain an understanding of the physical system, or offering an opportunity to attack either or both systems through a vulnerable backdoor. Attacking the Digital Twin could be more attractive to cyber criminals due to the aggregated data holding, coupled with the potential reduction in the physical and procedural security measures in place compared to the physical system. System security (including cyber aspects) must be addressed prior to designing, building, and operating Digital Twins to understand and plan to manage the threats to both the Digital Twin and the original system. Security considerations should consider the hosting environment, for example the cloud hosting the twin, the security around the aggregation of multiple data sets to a single Digital Twin location, and the appropriateness of replicating security design and controls of the physical system. Where these controls are insufficient or inappropriate, additional controls should be provided for the access control and data within the Digital Twin, such as encryption or multifactor authentication.

It's not all negative however, and the existence of the twin can have significant benefits from a security perspective. These benefits include the ability to analyse and assist in the response to security threats quickly across multiple solution platforms, independently of commercial agreements with individual system providers and onboard integration specialists.

For Digital Twins, a secure by design approach should be employed to ensure that the issues detailed above are considered early in the design lifecycle. This, along with a holistic view of security risk in context of the Digital Twin and physical system, will provide an appropriate risk balance whilst maximising benefits offered by a Digital Twin. BMT has experience providing business assurance requirements analysis, advice on security considerations and trade-offs, and providing (cyber) security and business-aligned recommendations.

Data Governance

Data governance for Digital Twins

You might ask what data governance and data management have to do with Digital Twins. Well, the answer is that effective data governance and data management enables data to be used and exploited, as explained by Principal Systems Analyst Lisa Gralewski

What is data governance and data management?

- Data management is the effective management of data to achieve goals i.e. it ensures that an organisation gets value out of its data while minimising operating risk, such as breaching regulations like the GDPR.
- Data governance is the formal oversight, execution and enforcement of authority over the management of data and data related assets.
- Data governance ensures data is managed. It focuses on how decisions are made about data and how people and processes are expected to behave in relation to data.

Key to an organisation becoming data driven or successfully starting a digital transformation programme is understanding the data it holds (and the data it needs). If this is poorly understood, there is low maturity in data management practices and poor data quality practices, then becoming successfully data driven is pretty much impossible.

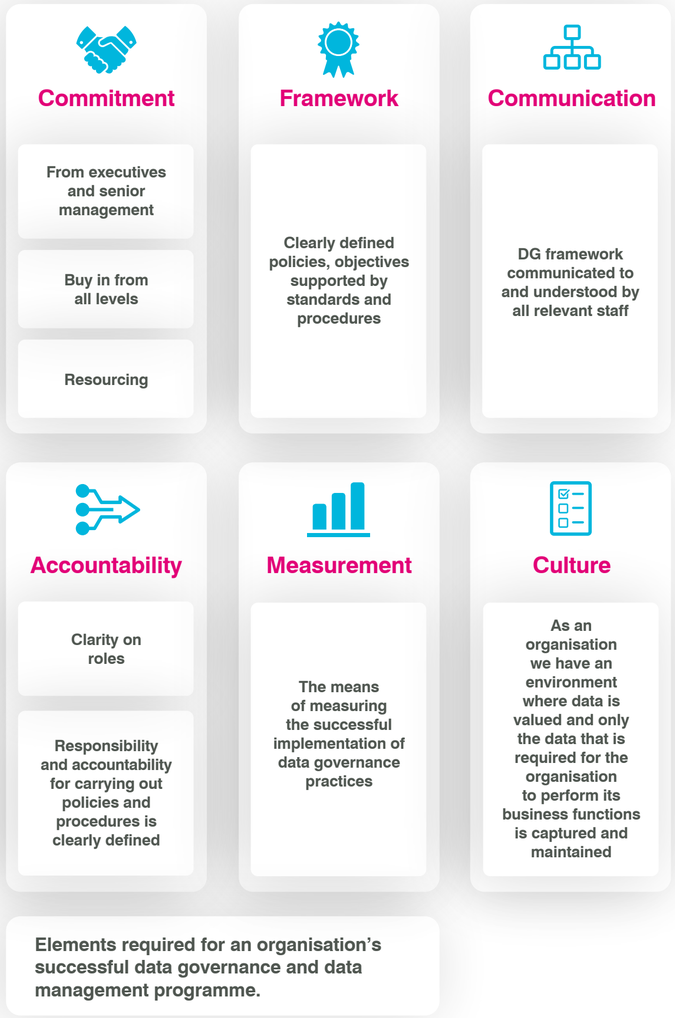
How does data governance impact Digital Twins?

With Digital Twins it is important that data can be collected, curated, managed, analysed and shared. Digital Twin information can be considered to be high value critical asset data. For this data to be exploitable, like with AI, we must have a strong data foundation, and the heart of this foundation is having an effective data governance and data management strategy.

With a successful data governance programme your Digital Twin project can benefit from:

- ✔ Effective master data management – a reliable single source of truth;
- ✔ improved data quality;
- ✔ secure data;
- ✔ improved decision making;
- ✔ compliance with regulations.

