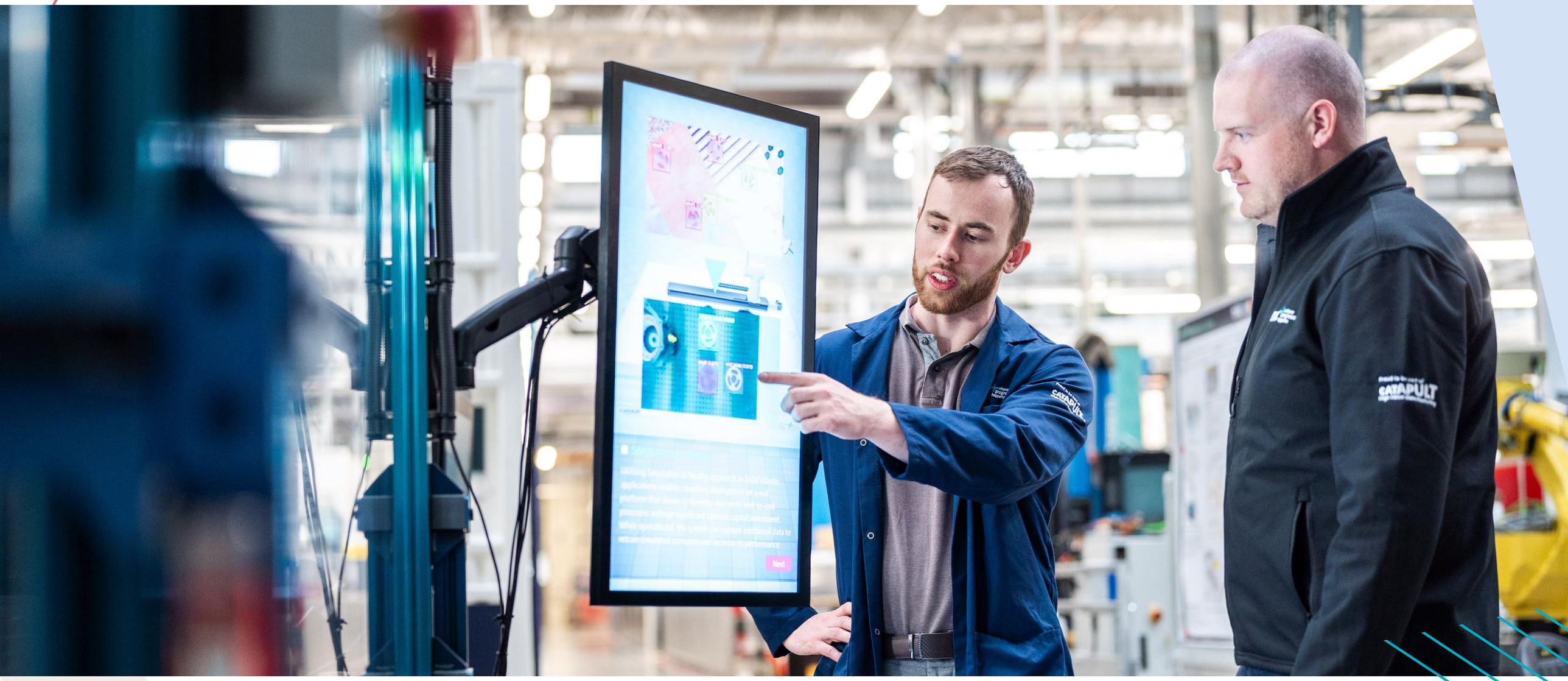
Digital engineering

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Connect with us

Andrew Patterson CEng, NCC
andrew.patterson@nccuk.com

Graeme McLaughlin CEng, NMIS
graeme.mclaughlin@strath.ac.uk

Digital engineering

The integration of people, processes, data and technology across the lifecycle of complex systems and high-value products, with engineering design at the heart of value creation and serving as a critical enabler for UK innovation and international competitiveness.



Digital engineering is transforming how products and systems are conceived, developed, manufactured and sustained. Engineering design sits at the centre of this transformation, shaping the decisions that determine product performance, cost, sustainability and long-term value. As complexity, software integration and AI adoption accelerate, organisations must move beyond traditional approaches to remain competitive.

Realising the benefits of digital engineering requires trusted data, interoperable systems, new skills and proven routes to adoption. HVM Catapult supports this transition by providing the expertise, infrastructure and testbeds needed to help industry develop, validate and scale the technologies, skills and practices needed to compete in an increasingly digital future.

