



CONSTRUCTION
INNOVATION HUB

Digital Capabilities:

A Framework for early career professionals
across built environment disciplines

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About the Construction Innovation Hub

The Construction Innovation Hub brings together world-class expertise from the Manufacturing Technology Centre (MTC), BRE and the Centre for Digital Built Britain (CDBB) to transform the UK construction industry.

Funded by Government in 2018 with £72 million from UK Research and Innovation's Industrial Strategy Challenge Fund, the Construction Innovation Hub brings together world-class expertise from BRE, the Centre for Digital Built Britain (CDBB) at the University of Cambridge and the Manufacturing Technology Centre (MTC).

The Hub is working with more than 300 public and private-sector organisations to deliver a fully integrated programme consisting of the Value Toolkit, Platform Programme, International Programme and Information Management, to co-develop solutions that enable better decision-making, drive digital transformation, improve delivery and accelerate sector recovery. The Hub and its partners are committed to fundamentally transforming UK construction so that it delivers better social, environmental and economic outcomes for current and future generations.

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Background and objective

The world is changing and the built environment sector needs to embrace digital ways of working to enable sector transformation.

This report sets out a Digital Capabilities Framework for early career professionals in built environment disciplines that aims to capture what they need to know, and be able to do, to work digitally after around two years in their profession.

The Framework is intended to stimulate discussion and action by enabling industry, built environment undergraduate and masters course providers and professional institutions to gain a shared understanding of the digital skills required by early career built environment professionals. It seeks to provide a common language and structure around which all professionals and disciplines can unite to support the development of the digital capabilities the sector needs.

The Framework is designed to be used by companies, professional institutions, universities and other industry organisations, as well as early career professionals and their managers, to support the development of the digital capabilities required at both the individual and organisational levels.

It builds on existing research and has been developed using insights generated through extensive consultation with stakeholders from across the sector, including a series of in-depth workshops with early career professionals from a range of built environment disciplines.

In this report a digital capability is defined as:



A way of working that captures and uses data, in combination with processes, methods, technologies, devices and/or systems, to generate, manage and/or share information.”



Drivers for change

Within the UK built environment sector, a dual problem has been identified ([Future Capabilities Report: the creation and through-life management of built assets and infrastructure](#)) that people with digital skills are not studying for, or entering, built environment careers; instead choosing sectors perceived to be more high-tech; and that the sector often undervalues the digital skills brought by new entrants.

The recently published [Transforming Infrastructure Performance: Roadmap to 2030](#) highlights a need for a fundamental shift in the culture and make-up of the built environment to make the sector a top choice for young people and calls for a focus on future skill needs in areas such as digital, automation, and sustainability, rather than simply filling current gaps.

The Construction Leadership Council's [Industry Skills Plan for the UK Construction Sector 2021 – 2025](#) aims to tackle these issues by setting out plans for high-quality training and development to build an industry that is a great place to work, with clear routes of entry and progression to attract and retain talented people. Our Framework aligns with and seeks to support the report's Challenge 2.3; Routes into industry – Higher education.

Routes to solving this problem include:

- Improving access and ensuring a diverse intake of talent;
- Improving links to employers to increase capacity and effectiveness of work placements and input to curricula design;
- Ensuring the right mix of competence – both traditional competencies, and enhanced technical, digital and modern methods of construction, as well as a greater focus on building safety, assurance, health and safety and security-mindedness.

The drive to Net Zero, a greater focus on digital ways of teaching and working as a result of the COVID-19 pandemic, as well as the growing focus on offsite assembly or manufacture and modern methods of construction and building safety, are also key drivers in the acceleration and value of digital capabilities in the sector.

If the industry fails to attract talent that expect to operate in a highly technological and innovative working environment, then these problems will be compounded.

Against this background, the Framework aims to articulate the digital capabilities that will be required by the industry now and in the future.

View from the sector I:

Mace

Harnessing digital technologies to push for Net Zero in construction

Mace is a global built environment expert that is leading the way to a more connected, resilient and sustainable world. As an organisation, Mace is keenly aware of the opportunities that digital technologies open up, and early career professionals are provided with ample opportunities to build digital capabilities through their work.

For Maud Santamaria, Workplace Experience Director at Mace, digital technologies hold a huge potential for the built environment sector, enabling companies to accurately measure and evaluate carbon emissions whether during construction (embodied carbon) or in operation (operational carbon).

“Digital forms of work are transforming the sector and will support the pivot to Net Zero”, she says.



