Attitude
Listening
Creativity
Teamwork
Vision
Structure
Agility
Fearlessness
Proactivity

The DNA of innovation

How industry leaders are delivering scalable success within the built environment.

bsi.

Contents

Introduction

From low-carbon materials and artificial intelligence to circular economy and offsite construction, the built environment is experiencing an evolutionary wave of change. While technologies like these may be facilitating the industry's digital transformation, they aren't always the catalyst of innovation. And they don't guarantee scalability and organizational resilience.

So, what is the key to innovation success?

In this report, experts from the built environment explore the DNA of innovation: the characteristics, mindsets, tactics, and strategies leaders and organizations must adopt to meet their carbon-neutral, circular economy and the fourth industrial revolution goals. Furthermore, BSI provides professionals with a framework that'll help those within the built environment go even further by demonstrating which innovative technologies and processes will help organizations deliver responsible, scalable, and sustainable success.

With practical advice and real-life examples of how organizations within the built environment have benefited from these principles, this report demonstrates how innovation is not only necessary to remain competitive in the market but how it directly strengthens organizational resilience.

BSI standard BS 65000 defines Organizational Resilience and the value it delivers as: "the ability of an organization to anticipate, prepare for, respond and adapt to incremental change and sudden disruptions in order to survive and prosper." **Organizational resilience** is much more than risk management. It's a holistic view of business health and success.

Section 1

Technology vs. innovation: The great debate

Technology is instrumental — and insufficient alone — to achieve true innovation.

Technology vs. innovation:
The great debate

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Whether you're trying to become carbon-neutral, or want to embrace the fourth industrial revolution, big goals require big changes.

When an organization invests in new technology to pursue ambitious goals, does that make them innovative?

Yes and no.

In the built environment, technology and innovation are often seen as identical. They're not. **Innovation is the process of creating something new which delivers value – often through technology. But innovation itself goes beyond technology.**

Innovation uses existing technology in inspiring ways; look at the incredible things we keep achieving with steel. And innovation spurs the creation of new technology with untold potential for change; Building Information Modelling (BIM) was created with a clear vision to revolutionise the built environment, and has become the platform for yet more innovation.

"The value of an idea lies in the using of it."

Thomas Edison

'Listening to customers and developing solutions that address a specific need, or a future need, is considered one of the fundamental ingredients of our innovation success at Polypipe'

Jason Shingleton, Marketing and Development Director, Polypipe

Not all innovation is equal

Innovation is more than the sum of its parts. For example, the circular economy isn't just smart materials or photovoltaics or clever logistics.

It goes way beyond any individual product or outcome. On their own, smart materials or sustainable processes wouldn't have revolutionised sustainability within the built environment. Innovation is the vision, the process, the framework that sits behind technology.

Similarly, blindly investing in solutions like BIM (Building Information Modelling), AI (artificial intelligence demonstrated by machines) or VR (virtual reality - a simulated experience that can be similar to or completely different from the real world) isn't a fast-track to the cutting edge for any organization within the built environment. Just because something is new doesn't mean it is valuable.

Truly innovative businesses share a mindset. They are always asking:

"What comes next?"

"How can we do this better?"

"Where are the untapped opportunities?"

"What do our customers need?"

Because risk, resources, and rivals don't stand still. Neither do resilient organizations. They're able to turn visionary goals into tangible results because their innovation strategies are underpinned by standards, and they leverage technologies and processes with a clear purpose. And principles.

Responsible innovation

As explained in **PAS 440**, responsible innovation "seeks to eliminate, minimize or mitigate any potential downsides from the perspectives of the company, its employees, suppliers and customers, and stakeholders who might be impacted, directly or indirectly, by the innovation. It is an attempt to improve our collective futures by taking responsibility for, and improving, today's innovation practices."

Innovation principles

As we begin to slowly move towards a post-Covid landscape, every member of the built environment must ensure they operate ethically, safely, and with agility, if they are to maintain organizational resilience. When it comes to investing in new technologies, solutions or processes to help organizations achieve that, they must choose to innovate in ways that are both responsible and sustainable. Frameworks like **PAS 440** or the **UN Sustainable Development Goals** are vital for organizations looking to innovate in today's complex landscape.