Why: Demand drivers

- Industrial scale deployments of Digital Engineering technology to increase productivity
- Managing the complexity of current and future Engineered systems
- Addressing circularity, value retention and supply chain resilience
- Engineering within a complex software and data ecosystem
- Underpinning and enabling technologies and infrastructure

What: Priority industry capability needs

- Standardise models and data formats to enable interoperability between software packages
- Deploy explainable and Human-in-Loop AI workflows for design / engineering, manufacturing, inspection and testing
- Access databases and toolkits for assessing repair, reuse, life-extension and end-of-life options for products
- Apply 'Playbooks' and assessment tools enabling acceptance of digital process and product assurance / certification regimes
- Utilise testbed environments for academic/RTO/industry collaboration and demonstrations of secure, federated digital threads

How: Priority innovation requirements

- Model-Based Practices demonstration and adoption
- Agentic AI systems for autonomous system development and validation
- Product passports/technical data packs enabling optimisation of in-service and end-of-life strategies
- Full virtual/hybrid testing with verification, validation and uncertainty quantification
- Digitally connected material and component test and characterisation facilities and accessible databases

Key HVM Catapult capabilities in digital engineering

Isambard-AI, NCC (Bristol)

Built by the University of Bristol and hosted by NCC, Isambard-AI is the UK's fastest and most powerful AI supercomputer. It facilitates research into using AI and machine learning for accelerated design, simulation and optimisation for materials and manufacturing.

AI², NMIS (Renfrew)

AI² combines advanced AI infrastructure with manufacturing expertise to help researchers and industry tackle complex engineering and production challenges. The platform supports data-intensive modelling, intelligent automation and digital innovation, enabling faster development of new products, more efficient processes, and greater adoption of AI across the manufacturing sector.

Autonomous Driving Development, WMG (Coventry)

Led by WMG, the autonomous driving development facilities provide a dedicated environment for the design, testing and validation of connected and autonomous vehicle technologies. The platform supports research into perception, decision-making and vehicle control systems, helping accelerate the safe deployment of next-generation mobility solutions.

AI Validation Platform, MTC (Coventry)

The ***AI Validation Platform*** provides a trusted environment for testing, evaluating and deploying AI solutions in manufacturing settings. It helps manufacturers assess the performance, reliability and scalability of AI technologies, reducing adoption risks and supporting the transition from proof-of-concept to industrial implementation.

Digital Engineering and Process Innovation, CPI (Darlington)

CPI applies digital engineering tools including predictive modelling, AI, process simulation and connected data systems to support innovation across manufacturing and product development. Its facilities enable organisations to test, validate and optimise new technologies in realistic industrial settings, reducing risk and speeding the path from research to commercial deployment.

AMRC Interoperability Hub, AMRC (Sheffield)

The AMRC have developed capability in a broad spectrum of technical areas, and underpinning technologies, that address the interoperability problem. This is helping to support data continuity throughout the product lifecycle from design into manufacture. The AMRC have capability in Unified Name Space (UNS) deployment, Digital Passports, semantic data understanding, and enabling secure data sharing practices.

Connected technology platforms

Through cross-domain analysis, eight connected technology platforms have been identified. They underpin both the core advanced manufacturing process technologies and the cross-cutting enabling technologies set out in this strategy.

They provide a shared foundation of insight and collective capability, showing where coordinated effort across our domains can best strengthen, connect and accelerate the technologies that matter most to UK industry.

An industrial AI for advanced manufacturing UK adoption plan is now being developed in partnership between Made Smarter, Make UK, HVM Catapult and the Department for Business and Trade, led by the AI Champion for Advanced Manufacturing.

Priority: Artificial intelligence enabled advanced manufacturing

Enhancing human capabilities with industrial AI technologies applied across the product development and operational lifecycle

Harmonised life-cycle assessment

Standardising assessment methods and data ontologies to consistently measure environmental impact across a product's lifecycle

Value retention

Preserving the life of products, components and materials through recycling, repair, remanufacturing etc (Re-x)

Manufacturing with advanced materials

Accelerating the deployment of next-generation materials across the full value chain, and supporting the development of an agile and responsive UK supply base

Capability development

Advanced and interconnected process modelling

Integrating detailed simulations and enabling interoperability across the value chain to optimise manufacturing performance

Automation of processes and digital integration

Streamlining manufacturing processes through digitally connected systems and interoperability

Digital thread

A seamless flow of data connecting design, production and operations across a product's life cycle

Intelligent manufacturing assurance and regulatory engagement

Leveraging smart systems to ensure quality and compliance, and early-stage dialogue to decrease barriers and accelerate validation and verification

Interpreting our roadmaps

The strategy structure

Why: Demand drivers
External pressures or opportunities that create the need for new or improved manufacturing capabilities.

