Smart Building Overlay to the **RIBA Plan of Work**

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Plan of Work

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Acknowledgements and contributors

Credits and acknowledgements

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Foreword

Building intelligence has grown at a rapid rate as has the demand for smart, connected buildings. We therefore welcome the Smart Building Overlay to support members and the wider built environment.

Opportunity exists at a domestic level to remotely manage heating, lighting, security, appliances, electric vehicle charging and air quality to name a few benefits. Commercially, as the Smart Building Overlay covers, the opportunities go beyond to support business activity, space versatility and management and maintenance regimes. In any case, Smart Building Technology offers:-

- benefits to all building typologies, from single domestic dwellings to commercial office blocks.
- automation that can result in financial and user comfort efficiencies.
- quantifiable data to assess actual performance, performs at least as well as designed performance and allows opportunity to better understand the use of the technology and building.
- reduced energy consumption through automation or remote access of systems benefitting asset owners, users, and the wider environment.
- reduced operational costs, through reduced energy consumption, but also the ability to use the quantifiable data through leveraging Smart Building Technology.

The Smart Building Overlay discusses innovative approaches to support opportunities for Smart Building Technology in any building typology, within the framework of the RIBA Plan of Work. It addresses the crossover of technology, sustainability and the built environment with principles that may be applied to any project.

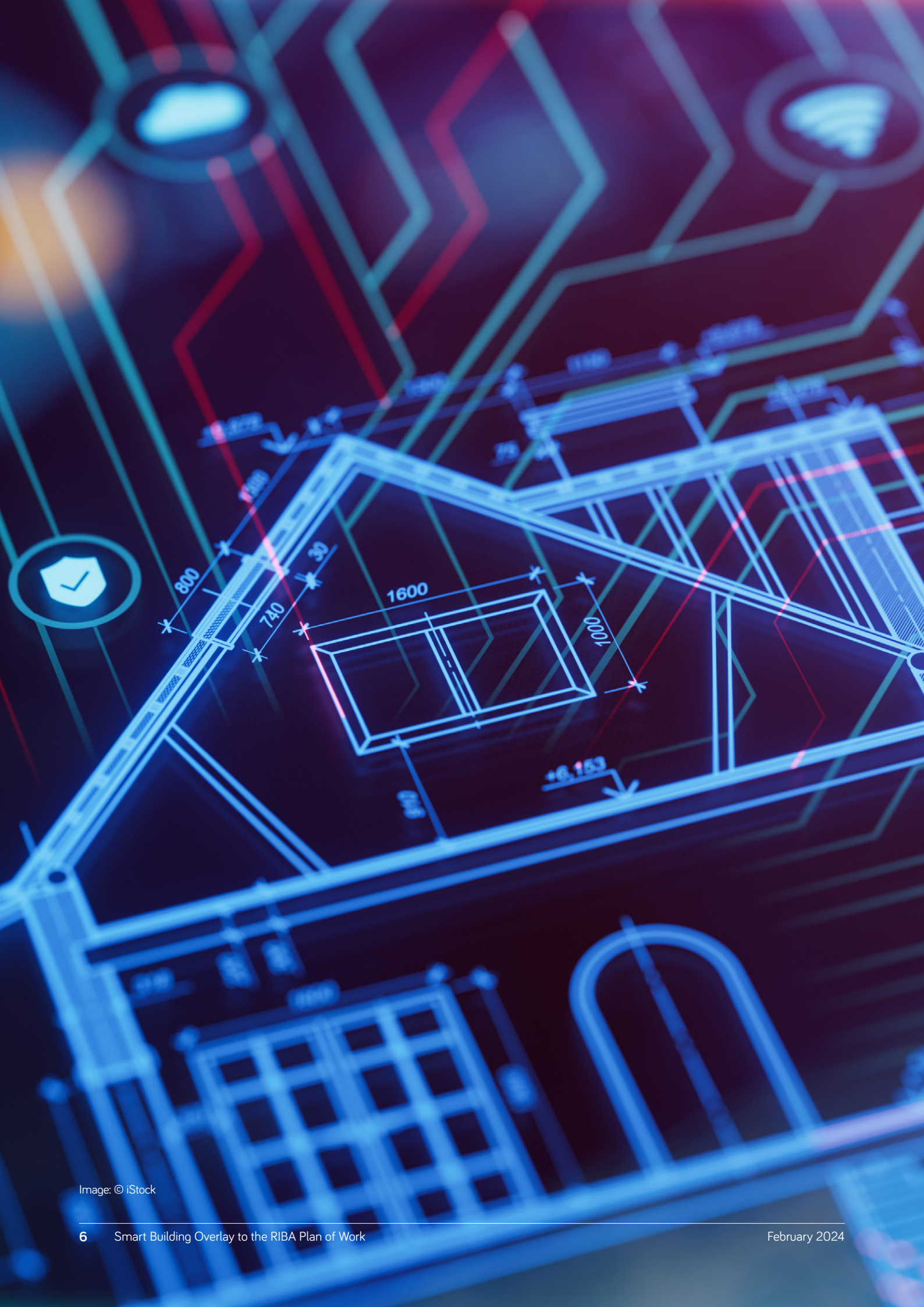
As we are seeing increasingly in our overlays, early engagement and co-ordination is critical to successful outcomes and a cost effective project. Industry feedback is consistent in reporting that Smart Building designers are not included early enough in concept design discussions and are instead an afterthought, too late in the design process to meet client aspirations, project outcomes and to even dissect the client's requirements into tangible Smart Building Technology.