Sustainable innovation

With the **UN Sustainable Development Goals** as the lodestar, sustainable innovation covers processes and frameworks that help organizations go beyond the industry's carbon-neutral and circular economy goals to deliver spaces that improve the health, well-being, and safety of people in every aspect of their lives.

Section 2

The innovation cycle:
What's needed for success?

**Innovation can't be switched on and off
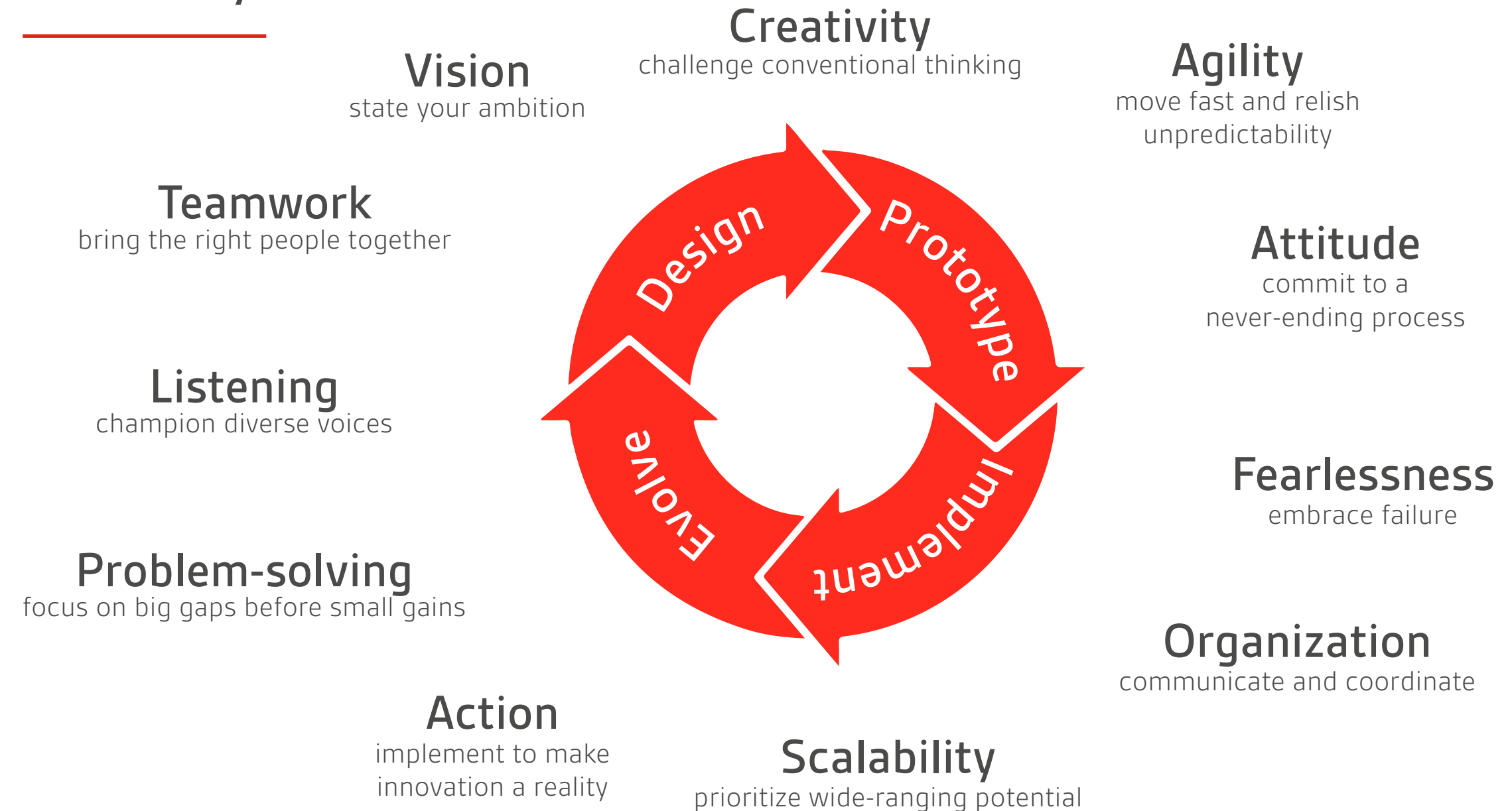— it must be embedded into your culture.**

The innovation cycle: What's needed for success?