Data is how we look at the carbon footprint of projects, and technologies like Building Information Modelling (BIM) help us build a picture of the project across its lifecycle to evaluate its impact. Net Zero is coming across as a particularly important issue for early career professionals. They want to see more work done on carbon emissions and digital tools allow us to capture and analyse these.”





How was the Framework developed?

We have consulted broadly across the following stakeholder groups to develop and test the Framework:

- Recent graduates and their line managers;
- Senior officers from across industry, including asset owners and a range of supply chain organisations;
- Professional institutions;
- Course leaders for bachelors and masters degrees in built environment disciplines.

The process started by building on prior research and undertaking stakeholder interviews and internal consultations. An initial Framework was then presented to the project's Advisory Group along with a plan for development which included a series of workshops with early career professionals.

A total of 56 people attended these four workshops. This included 37 recent graduates as well as line managers and education professionals.

The workshops were organised by the professional job role groupings identified in Construction Industry Training Board (CITB) and Construction Industry Council (CIC) [A professional career in the built environment: an opportunity to transform our world](#)

- Spatial design – architect, architectural technologist, landscape architect and urban designer;
- Planning and surveying – town planner, land surveyor, quantity surveyor, building surveyor;
- Engineering – civil engineer, structural engineer, building services engineer;
- Management – project manager, construction manager, facilities manager.

The workshops followed a process using a task-based approach adapted to capture data across the sector. Participants were asked to:

- Write down as many tasks as they can think of that they undertake as built environment professionals;
- Cluster and theme these tasks;
- Identify how these tasks are done in a digital way.

Task data from the workshop was mapped against the initial framework, highlighting gaps and anomalies.

After the workshops, we held a series of roundtables where the initial Framework was presented along with insights from the workshops with the three main stakeholder groups:

- Academic course leaders for bachelors and masters degrees in built environment disciplines from 16 universities and other academic institutions;
- Representatives from 16 professional institutions;
- Representatives from 19 companies across the built environment industry.

Analysing data and incorporating insights from the workshops, roundtables and relevant publications allowed us to configure the Framework so that it could be applied across the sector.

Finally, 16 individual consultations were held with representatives from across the stakeholder groups. During these consultations, the interim framework was presented to consultees for feedback. Reactions to the Framework were overwhelmingly positive, with a range of helpful suggestions and improvements received and incorporated in the final version. Comments from three of the consultees are included in this report.

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The Framework explained

The Framework covers three main areas:

- digital capabilities;
- practice and discipline-specific capabilities, and;
- the context in which the work is undertaken.

It draws on task-based capability frameworks that have been successfully generated for [engineering disciplines](#) and for solving real work problems in [Short industrial placements – developing an activity framework to support teaching and learning](#).

The Framework is intended to be applicable sector-wide and is distinct from discipline-specific competence frameworks providing role-based standards at several levels of proficiency, e.g. foundation, practitioner, and expert.



Digital Capabilities

The research identified three overarching groups of digital capabilities:

General Digital Capabilities

These are enablers of learning and digital work within and beyond the built environment. We found that the [JISC Building Digital Capabilities Framework](#) closely matched our workshop data and the intended application for those in the early stages of their professional career.

Discipline/Role Capabilities

These relate to the effective deployment of specific tools, systems, technologies, software and platforms, etc. Whilst essential for early career professionals, the specific digital capabilities required will be determined by their discipline, role and their built environment work context. Sources of information should be professional bodies and training providers.

Built Environment Core Digital Capabilities

These are the core digital capabilities that were identified through our data analysis and consultation as essential for all built environment disciplines. Whilst there was broad agreement from those involved in this project there is scope for these core digital capabilities to be further developed so that they work effectively across the sector.

These six built environment core digital capabilities underpin the digital work and transformation of the sector and are explored in more detail on the following two pages.

1. Data collection and instrumentation

Data is the underlying resource that improves decision making, measurement and insights across the built environment. This capability pertains to the creation of new data (not the importing of existing data).

This capability includes:

- Measurement and instrumentation: awareness of the range of technologies which may be deployed to collect the data, their applications and limitations as well as security considerations;
- Campaign design: sample size, calibrating instruments, siting instruments, collecting field data, analysing error margins, training data sets;
- Sensor or device deployment, operation and maintenance, replacement;
- Understanding scale, measurement error and uncertainty, awareness of what/who is missing from data;
- Creating metadata for context, and using it to document limitations identified.