Successful Digital Twin strategies must include a data governance structure otherwise the value of Digital Twins cannot be realised. Data Architects should be engaged to identify Digital Twin data governance needs (this will include data curation, data orchestration, data management and data oversight). These needs must consider all partners in the Digital Twin ecosystem. It is likely to require agreement of data formats and open standards-based data formats.



Elements required for an organisation's successful data governance and data management programme.

What does successful data governance and data management need?

Data management and governance is not a one-off task; successful initiatives need continuous maintenance and improvement. Some of the key needs for an organisation to successfully implement data management and governance are shown above.

In the words of Rob Seiner, author of 'Non-Invasive Data Governance – the path of least resistance and greatest success'

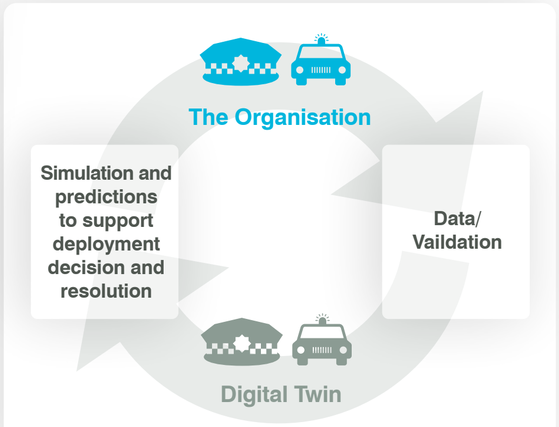
> **All organisations already govern data. They may do it informally, sometimes inefficiently, often ineffectively, but they already govern data. And they all can do it better.**

Interview

Digital Twins in Policing

A Digital Twin is a virtual representation of physical assets, processes / people / places / systems / devices that when fed or provided with real-world data enables effective decision making to optimise the performance and utility of the system of interest.

Christian is an experienced consultant who leads our Justice and Security Business Unit. He has been involved in projects across this domain including replacing Command and Control systems, Blue Light Collaboration, reducing deployment times and digital forensics. Prior to consulting, he held operational roles within law enforcement, working for the police and the National Crime Agency.



How are emerging technologies changing the future of policing?

This is an innovative and exciting time with a vast array of new technologies being developed that could be adopted within Policing.

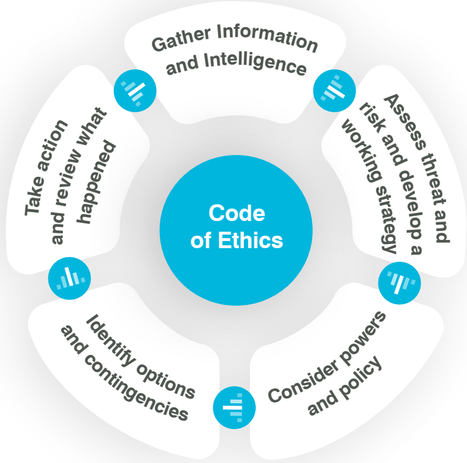
Some of these new technologies revolve around digital tracking, using small sensors on existing and new equipment to provide real time data/information on what is happening on the ground.

Christian Ellis
Security and Justice Lead Consultant

For example, by monitoring which assets/ equipment officers deploy, supervisors/tactical advisors can be alerted to changing situations without the need for radio transmission. Even simple trackers such as GPS on cars and tracking of doors opening to determine an officer has arrived on scene can help to improve situational awareness and aid decision making and further deployment decisions.

Automation and Robotics are also continuing to be implemented into Policing with an increased use of drones. Small drones operated by regular officers can be a much more cost effective and responsive alternative to traditional air support in areas such as searching and provision of situational awareness during operations.

There is still some work left to do, especially around the digital space, with adoption of further functionality by exploiting the equipment already in use such as the capability that mobile devices possess; all these different development threads and demands are being pulled together as part of the National Policing Digital Strategy. By employing a co-ordinated development approach, we can unlock new opportunities and stay ahead of equally emerging technological threats.



How could Digital Twins be used to support future policing operations?

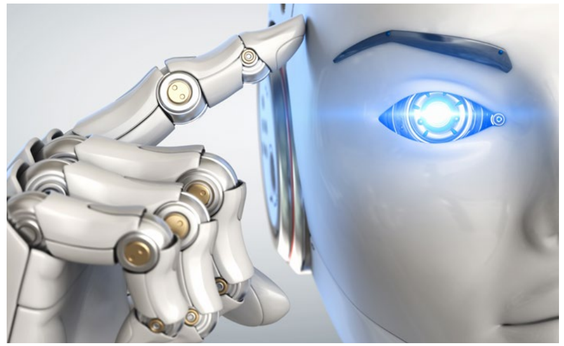
New command and control solutions and other platforms being implemented across Policing have the ability to pull multiple feeds of information into a single view. We must be careful with all these new information and data sources; if there is too much data it can be quickly overwhelming, and the important information may be lost in the noise. There is, therefore, a need for intelligent decision support, to filter out and select the key information and trends. This is where a Digital Twin can come in to capture, store and categorise the data whilst preserving its integrity.