The Plan of Work supports a linear process of working, which as project complexity evolves, requiring further co-ordination with specialist supplier/ designers, may result in a more circular approach to work stages where early engagement is not considered.

Where technology is involved it would be remis to not also cover procurement. The overlay also addresses the sensitivity of 'current' technology and future planning; not just to anticipate emerging technology but to also allow for the timeline from design to delivery. It is therefore important that procurement routes are discussed early and where possible, specialist design incorporated at the earliest opportunity.

I am delighted that RIBA have been able to support this important reference for Smart Buildings.

Muyiwa Oki
RIBA President 2023-2025



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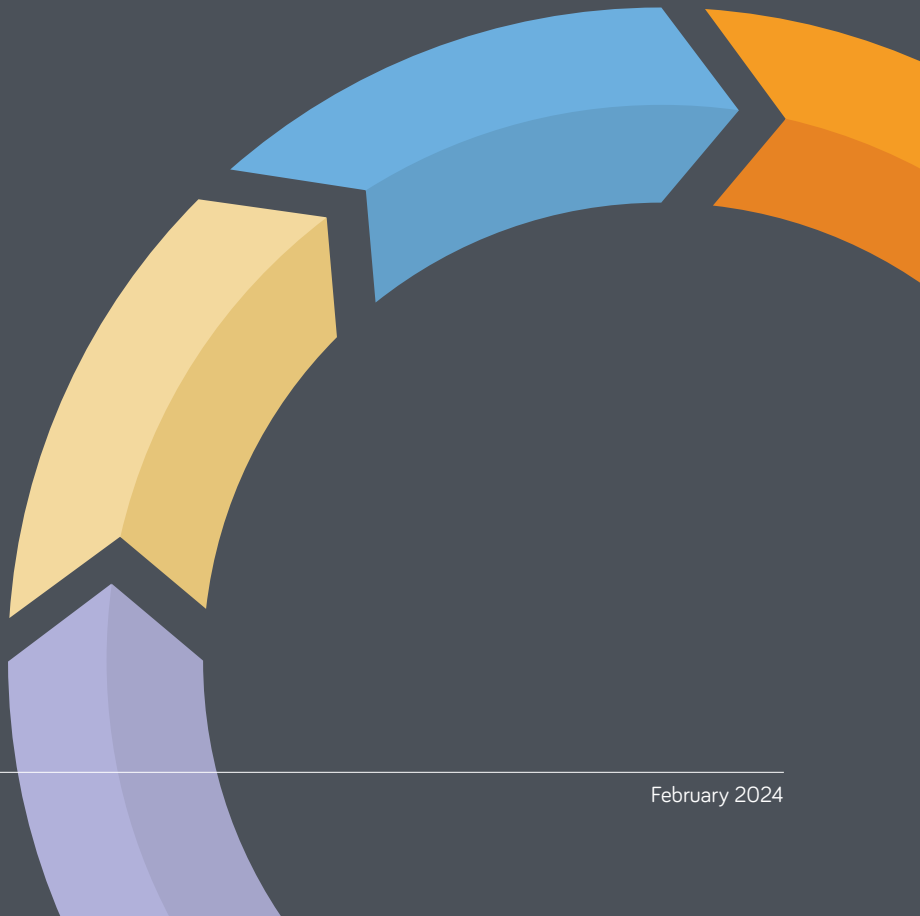
Introduction