2. Information Management

Information Management for early career professionals is involved whenever they produce digital work that forms part of a larger project or activity. The work that they produce will need to be co-ordinated with other information and assured effectively.

This capability includes:

- Data wrangling: importing (including use of APIs), cleaning, standardising, classifying, validating and linking data;
- Data in organisational systems; including management systems, enterprise resource planning systems and in built environment sector platforms;
- Information structures, taxonomies, ontologies;
- Data models;
- Classification systems;
- Appropriate data access, use and storage.

3. Data interpretation and analysis

In addition to working with information produced by other professionals, early career professionals will need to be able to work with data to gain insights.

This capability includes:

- Photogrammetry: measurement from images;
- Interpretation of sensor data and thermal imaging;
- Data analytics, applying statistics, trend analysis, finding insights;
- Modelling and simulation, machine learning.

4. Data governance

This capability covers an understanding of relevant data laws and policies as well as working within identified regulations, ensuring data is accurate and reliable and that sensitive data is appropriately protected and managed and is retained for the relevant purposes only.

This includes:

- Information security;
- Information quality and fitness for purpose;
- Data retention policies; access; protection; compliance;
- Information risk management: risk assessment, identification, analysis, mitigation and evaluation.

5. Data visualisation

Creating effective ways of appropriately sharing work, making it understandable to a wide variety of stakeholders is essential across built environment disciplines. This can be achieved in many ways, including 3D modelling software and databases.

This capability includes:

- Communicating information effectively to different audiences;
- Use of technology interfaces (e.g. VR, AR);
- Rendering of images;
- Visualising data; Dashboards, 3D models, GIS.

6. Software development

Software development and programming is a key capability for early career professionals, although the environments and languages used will vary between organisations and disciplines.

This capability includes:

- Following a code architecture;
- Developing websites and apps;
- Agile methods, prototyping and systems integration;
- Testing, localisation and specifications.

Practice and Discipline Capabilities

The Framework also identified three capabilities that are not inherently digital, but which act as enablers of digital work.

- **Discipline/Role Capabilities.** These are the fundamental capabilities associated with the discipline or professional role. Sources of information should be professional bodies, sectoral and industry bodies as well as institutions that define the relevant standards.
- **Project Management Capabilities.** We found that early career professionals across the disciplines had a project focus for their work making project management a key capability. Many different digital project management package solutions are used in practice.
- **Strategic Capabilities.** These relate to the broader considerations of built environment work. Five areas were identified as particularly important in support of digital work:
 - Societal responsibility: including ethics, sustainability and security;
 - Systems thinking: working in a complex ecosystem;
 - Delivering value: meeting the needs of a diverse range of stakeholders;
 - Future perspectives: including an appreciation of the digital sector vision and future scenarios, technology advances and digital trends;
 - Lifelong learning.

Built Environment Work Context

The context in which work occurs also has a significant impact on any capabilities required. In the built environment sector three context aspects are highlighted:

- Organisational: relates to the many different ways that the organisation you work for or collaborate with impacts on work including: operating processes and systems, culture, strategy and change management, security-mindedness;
- Practice: relates to both the stage in lifecycle of the asset and the discipline or vocational aspects of the work;
- Asset scale: relates to both the type of built environment asset system, and the scope and complexity of the project in question.

View from the sector II:

Calvium

Design and construction between bits and atoms

Calvium is a leading digital agency which combines expertise in research and experience design with insights from software engineering and mobile innovation. Through their work, Calvium sees a clear need to meet the transformations taking place in the built environment sector with new capabilities and mindsets.

Jo Morrison, Director of Digital Innovation & Research at Calvium, explains,



All built environment professionals should be reframing the way they understand space. We are no longer working in isolated physical and digital spaces. We are working in a hybrid space which includes digital and physical components, bits and atoms. It is critical that built environment professionals are able to employ digital technologies creatively and in ways that operate with this expanded framing of space. That's where we are headed. When I talk to early career architects, designers, and so on, they understand this. Now the sector needs to catch up."