Innovation can't be switched on and off – it must be embedded into your culture.

Industry leaders agree that successful innovation is born out of a managed, inclusive culture of innovation from all parts of the organization. Organizations which actively allow individuals to participate, and who include a feedback loop, may find themselves to be more sustainable and resilient.

Innovation isn't always a linear process, and it certainly isn't a tool you can pick up and put down. It's a continuous process that requires a range of different actions and attributes from individuals, teams and business leaders. In this section, we not only explore the DNA of innovation, but the framework that facilitates change.

The BSI innovation culture cycle

Creativity
challenge conventional thinking

Vision
state your ambition

Agility
move fast and relish unpredictability

Teamwork
bring the right people together

Attitude
commit to a never-ending process

Listening
champion diverse voices

Fearlessness
embrace failure

Problem-solving
focus on big gaps before small gains

Organization
communicate and coordinate

Action
implement to make innovation a reality

Scalability
prioritize wide-ranging potential

Design Prototype Implement Evolve

'If you say yes to everything, you achieve nothing. Innovation can't afford to be sentimental, especially in the built environment. It has to work.'

Paul Evans, Executive Director and CTO at Gammon Construction Limited

The DNA of innovation

The attributes BSI has found leading innovation businesses to share over the past 100 years.

Innovation flourishes in a framework

The principles above are everything organizations need to embrace positive change and leverage technology with purpose. Almost.

Right people. Right culture. Right technology. What's missing?

Right framework.

Standards are the most effective way to bring ideas to life. They are a proven framework that can enable your business to reliably — and responsibly — transform the ingredients of innovation into tangible results.

The Innovation guide, **PAS 440**, provides a template and framework for built environment organizations developing new products, processes, or services.

The International Standard **ISO 56002**, provides guidance for the establishment, implementation, maintenance, and continual improvement of an innovation management system for use in all established organizations.

Encouraging a positive learning journey

Good ideas can come from everywhere. That's why many successful organizations champion inspiration at all levels, from operations to leadership. When you give a voice to everyone, from a diverse range of specialisms and backgrounds, you build the confidence and collaboration that sparks so many new ideas. Crucially, the most innovative organizations don't expect every idea to work. Quite the opposite. Failures are landmarks on the road of progress; when your colleagues are happy to fail, they won't fail for long.

"At Skanska UK, we believe that creating a collaborative culture is key to driving innovation. We motivate and empower our people to innovate – channelling ideas and harnessing the creativity across the business.

We also create the right partnerships and work collaboratively with our customers, supply chain, industry and academia. This brings more diverse thinking and leads to improved productivity and better outcomes for our customers."

Vaibhav Tyagi, Head of Innovation, Skanska UK

Measurement and reporting make it real

If something is worth innovating, it's worth measuring. Stakeholders and leadership teams must agree on what quantifiable metrics to track, and how they will capture and share the evidence. This will provide essential feedback to refine or refocus innovation roadmaps — and reassure investors, customers, and regulators. Regular or continuous measurement, reviewed at agreed stages in a project, helps to avoid any unwanted surprises and also identify opportunities that would otherwise be overlooked.

What outputs can you measure?

Commercial success, customer satisfaction, cost, speed, energy performance, resource efficiency, emissions reductions, elimination of waste, ease of maintenance, longevity, health and safety, economic impact, employment opportunities...

Will it scale?

As every Government agency, contractor or manufacturing firm knows, there is a world of difference between a successful trial and a scalable product or process. Organizations that adopt a standards-based approach, together with robust measurement and reporting structure, can make more informed investment choices to develop repeatable, reliable innovations and unlock future opportunities.

If all stakeholders were to embrace a standards-based culture of innovation, smart cities, fourth industrial revolution, and the circular economy could quickly become the baseline for even greater advances in the built environment.

"For any innovation management programme, the key is to be able to measure the results. The BSI Kitemark for innovation management is a rigorous solution for organizations looking to realize true value from their innovation management programmes because we test the input, output, and throughput of the process for incrementally improving results, going beyond a management system audit"

Kareem Aboul-Fadl, Client Manager – IMETA
Global Scheme Manager – BSI Kitemark for Innovation Management, BSI

Frameworks make innovation scalable

As projects or organizations scale and achieve critical mass, it's all too easy for people and processes to **fall through the cracks**. Establishing a shared framework from the outset facilitates collaboration and dissemination of information, so everybody's working in a coordinated way.