Introduction

The Smart Building Overlay is intended to be read in conjunction with the RIBA Plan of Work by anyone involved in the design of new-build, retro-fit or refurbishment projects where **Smart Building Technology** is a consideration. The principles within may be applied to projects of all scales and sectors, whether residential, healthcare, education, commercial or industrial. The purpose is to prompt the client and project management team to discuss **Smart Building Technology** at each work stage and make timely decisions, so that the project aspirations articulated at the outset are delivered at completion and when in-use.

The impact of including **Smart Building Technology** on a design is not limited to the mechanical and electrical services as sometimes assumed. In fact, this is a multi-disciplinary design challenge which may impact many spatial, functional and aesthetic elements of a project. This overlay recognises that members of a multidisciplinary team will have varying knowledge and experience of **Smart Buildings**, but early inclusion of **Smart Building Specialists** to support the overall design process, will ensure better project outcomes and mitigate potentially costly rework. There are added benefits to **Smart Building Specialists** being part of the design discussion and coordination that supports efficiency during construction, commissioning and in the operation of a building.

The overlay has been produced and peer-reviewed by a group of industry professionals who recognised a need for new guidance for project teams who are considering **Smart Building Technology** in their project. Feedback during consultation for this overlay also identified that the aspirations for a **Smart Building** are often expressed too late in the design process to realise the potential benefits efficiently.

This document therefore seeks to highlight the benefits of a **Smart Building**, introduce smart building terminology, and support timely decision-making.

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What is a Smart Building?

The term **Smart Building** is used to describe a building which has been designed and built or retrofitted to include technology gathering and sharing operational data, providing opportunities for integration or automation to enhance the operational phase of the building. Compared to traditional methods this provides an improved experience for a wide range of users and allows for better monitoring, control and analysis.

The value in a **Smart Building** is not only the installation of the technology itself, but the improved outcomes created by the interaction between the people using the building and the technology. It is at its most powerful when underpinned by a clear **Digital Strategy**, robust processes and appropriately skilled people using the data generated by a **Smart Building**.

There are a number of other terms used to describe **Smart Building**, such as 'Intelligent Building', or 'Digital Building'. These are often interchangeable and none have a recognised standard definition. However, it should be noted that a **Smart Building** is not the same as a Building Information Model, generative design or optimised design.

As systems such as zone based temperature control and access control solutions become increasingly reliant on data rather than physical interaction devices like thermostats and keys, building users will also rely more and more on the smart aspects of their buildings. This increased connection between building users and building systems can enrich user experience and improve the efficiency of facilities management, but also increases the importance of ongoing rigorous **Information Management** to ensure the accuracy and functionality is preserved.

Why are Smart Buildings increasing in popularity?