What: Industry capability needs and priorities
The practical abilities industry must have to remain competitive in the future and the priorities for HVM Catapult.

How: Innovation requirements and priorities
The specific technologies, tools, processes, data, skills or system enablers that must be developed, improved or integrated to meet future industry capability needs, and the priorities for HVM Catapult.

Connected technology platforms
Highlight where coordinated effort across our domains can best strengthen, connect and accelerate the technologies that matter most to UK industry

Priority industry capability needs
The most critical capability gaps identified through industry consultation that must be addressed first to deliver impact.

Roadmap activity examples

Establish test beds to develop, integrate and validate novel inspection, measurement and test techniques and processes. → Demonstrated the trustworthy comparative robustness of emerging inspection, measurement and test technologies

The above 'what' items are linked and dependent – denoted by the overlapping boxes

Deployment of increased mechanisation to remove variability and increase standardisation linked to respective process specifications → Standardised digital weld procedures, reusable qualification libraries, harmonised standards

The above 'how' discreet items that are not linked and occur in different time horizons

IUK Strategic imperatives

Alignment with the Innovate UK vision
Each demand driver is colour-coded to align with the four imperatives of the Innovate UK materials and manufacturing vision 2050.

Innovative and digital
Businesses drive continuous and transformative innovation and create, adopt and export advanced digital technologies

Resilient and responsive
Mitigating risks from supply chain disruptions, national/global crises, and climate change.

Resource-efficient and regenerative
Sectors maximise circularity of materials, energy and water and aim for a net positive impact on the environment

Skilled and empowered
Workforces are highly skilled in executing advanced tasks and are empowered by configurable, open technology stacks

Digital engineering - transformation map

	2026	2030	2035	2040	Vision
Industrial scale deployments of Digital Engineering technology to increase productivity	Utilise open-access digital testbed environments for demonstrations of secure data sharing, digital identity, governance frameworks and standards	Develop business cases and digital transformation roadmaps with clear and quantifiable return on investment (ROI)	Adopt agreed UK standards for engineering data models to enable interoperability between software packages and mass adoption of MBSE	Include closed-loop feedback and data from products in-service and at end-of-life for continuous improvement	**To realise a nationally-connected digital engineering capability where integrated data flows, intelligent automation and lifecycle-aware design combine with a future-ready skilled workforce to deliver world-leading, sustainable, and resilient systems and products at scale and across the full value-chain**
Managing the complexity of current and future Engineered systems	Facilitate data collection pipelines for engineering and manufacturing use cases – model training, testing and validation (requiring physical assets)	Deploy explainable and Human-in-Loop AI workflows for design / engineering, manufacturing, inspection and testing	Access to validated multi-modal AI models for engineering and manufacturing analysis, enabling agentic workflows for rapid design	Apply 'Playbooks' and assessment tools enabling acceptance of digital process and product assurance / certification regimes by regulators and certification bodies	
	Incorporate dynamic, intelligent (process parameter dependent) material characterisation datasets resulting from greater capacity and capability in Smart Testing	Access UK-hosted digital thread infrastructure and compute capability including sovereign engineering data spaces aligned with FAIR data principles	Access databases and toolkits for assessing repair, reuse, life-extension and end-of-life options for products – embedded within industrial engineering design workflows		
Addressing circularity, value retention and supply chain resilience	Model-Based Practices demonstration and adoption including FAIR data principles, standards, cybersecurity and federated data sharing platforms	Interoperable software platforms and rapidly reconfigurable and scalable toolchains for integration of mechanical, electrical and software domains through design, manufacture and operation	Agentic AI systems for autonomous system development and validation, with use of immersive technology to support product design reviews	Full virtual/hybrid testing with verification, validation and uncertainty quantification – providing through-life optimisation and assurance/certification	
Engineering within a complex software and data ecosystem	Multi-objective and multi-fidelity simulation methods incorporating uncertainty quantification and probabilistic analysis to support system design and optimisation	AI literate workforce with access to open Engineering databases for physics-informed machine learning model development and validation	Digital twin infrastructure including interoperability, standards, governance and assurance for interconnected virtual-physical assets		
Underpinning and enabling technologies and infrastructure	Large scale, digitally connected material and component test and characterisation facilities providing accessible databases for design/simulation	Safe and Sustainable by Design practices, tools and product exemplars	Product passports/technical data packs enabling optimisation of in-service and end-of-life strategies including material circularity and reuse		