Section 3

Putting innovation into practice

With foundational principles in place, technology becomes transformative.

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How are you going to make it happen? It's time to select and combine the right solutions to remain **innovative, competitive and resilient.**

"Innovation is core to Costain's work, our people, and our business. It defines what we do and how we serve our clients and society, and helps us leave a legacy of better, greener, and digitally optimized infrastructure that improves people's lives."

Tom Embley
Group Research and Innovation Director
Costain

Navigating the technology landscape

The top 12 tools and systems for built environment innovators

Innovation isn't blindly following tech trends. You need to select solutions carefully. Here are some of the most important investments you should consider; and the 'must-haves' for modern construction.

Diagram

- 6 — Offsite Construction
- 5 — 3-D printing
- 1 — AI and ML
- 2 — Analytics
- 8 — Drones
- 3 — VR
- 9 — BIM
- 12 — Quality control
- 10 — Digital twins
- 4 — Remote auditing
- 11 — Supply chain optimization
- 7 — Robotics
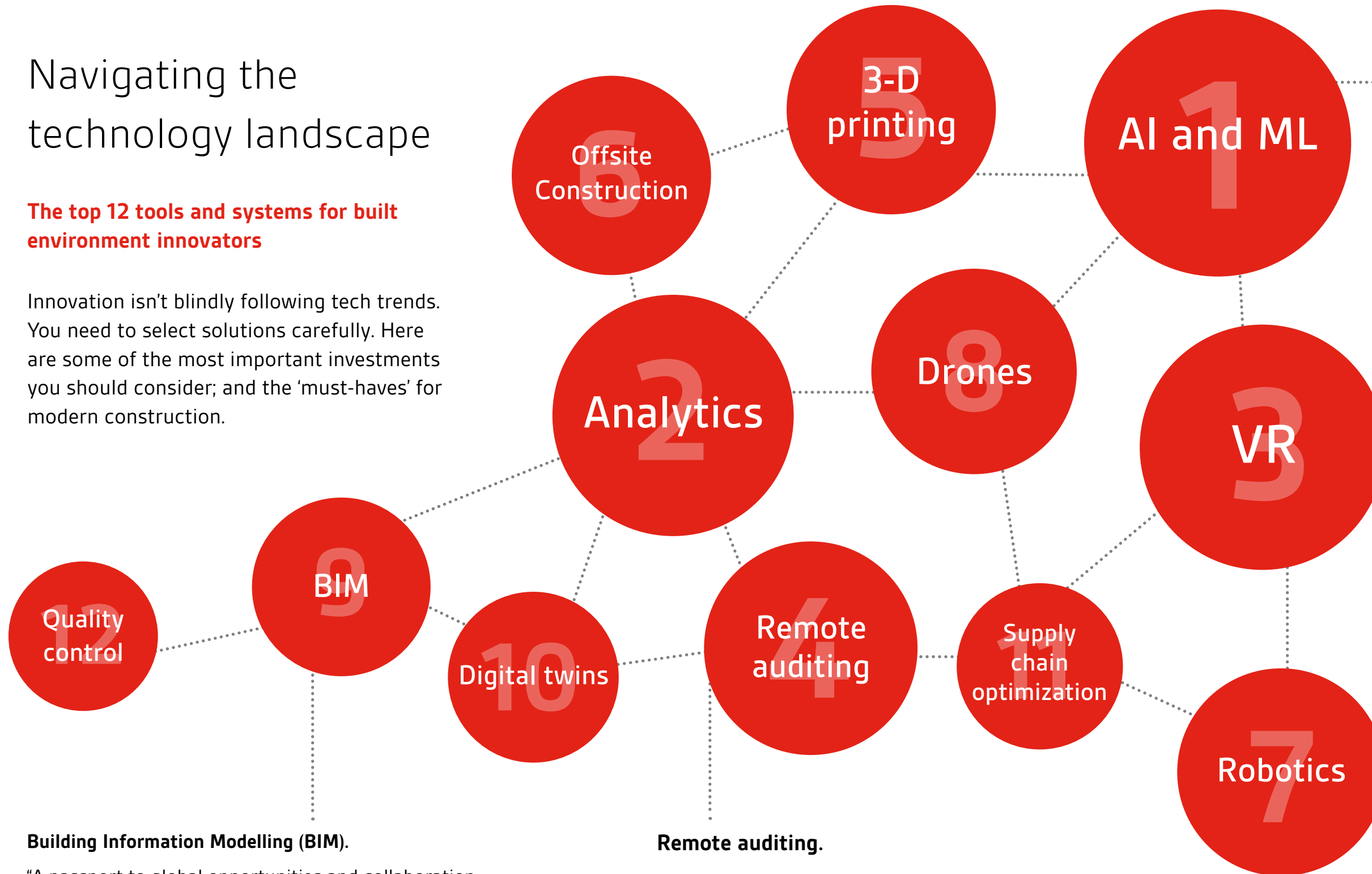
AI (artificial intelligence) and ML (machine learning).