What separates **Smart Buildings** from traditional buildings is their digital integration capabilities and the ability to exploit their connectivity. This integration offers new opportunities for building operators and building users to interact with building systems using digital control systems and applications which may even allow these interactions to be automated remotely. Whilst the **Asset Management Team** will use applications to optimise building performance and utilisation, building user's interactions with **Smart Building Technology** will vary depending on the building type and user type. From offices that allocate desks to employees whose mobile phone is approaching the building, to navigation support for hospital patients, the future opportunities for human-centric building experience are far reaching and highly attractive as a differentiator, especially in competitive sectors such as commercial real estate.

The application of **Smart Building Technology** and the analysis of the data it can generate, has the potential to transform the way we approach the spatial and services' design of a building. For example, analysing building usage trends combined with plant and equipment tuning (based on this analytic data), could significantly reduce energy consumption, allowing for new typologies in plant and distribution design that requires less floor space and capacity to become the norm. Another example could be improved utilisation of space through improved understanding of building user needs, allowing for rationalisation of space requirements and potential build cost reduction.

The benefits of deploying **Smart Building Technology** can be significantly amplified when systems are integrated to work together and can provide key insights to support optimised operation. These insights can contribute to achieving business goals as well as contributing to delivering sustainability ambitions. For example in Heating, Ventilation & Air Conditioning (HVAC) systems, integrating HVAC with occupancy sensors means temperature and airflow can be automatically adjusted based on room occupancy, reducing energy demand thereby saving cost and carbon. Using sensors to track space utilisation and optimise room scheduling or facilities management resource allocation, enables a smoother functioning office or education building. Similar systems can be used with wayfinding to manage people-flow in museums or transport hubs.

As **Smart Building Technology** matures and the industry refines how to incorporate opportunity into projects, the technological delivery of **Smart Buildings** is becoming more accessible. Successful delivery requires more than technology to maximise potential; it needs integrating within the brief and clearly defined outcomes which are best achieved through multi-disciplinary collaboration.

As smart buildings become increasingly powerful and complex, the need for timely decision making and clear requirements aligned with the RIBA Plan of Work is paramount for successful delivery. This overlay has been prepared to offer advice and guidance regarding the key areas of focus to make informed decisions on whether a **Smart Building** is appropriate to meet the building's operational needs, and if so, how and when to undertake activities to deliver success.