This digital data stream will also need to be scrutinised and we need to consider the human interaction and implications of any decisions made. When considering the National Police Decision Making Model (NDM), the Digital Twin could provide some levels of automation of elements of the first four components (Gather Evidence, Assess Threat, Consider Powers and Identify Options) allowing the decision maker to review the options from a position of knowledge and then take action.

Repetition of the same information from different sources could lead to information overload. A Digital Twin, if designed correctly, will reduce the data entry burden and analysis, by having a single point of truth in a virtual representation and pulling the required information across automatically.

The system you are describing is an "Organisational Digital Twin", how does this differ from the more widely known "Asset Digital Twin"?

Normally when people think about "Digital Twins" they think about asset twins, a virtual representation of a singular asset. An organisational twin differs in that it is not just modelling singular assets but an entire organisation, including how it works and the services it provides. This provides a higher level of complexity but is exactly what is required to provide intelligent decision support to the operational commands; to enable the police service to perform as effectively as possible, as a whole.



How do you see future variations of these tools evolving in years to come?

As the previously discussed technologies mature, we will see increasing efficiency in the police service. The future of policing is not "Robocop" – digital information can be an excellent tool but we still need to maintain the human dimension to stay relevant and approachable. Automation and technology are there to enable intelligent decision-making support, allowing staff and officers to concentrate on what is important and what they do best.

What is BMT doing to support the implementation of these change programmes?

BMT is providing management consultancy services to help support transformation programmes across the country. This includes supporting the Metropolitan Police Service who are delivering a portfolio of Transformation. We are helping to ensure the UK continues to have the world's leading police services.

For a more in depth interview with Christian Ellis, listen to our podcast episode on Digital Twins in Policing.

Future Tech

The technology, ideas, inventions and gadgets that will revolutionise the world as we know it.

New technologies developed for aerospace industry

A new project led by Rolls-Royce with support from the Aerospace Technology Institute (ATI) Programme will make future aerospace servicing technologies a reality.

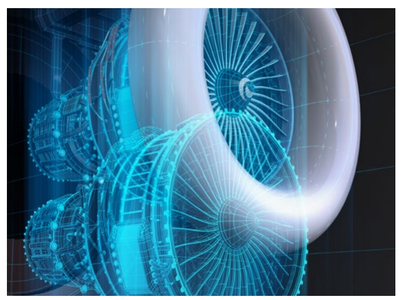
Engineers will work on 20 technologies that will reduce disruption for airlines and lessen environmental impact by repairing components rather than scrapping them.

Technologies include:

- Snake robots which travel inside jet engines to access complex parts, enabling repairs which are not possible with today's tools.
- Engine sensors which send data from the sky and enable better predictions of when engines need maintenance.
- Inspection and analysis tools to inspect parts buried deep within engines while they are being repaired.
- Advanced automated repair technologies targeting parts which cannot currently be repaired, meaning they do not need to be scrapped.

These technologies have multiple uses that can be applied to several other industries, but most importantly they can all help support and feed information into a Digital Twin.

Find out more



Introducing Digital Twins that learn

A key challenge of Digital Twins is how to transform large amounts of data into useful and actionable information. Digital Twins need to be created based on detailed understanding of how assets they represent perform, and they need to be paired with their real-world siblings to be useful to stakeholders on the front line.

SWIM EDX addresses these challenges by enabling any organisation with lots of data to easily, affordably, and automatically create Digital Twins that learn from the real-world continuously. EDX simplifies analysis by learning on-the-fly using powerful self-training deep neural nets that accurately predict future performance. The SWIM EDX software runs on relatively simple edge devices.

Find out more

Augmented Reality to provide Additional Driver Information

Another core challenge for Digital Twins is the effective transfer of information from the system to the users. One solution could come from the Automotive sector and Panasonic's Augmented Reality Head-Up Display (AR HUD). The system projects 3D, AI-driven key information into the driver's line of sight to help reduce driver distraction and potentially increase safety on the road.

Panasonic utilises its latest advances in optics, volume optimisation and imaging technology, combined with AI technology from its SPYDR cockpit domain controller to render near-field and far-field content for vehicle information (like speed), object and pedestrian detection, and mapping / route guidance, for what they say will be a seamless, more engaged and informed driver experience.

Find out more

Starlink: SpaceX's satellite internet project

Current satellite communication networks make internet and network connectivity in remote places extremely expensive, however could a new rising trend in low earth orbit satellite internet connectivity could change all of that. Starlink is the name of a satellite network that the private spaceflight company SpaceX is developing to provide low-cost internet to remote locations. SpaceX eventually hopes to have as many as 12,000 satellites in this so-called megaconstellation.

To put that into perspective, only about 2,000 artificial satellites currently orbit Earth, and only 9,000 have ever been launched in all of history, according to the United Nations Office for Outer Space Affairs.

Rather than sending internet signals through electric cables, which must be physically laid down to reach far-flung places, satellite internet works by beaming information through the vacuum of space, where it travels 47% faster than in fibre-optic cable. There are also similar programmes being developed by Google, Facebook and satellite communication companies.

Find out more

www.bmt.org/signal