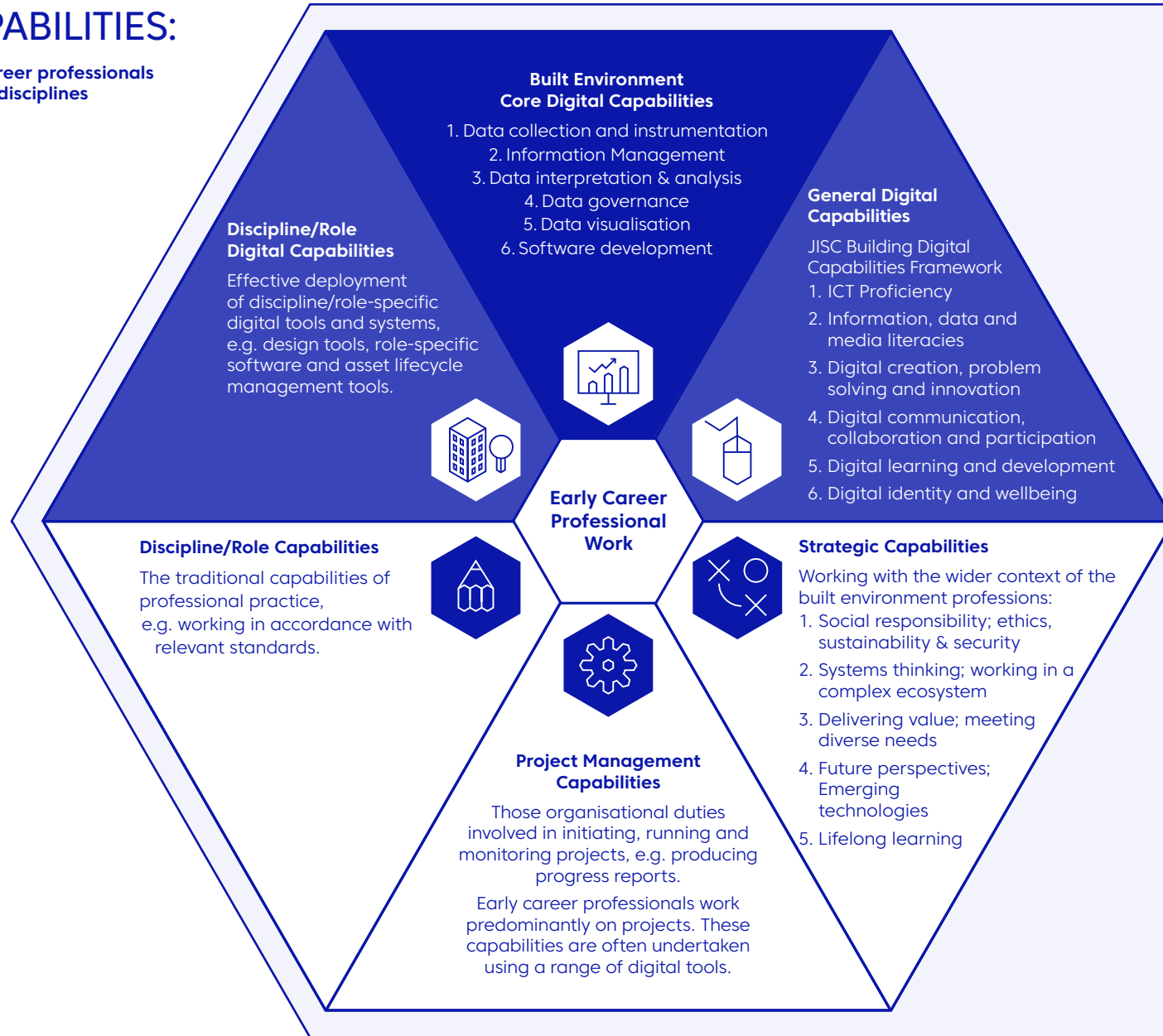


DIGITAL CAPABILITIES:

A Framework for early career professionals across built environment disciplines

DIGITAL CAPABILITIES

PRACTICE AND DISCIPLINE CAPABILITIES



BUILT ENVIRONMENT WORK CONTEXT

Organisational Context
The role of the organisation. Its culture, processes and systems. How it manages change and how it collaborates.

Practice Context
For an asset system which is made up of both physical and digital assets

1. Determine the requirement, context and timescale
2. Design and planning
3. Build and commission
4. Operate and maintain
5. Decommission

Asset context
Early Career Professionals work at a variety of scales:

1. Asset system component
2. Single asset system e.g. specific building or structure
3. Multiple asset system (neighbourhood/network scale)
4. Multiple asset system (city/regional scale)
5. Multiple asset system (national/international scale)



What comes next?

The development of the Early Career Digital Capabilities Framework has been a collaborative effort involving a wide range of stakeholders from across the sector and we would like to thank everyone who contributed for being so generous with their time and expertise.