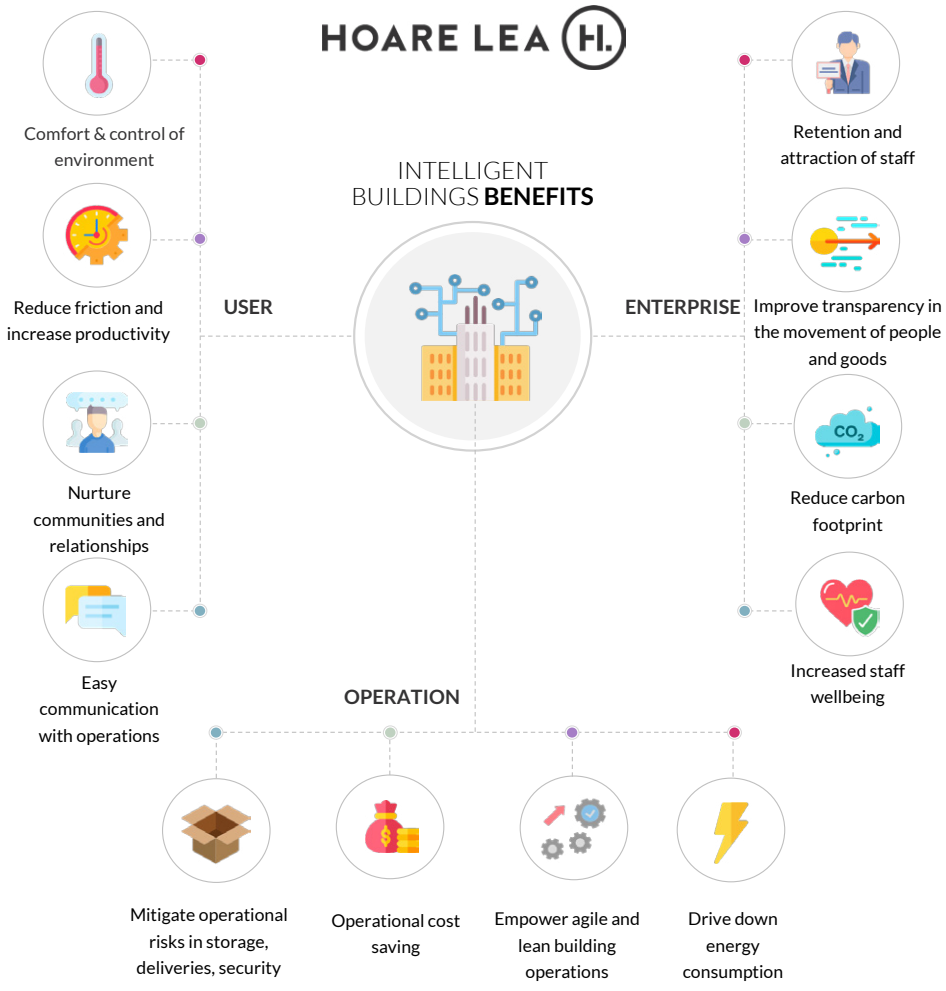


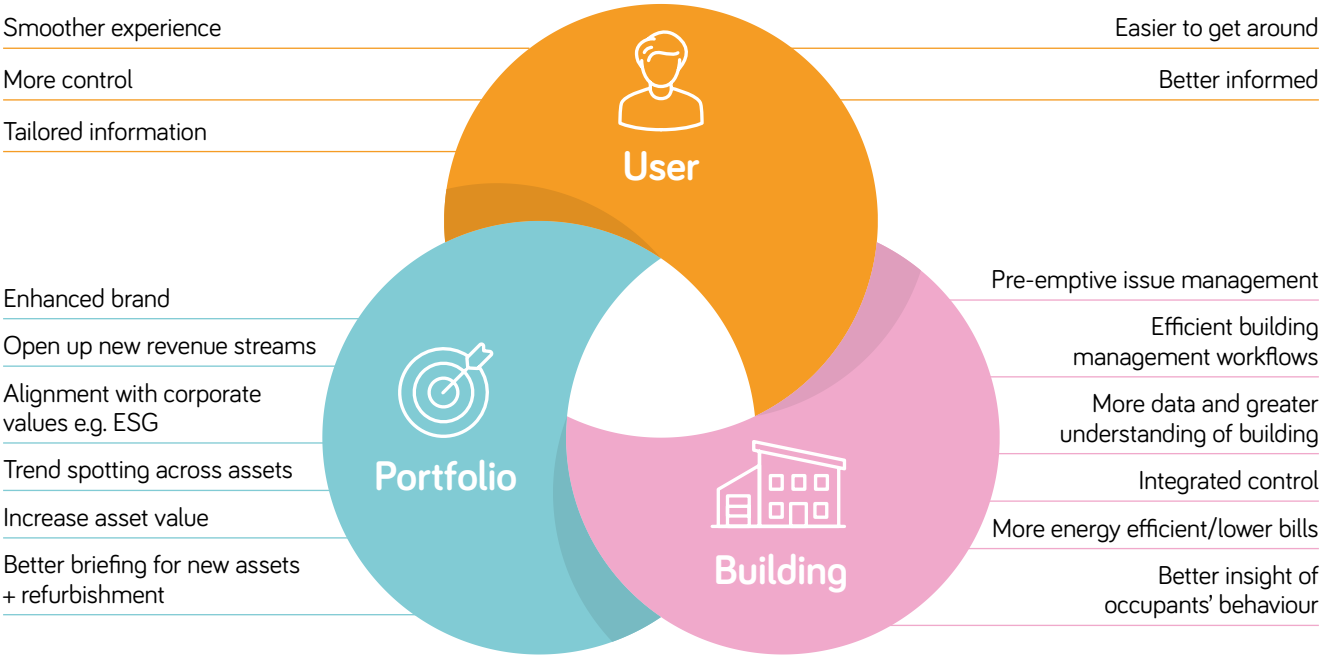
Image: Smart Building Network Architecture Credit: Hoare Lea