Key Demand Drivers
are the relevant challenges to this manufacturing technology that the UK manufacturing sectors are facing

Industry Capability Needs
are what industry needs to be able to do (skills, processes, tools, systems) to stay competitive & meet future challenges

Innovation Requirements
are the technologies, tools, processes or technical enablers needed to support the UK's frontier industries

Priority industry capability needs
these are the critical areas identified through our extensive workshop process and data analysis. Refer to the L2 pathways diagram for further details

Digital engineering – demand drivers

Industrial scale deployments of Digital Engineering technology to increase productivity

Scaling barriers: The transition from isolated pilots to enterprise deployment is impeded by slow organisational change, the absence of shared standards and practices, disparity in supply-chain maturity and risks associated with return on investment.

Productivity pressure: Rising product complexity and engineering workloads leads to urgent demand for automation and streamlined workflows at scale.

AI-enabled workforce: Competitive pressure and labour constraints are driving demand for AI tools to automate routine engineering tasks and amplify skilled workforce output.

Tools vs. capability gaps: Advanced tools often fail to become consistent, repeatable ways of working, limiting their contribution to sustained productivity improvement.

Managing the complexity of current and future Engineered systems

Advanced system architectures: Products are increasing in complexity, requiring digital methods to effectively manage the deepening interdependencies and the scale of the engineering challenge.

Interface and configuration management at scale: Large systems need rigorous control of interfaces and configurations, with document-based processes limiting effective change management.

Synchronous multi-physics and multi-domain integration: Designs span multiple disciplines so continued reliance on isolated, sequential engineering activities introduces costly rework, integration failures, and programme delays as system complexity increases.

High-fidelity modelling: Increasing system complexity requires richer, more accurate and faster simulation approaches to confidently predict behaviour and performance.

Addressing circularity, value retention and supply chain resilience

Circularity and value retention: Products must be designed to enable the preservation of materials and value across multiple life cycles.

Multi-life traceability deficit: The lack of rich, continuous asset data across operational lives creates critical gaps in condition awareness, remanufacturing decisions, and end-of-life value recovery.

Supply-chain fragility: Geopolitical instability, single-source dependencies and limited visibility of supply chains exposes UK manufacturing to external shocks, demanding more adaptive and digitally connected supply networks.

Digital exclusion risk: The accelerating pace of digital adoption at prime and tier-one level risks creating a participation gap where smaller suppliers lack the tools, standards access, and capability to engage with shared data environments, weakening overall supply chain cohesion.

Engineering within a complex software and data ecosystem

Fragmented tools and data formats: Disconnected tools and formats make sharing, reuse, and automation difficult and costly.

Inconsistent data structures: Missing common definitions and standards as well as duplicate, incomplete, and hard-to-find data prevents systems from reliably linking and interpreting information without significant customisation and integration effort.

Governance and compliance deficit: The absence of consistent frameworks for managing data provenance, ownership, access rights, and versioning across the engineering lifecycle and for the life of the product creates liability exposure, version conflicts, and loss of audit traceability.

International regulations and compliance: Global engineering organisations must navigate complex, changing data-sharing and sovereignty rules.

Underpinning and enabling technologies and infrastructure

Platforms and data backbones: Integrated and scalable platforms and data backbones are needed to support end-to-end engineering workflows across extended supply chains.

Computational resources: Demand for, and cost of, compute capability limits the availability of these resources. Multi-fidelity analysis, efficient workflows and open-source tools and licensing models are required to enable engineers to do more with less.

Sensors, test assets, instrumentation: High-quality sensing and test assets are essential for generating accurate model and validation data with suitable fidelity.

Connectivity infrastructure: Reliable 5G and industrial networks are required to move data quickly and securely across assets and sites. Models also rely on timely access to real assets for calibration, testing, and improvement or to enable live digital twins.