The publication of the Framework is intended to be the first step in a process of further engagement and refinement. It is recommended that a next step be a cross-discipline, sector-wide agreement on the Built Environment Core Digital Capabilities. We are mindful of the fact that the number of early career professionals who attended the workshops was quite small and that more work needs to be done to develop it so that it is really robust and relevant across a wide range of disciplines.

We are also aware that timescales in educational policy change are often longer than other policy areas and that the full impact of this project will only

be felt when professional and academic institutions adopt the Framework and build it into the design of undergraduate course and professional accreditation requirements. Some digital capabilities will be best taught in practice, rather than in academic programmes and there are important contributions that can be made to developing and credentialing digital capabilities from a range of training providers, including large digital transformation companies.

With this in mind, we will continue to work closely with the Construction Leadership Council People and Skills Network and other sector organisations to ensure that the digital capabilities of early career built environment professionals are appreciated, nurtured and aligned to helping us achieve an effective digital built Britain.

The Framework will be shared with a wide range of stakeholders including industry partners, early career professionals, course

providers and professional institutions to demonstrate that digital capabilities are highly prized by the built environment professions and to promote the sector as a place where digital transformation is happening and that offers a range of exciting, interesting and challenging job opportunities.

We would be interested to know how the Framework is being used and applied from employers using it to define graduate roles in their organisation and training activities to course leaders using it to inform the design of future degree courses.

Its primary role is to support a conversation between industry, professional institutions and academia to accelerate the development of the digital capabilities that are needed to drive the personal development of early career professionals, organisational change and ultimately sector transformation.



Recommendations

In addition to adopting and using the Framework, based on the evidence we gathered through our consultation process, we recommend the following actions to further advance this agenda:

Built environment employers:

- Provide an organisational environment that allows digitally enabled graduates to flourish and influence how the organisation does things digitally;
- Provide opportunities to develop specific digital capabilities relevant to the organisation's work and enabling digital innovations, as well as professional accreditation;
- Ensure that the acquisition of digital capabilities and knowhow is incentivised and part of career progression within the organisation;
- Demonstrate to graduates and early-career practitioners how your organisation is engaging with the digital agenda, for example, at open days and similar events.

Academic Institutions:

- Teach the strategic and core digital capabilities as well as integrate the general digital capabilities into your built environment programmes;
- Consider collaborating with external training providers and/or digital companies to get access to and provide up-to-date sector specific knowledge and/or training on key tools, systems and processes for the discipline;
- Review and refresh built environment programmes frequently enough to keep them relevant and aligned with changing sector requirements.

Professional Institutions:

- Collaborate to develop a common understanding of sector-wide core digital capabilities;
- Engage members to explore the digital capabilities needs they experience in their daily practice;
- Drive the update of accreditation and professional requirements and refresh regularly to integrate digital aspects of professional work.

Students:

- Request digitally-focused content, case examples and projects that will equip you with skills for the future;
- Pursue ways to develop digital skills appropriate to your career goals (this could be within or external to your institution).

Early career graduates and built environment professionals:

- Advocate for and demonstrate the benefits of digital approaches;
- Request access to and funding to develop appropriate digital skills as your career progresses.

Policy development:

- Provide practical support to facilitate sector-wide digital transformation for the full range of employers and disciplines;
- Consider the process and actors in the accreditation of built environment degree-awarding institutions, to ensure that degree programmes are, and continue to be, appropriate and relevant in a rapidly changing digital world.

Non-university digital solution and training providers:

- Complement and augment academic qualifications by providing access to knowledge or training that covers key sector digital transformations, tools and systems.



View from the sector III:

Institution of Civil Engineers

Using data to help drive a systems-led approach to infrastructure

Modern infrastructure projects involve the interaction of multiple diverse systems, such as mobility, energy, data and sanitation. To ensure that these are designed to achieve the best outcomes for the environment, society and the economy, the Institution of Civil Engineers – a professional engineering institution for civil engineers – advocates that a systems-based approach is taken to infrastructure delivery, and data plays a key role in this.

To Ruby Kitching, Head of Engineering Insight, digital is the key enabler, “We have been exploring scenarios for the future civil engineer, and it is obvious that digital capabilities are extremely important to this agenda. From parametric design to high-quality CAD visualisations and tagging of

information – these are the components of future work and decision-making.”

Kitching believes that digitally enabled approaches will be key to addressing the biggest challenges faced by society such as climate change.



One of the most powerful ways to ensure you reduce carbon emissions is to measure the emissions of what you’re designing throughout the project lifecycle. An important part of our Net Zero work is structured around collecting, validating and sharing this data.”





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