What are the benefits of Smart Buildings?

According to the UN's 2022 Global Status Report for Buildings and Construction, buildings are responsible for 40% of all emissions[1]. Reports on the UK's emissions vary, though it is generally thought a quarter of the emissions reported in the UK are generated from the built environment[2].

Smart Buildings offer benefits across a full range of perspectives, from the day-to-day experience of visitors and building users to operational benefits at a building and portfolio level, as well as benefits achieved at the local, national and global level through meeting sustainability targets. Appendix B contains a list of potential benefits as a reference, but this list is not exhaustive.

Full range of benefits from the user, building, and portfolio perspective



Credit: Smart Building Overlay authors

Sustainability benefits at local, national, and global level

Credit: Smart Building Overlay authors

[1] https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction

[2] https://www.ukgbc.org/climate-change-2/

Many benefits of delivering a **Smart Building** are realised as soon as the building is occupied, for example building users can check if meeting spaces are available or the canteen is busy, or efficient space utilisation and ventilation control provides energy savings. However, the major operational benefits can only be effectively harnessed once the building is up-and-running and when a full cycle of data has been generated and analysed. The Stoddart Review 'The Workplace Advantage' shows that a 1% increase in productivity through a better office environment would equate to an additional £20bn in national output[3]. Productivity gains, along with improvement in building lifecycle cost can be considered as individual benefits or together under the umbrella of commercial benefits as part of the business case for investment in a **Smart Building**.

Who benefits from Smart Buildings?

Anyone who interacts with a **Smart Building** has the potential to benefit from it being **Smart**. At a building user level, a visitor for example could benefit from **Smart Building Technology** through personalised wayfinding - directions to points of interest, or step-free routes. Someone working in a building could have customisable settings for workstations, real-time information on canteen occupancy, or hyperlocal control over lighting and temperature.

At an operational level, data generated by **Smart Building Systems** can be used to monitor building performance, improve efficiency, and predict maintenance requirements.

At an organisational level a **Smart Building** could attract and retain staff/ visitors/residents who enjoy the benefits of working or living in a **Smart Building**. Improved energy efficiency and lower running costs can benefit the owner, tenant and/or the landlord, and organisation-wide trends can be identified by comparing data from one **Smart Building** with another.

Finally, from a societal perspective, a **Smart Building** is an optimised building that may be smaller than previously envisaged, thereby having reduced embodied carbon by virtue of reduced construction materials, and which through its energy efficiency and smaller volume also minimises operational carbon.

The importance of early engagement

Smart Building Systems need to be designed in a coordinated manner to avoid potential interoperability or compatibility issues between technologies and to allow the opportunity to implement **User Interface Platforms** which will reduce the need for multiple standalone applications to manage the building.

However, ensuring technical feasibility is not the only reason to engage early. There is also a need to start developing the aspirations and business case for **Smart Building Systems** and defining who will benefit from each system and how they will benefit. This early stage outlining of the **User Journeys** for the eventual use of the building systems will identify the key **User Personas** which need to be referenced in developing great experiences. This approach identifies potential systems and user experiences which will link building users to the **Smart Building** which will inform key design concepts and constraints.