Andrew Patterson
NCC
andrew.patterson@nccuk.com

Strategic summary

By 2040, competitive advantage will depend on scaling AI-enabled digital engineering. As product value shifts toward software, organisations must move beyond isolated pilots to repeatable practices that boost productivity, innovation, and the capabilities of multidisciplinary teams, enabling faster delivery of critical technologies. Achieving this requires overcoming fragmented data systems, manual rework, and disconnected infrastructure. Organisations must adopt shared standards, transparent data flows, and open digital backbones to improve modeling, simulation, and traceability. Those that do will gain reduced time-to-market, as well as greater productivity, resilience, and innovation.



Innovate UK strategic imperatives

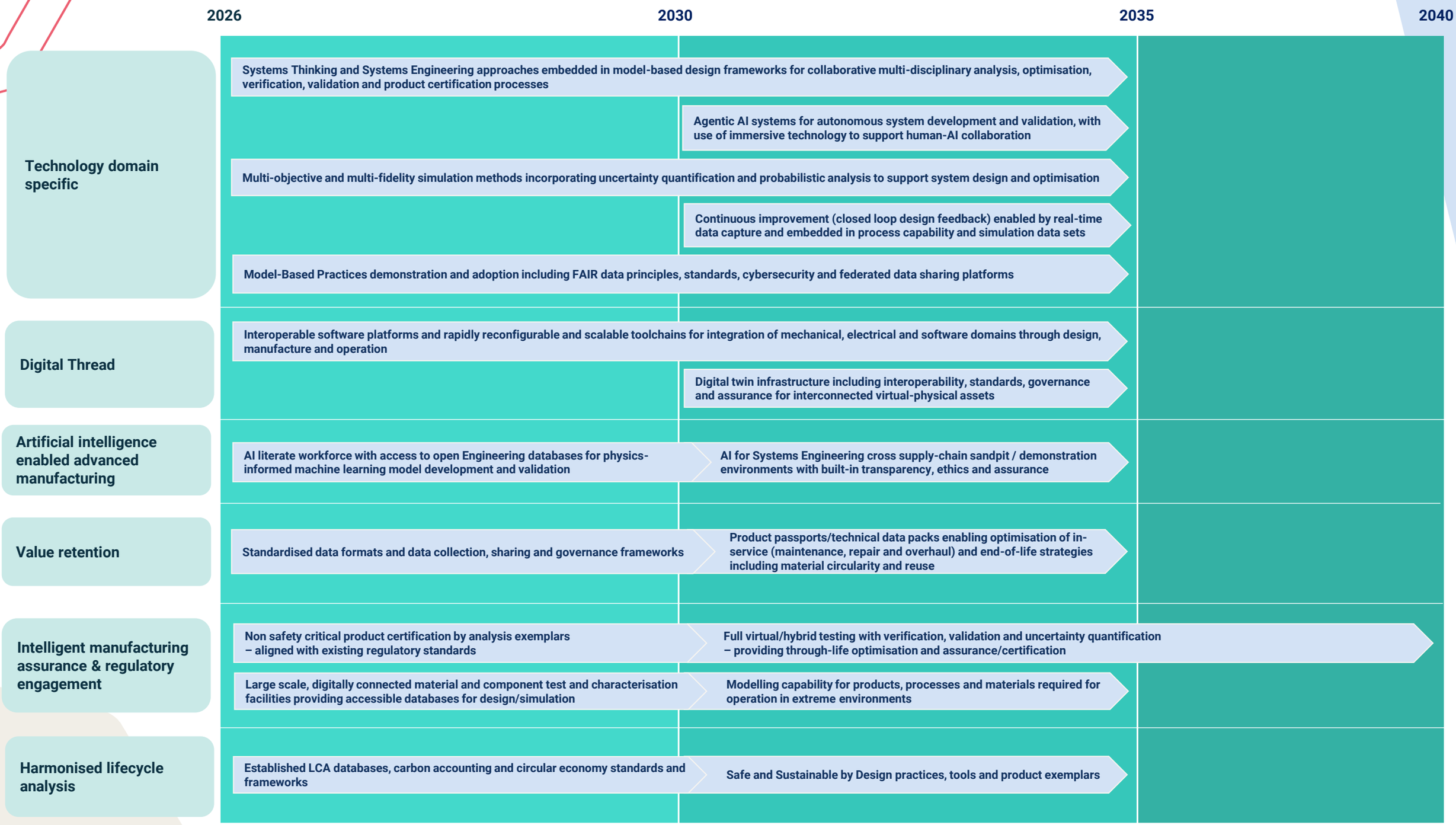
Innovative and digital

Resource-efficient and regenerative

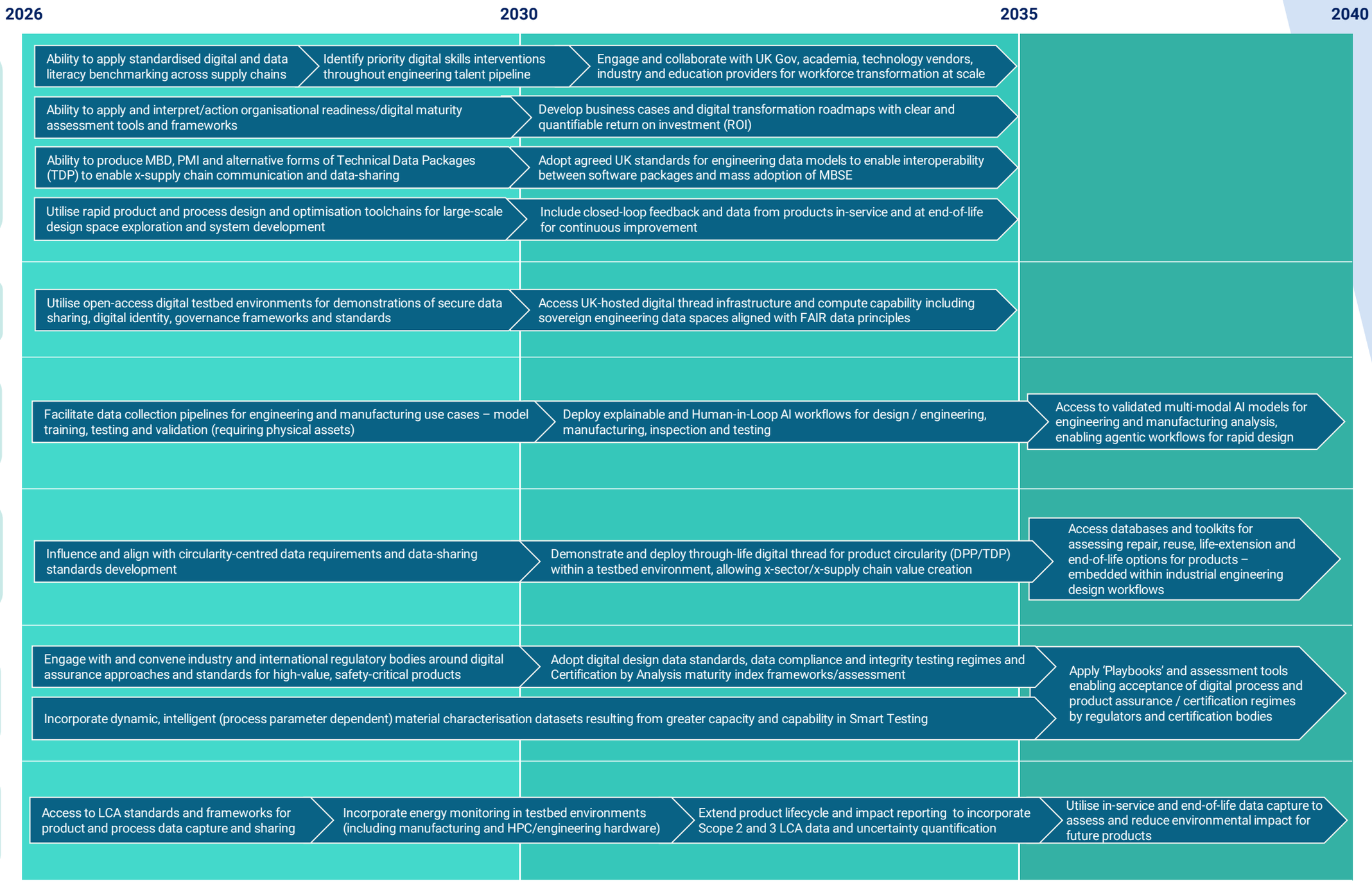
Resilient and responsive

Skilled and empowered

Digital engineering – innovation requirements



Digital engineering – capability needs



Digital engineering: Priority pathways

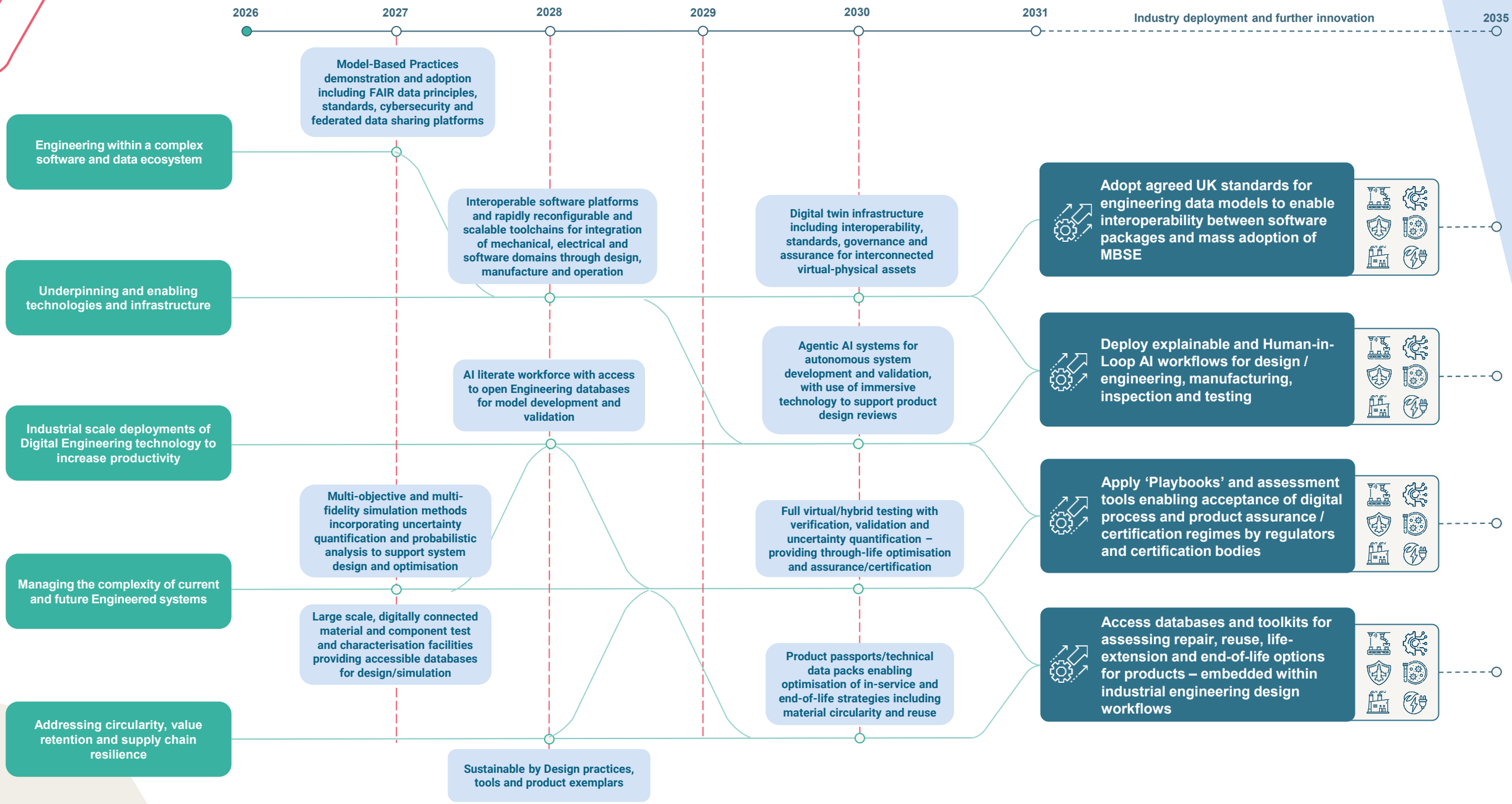


Diagram Legend

Demand drivers
Why change is needed

Innovation requirements
How capabilities must develop

Industry capability needs
What capabilities industry needs to respond to these challenges

Priority industry capability needs
The most critical capability gaps identified through industry consultation that must be addressed first to deliver impact

Industrial strategy growth-driving sectors

Department for Business & Trade

- Foundation Industries
- Clean Energy Industries
- Digital & Technologies
- Life Sciences
- Advanced Manufacturing
- Defence

Version control

Version	Date	Author	Sponsor CTO	HVMC CTO
1.0	09/10/2026	Andrew Patterson	Mark Summers	Chris Dungey