"AI and ML are rooted in data [...] For example: how is a building really operating? How are its structural components doing over time? What are its real-time energy, lighting and water uses? How do they get to and from the building? How do people actually use the building in practice, and what do they really want?"

Will Cavendish, Arup

VR (virtual reality) technology.

"From initial design mock-ups, to project collaboration, through to the finishing touches that make a building design go from good to great, virtual reality possesses the capability to really sell an idea better than any other medium."

TMD STUDIO LTD

Robotics.

"In the past, robots were used for specialist jobs that were too dull, too dangerous or too dirty for people to do. Today, thanks to their ability to process sensor data in real time, robots do an incredible range of things. They already clean your house. Soon they'll be able to help design and build your house too."

Alvise Simondetti, Global Leader, Arup Explores

Building Information Modelling (BIM).

"A passport to global opportunities and collaboration. BIM enables efficient, consistent, and transparent communication throughout an asset's entire lifecycle — by giving the right people shared access to the right data."

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Remote auditing.

"Using video calls, remote auditing can reduce the number of people required on site, which helps minimize the risk of a COVID-19 outbreak and prevent unnecessary delays in the review of a site — all whilst allowing more people to share their expertise quickly."

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Section 4

The forefront of innovation

Three groundbreaking technologies and practices advancing the industry.

The forefront of innovation

Three groundbreaking technologies and practices advancing the industry.

Many of the technologies above are well established and quickly becoming obligatory. So what comes next? Any organization that wants to become—or remain—an industry leader is already investing in the next wave of innovation. Below are some of the most promising technologies poised to advance the circular economy and the fourth industrial revolution.

"The enabling technologies of the fourth industrial revolution are a set of complex systems that combine technologies, such as smart materials, with embedded, bio-inspired sensors. Therefore, each of the following categories can only unfold its potential when combined with others, as a part of systems and technological frameworks."

European Commission

Case study

Bio-inspired technologies and smart materials

Smart construction materials adapt to changes in their environment, including mechanical stress, magnetic and electrical fields, temperature, moisture, pH, and light. They hold the promise of creating responsive environments with enhanced performance and energy efficiency. Bio-inspired materials take this one step further, exploiting natural mechanisms to achieve various advantages, including self-repairing surfaces and intrinsic traceability.

A 'living building'

"The OME is an experimental biological house that forms a key part of the £8m **Hub for Biotechnology in the Built Environment (HBBE)**. A joint initiative between Newcastle and Northumbria Universities in the UK, the HBBE is "creatively harnessing biotechnology to develop a new generation of sustainable 'living buildings'.

"The OME will study a wide range of technologies "from new materials grown from microbes through to waste systems which generate power from the output of the toilet […] The apartment will sit above a laboratory, where processes will be developed to convert domestic waste, including human waste, food waste, cardboard, and plastics, into fuel, electricity, and other useful products.

"There is nothing quite like the OME anywhere in the world. The building will create a space to develop technologies which are well beyond the state-of-the-art."

Professor Martyn Dade-Robertson, Co-Director of the HBBE at Newcastle University[2]

Case study

Simulating entire systems and cities

'Digital twins' are digital representations of actual assets, processes and systems; typically using Internet of Things (IoT) sensors and actuators to maintain a dynamic, bi-directional relationship. Leveraging analytics and AI, developers can interpret the vast amounts of information being received to support decision making around use cases such as process optimization, preventative maintenance and energy use.