[3] https://workplaceunlimited.com/Stoddart%20Review%20Full%20Report.PDF

It is vital to recognise that **Smart Building Technology** is advancing rapidly and with a remarkably short iteration time by comparison to more traditional aspects of the building design. For example new building materials take a long time to come to market, whereas the development, testing and certification of **Sensors** and their subsequent installation into existing components such as mechanical plant and lighting fixtures is rapid. The quality, availability and functionality of these technologies is increasing at a phenomenal rate which may lead to more frequent upgrades and updates to maintainable assets compared to traditional components.

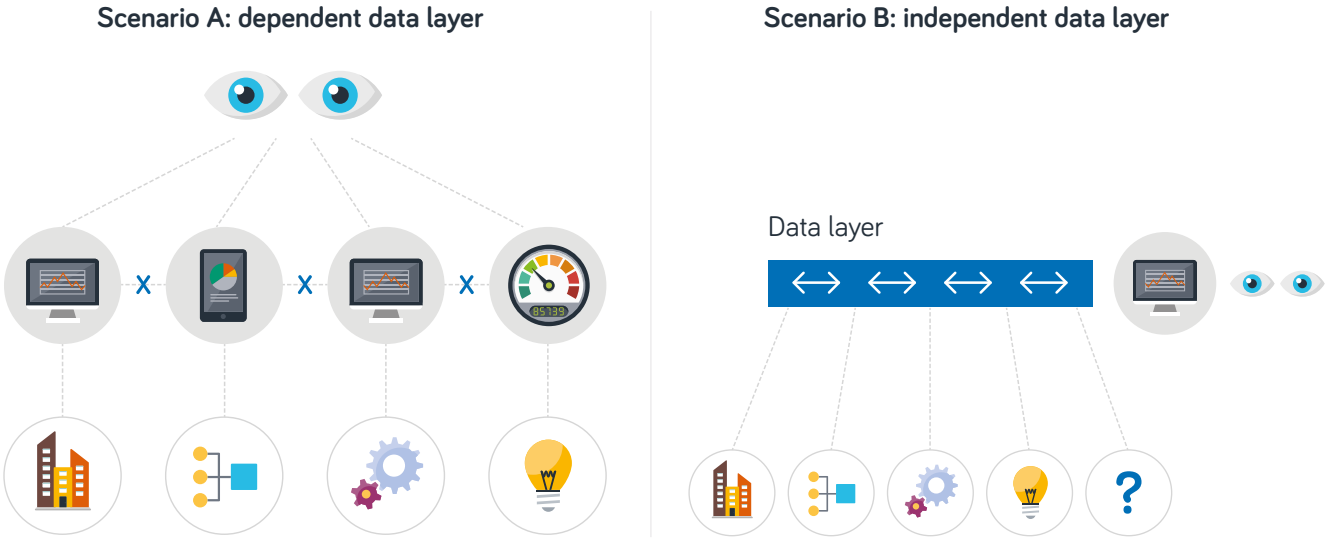
Consideration should therefore be given to the potential for future retrofit of **Smart Building Technology** relatively early in the project's life: system capacity and physical capacity can be designed-in to allow future installation or upgrade as technology develops further.

The design and construction programme may also be a factor as major construction projects can exceed five years from design to occupation. Technology available at project conception may be obsolete by the time it comes to be installed, therefore final selections may be best made at the latest practicable time. Furthermore the updating and change management of software solutions may have a significant impact on the management of a building, and should be fully assessed and understood as well as possible prior to installation.

As well as technological change, building users, operators, owners and suppliers may change and new suppliers and software may come on board. Therefore, it is important to consider an independent data layer which retains ownership of that data but democratises it and ensures it is secure and in the right format - i.e. the data is retained in the client's servers and feeds applications and systems rather than the data sitting in and potentially owned by the system provider.

Legislation around data may also need to be addressed, depending on the type of technology deployed. Data privacy and artificial intelligence are contemporary issues.