These digital twins can form the basis of models used to simulate the political, economic, social, and environmental impact of any conceivable changes or events; allowing organizations to optimize investments in everything from energy efficiency to the introduction of autonomous vehicles.

Limitless possibilities in the world's first virtualized city

Virtual Singapore is one of the first digital twins of an actual city. The dynamic 3D model is still in development but is already getting community buy-in for numerous sustainability innovations.

"Virtual Singapore serves as a convenient platform for citizens to visualise upgrades to their estate, and allows them to provide timely feedback to the relevant agencies. For instance, the Yuhua estate is a test-bedding site for the Housing and Development Board's Greenprint initiative, which features sustainable and green features such as solar panels, LED lights, pneumatic waste conveyance system, enhanced pedestrian networks and extended cycling networks. With the completion of Virtual Yuhua, it could be used to showcase the possibilities and benefits of the HDB Greenprint initiative in other estates."

National Research Foundation, Prime Minister's Office, Singapore

Case study

Flying factories and modular construction

Flying factories are temporary facilities used to manufacture prefabricated components. Typical offsite construction facilities require a lot of upfront investment and high transportation costs. Flying factories can be located close to or on construction sites, or where materials are sourced, to reduce transportation costs and speed up the process. They can also be scaled up or down to meet demand.

Flying factories generate efficiency savings on Britain's biggest road project.

Skanska UK has successfully implemented the flying factories approach on a number of projects, including the award-winning A14 Cambridge to Huntingdon improvement scheme.

Delivered by a joint venture bringing together Skanska, Costain and Balfour Beatty with Highways England, the A14 is a vital transport corridor linking the major ports in East Anglia with the West Midlands and the north.

The team created an adjacent temporary 'flying factory' that could manufacture precast concrete slabs for the new 750-metre River Great Ouse Viaduct, a critical structure on the A14. The slabs were manufactured in a controlled, weather-sealed environment to exacting technical specifications.

Thanks to the close proximity of the flying factory to the viaduct, slabs could be built larger than would otherwise have been possible if they needed to be transported to site on main roads. This also meant that 5,500 fewer crane lifts were required.

The offsite approach generated efficiency savings of £4 million and allowed the viaduct to be completed two months ahead of schedule.

Source: Skanska

Section 5

Taking the next step

Taking the next step

How can organizations exemplify the resilience and sustainability they seek to bring to the built environment? By adopting an authentic culture of innovation. Individuals, teams, and entire businesses must leverage technology, systems, and processes in novel ways that exceed the sum of their parts. Underpinned by a standards-based approach, these organizations can achieve the clarity, creativity, and collaboration to deliver a scalable, sustainable future.

Benchmarks for innovation

BSI provides the standards, training and certification to help you achieve meaningful change. Below is a selection of some of the most important assets for organizations pursuing innovation in the built environment.
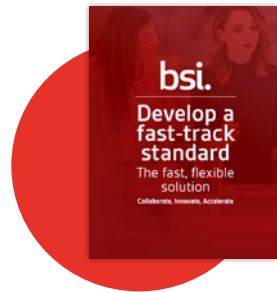
Develop your own PAS - a fast-track standardization document

ISO 19650-0/1/2/3/5
Organization and digitization of information about buildings and civil engineering works, including building information modeling (BIM).
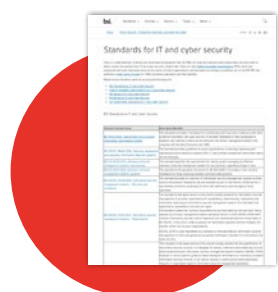
Standards for IT and Cyber security

Smart cities
Enabling collaboration and an open eco-system for city partnerships

PAS 440
Guidance on how to achieve and demonstrate responsible innovation.

BS 8001
Framework for implementing the principles of the circular economy in organizations guide.

Privacy and freedom of information standards

ISO 56000 series
The ISO 56000 family of standards provide guidance and support for creating value in your organization.

ISO 27001
Information technology. Security techniques. Information security management systems. Requirements.
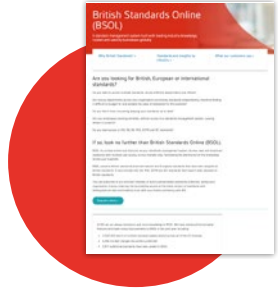
BSOL
British standards online for cyber security, information management and more.
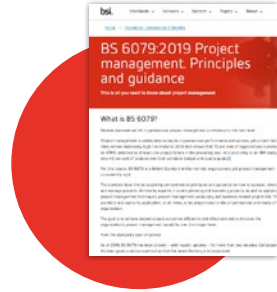
BS 6079
Project management. Principles and guidance.
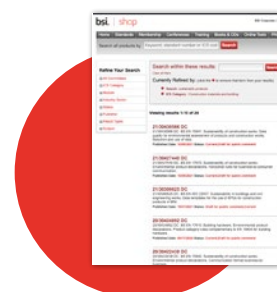
Standards for all construction and building materials

Offsite construction
Transforming product development and building processes

Assurance

Training and assurance solutions to help you embed and validate best practice in your organization.
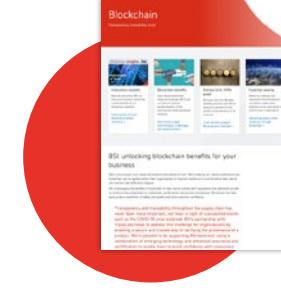
BSI Kitemark for innovation management

BSI Kitemark for BIM asset lifecycle

ISO 27001
Keep your confidential information safe.

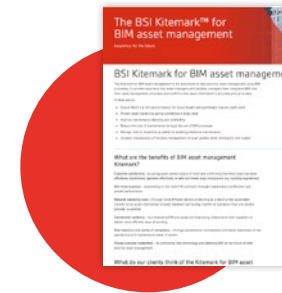**Blockchain and immersive technology solutions**
Transparency, traceability, trust.
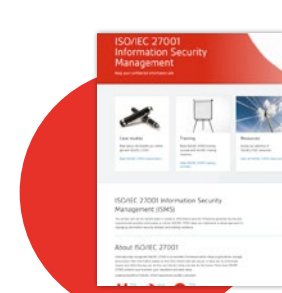
BSI Kitemark for BIM design and construction

BSI Kitemark for BIM software

ISO 27701
Accountability and trust for personal information.

BSI Kitemark for BIM asset management

BSI Kitemark for secure digital applications

IoT connected assets
Enabling a smart and secure world by creating best practice.

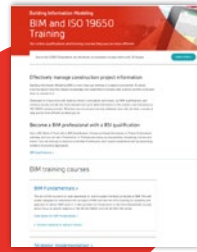**BSI Kitemark for BIM objects**

BSI Kitemark for smart cities and communities
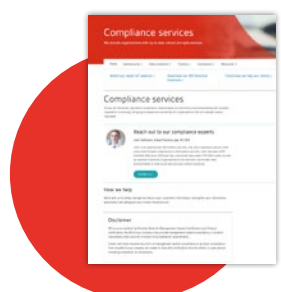
Compliance services for information security and risk management
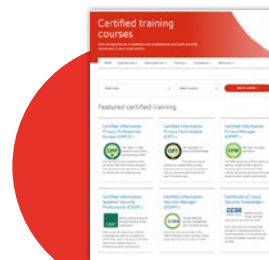
Training

Training solutions to help you embed best practice in your organization.

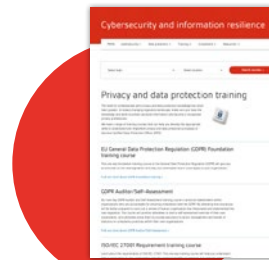**BIM training courses. From fundamentals to training on specific BIM standards**

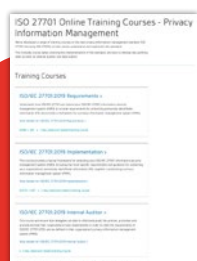**BIM qualifications for project management and asset management**

ISO 27001 Information Security Management systems

ISO 27001 Privacy information management training

Cyber security training

Data protection training

Cloud security auditing training

bsi.

To find out more
Call: +44 345 080 9000 or visit: bsigroup.com/builtenvironment-uk

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