Alternate approaches to viewing and analysing data



Credit: Smart Building Overlay authors

This can be used by current and future third party applications, Computer Aided Facilities Management (CAFM) systems, and data analytics platforms, as well as new technology such as artificial intelligence and machine learning toolkits. Whilst the providers of software solutions may change over time, data ownership should be retained. The design and implementation of this independent data layer may take the form of a new, existing or extended data warehouse, so good advice from IT specialists is recommended to manage costs and avoid duplication of systems.

Understanding and planning for the potential for change should be a key consideration when delivering a **Smart Building**. The capacity to start simple and extend later can be built into a design if the aspiration is made clear at an early stage. In circumstances where reducing changes to hardware during the operation of a building is a critical design and operational constraint due to expensive downtime, it may be more appropriate to define a system lifespan to inform the technical specification.

Futureproofing for **Smart Building Technology** should be considered as part of the overall futureproofing strategy for the project. Physical capacity may have implications for the architectural and structural design and will affect building services coordination, but primarily it is inextricably linked with building services design and any futureproofing measures affecting one is likely to affect the other. It should also be noted energy demands and heat generated by IT installations at time of commissioning and in future refit may also need to be factored into the futureproofing strategy.

As with all maintable assets, safe access to service, upgrade and replace sensors or other equipment has to be considered.

Smart Building Accreditation and Certification

Whilst commonly used building accreditations and certifications such as *BREEAM*, *LEED* and the *WELL* Building Standard are all incorporating elements of Smart Building assessment criteria, there are also specialist accreditations and certification available which may offer value and insight to those looking to evaluate, improve, benchmark, and promote cutting-edge **Smart Building Technology**. Whilst the authors of this overlay do not wish to express any preference in this regard, there are some noteworthy differences described below.

SmartScore certification uses a scorecard approach delivered by an accredited professional, whereas the *Smart Building Collective* uses a peer review model, and *BOMA Smart* offers a guided management tool approach with an on-site verification.

The most appropriate approach may vary from project to project, and should be discussed and agreed upon as soon as feasible after the decision to deliver a Smart Building has been agreed.

There are currently no regulations which mandate the need for accreditation or certification of **Smart Buildings** above that of compliance with non-Smart Buildings.

Procurement

Smart Building delivery affects how you plan and procure a project, so it is recommended that due consideration is given to using alternative standard forms of contract and seeking advice if you are unsure.

This document doesn't provide advice on procurement strategy. It should be recognised that **Smart Building Technology** procurement may require consideration of ongoing support services. For Design & Build contracts, special consideration should also be given to specification of **Smart Building Technology** and **Smart Building Systems** at procurement stages – this is due to the passing down of design responsibility to the contractor.

This overlay suggests when to involve experts like **Smart Building Specialists** and **Master Systems Integrators**. Sometimes, specific systems such as passenger lifts come with managed services in Stage 7, however as **Smart Building Systems** become more common it is likely many more provider specific managed service provisions will be offered. Consider a standardised service management approach, such as Information Technology Infrastructure Library (ITIL) or Control Objectives for Information and related Technologies (COBIT), that could simplify the management of these maintenance and support services. As this is an emerging field it is recommended that professional advice is sought from the **Smart Building Specialist**.

There may be different duties for a **Smart Building Specialist** depending on procurement routes too. On Design & Build contracts it may be desirable to include a 'review and approve' role for the specialist where design responsibilities have been passed to the contractor to develop, so that technical queries can be handled and stage submissions can be checked for compliance.

Smart Building Relationship to BIM and Digital Twins

There are clear relationships between the concepts of **Smart Buildings**, Building Information Modelling (BIM) and **Digital Twins**. Whilst this document is focussed on the former, it is valuable to appreciate these connections as they are increasingly likely to feature in discussions focussed on the digital elements of projects and strategies.

A properly considered, contracted and supported adoption of the BIM process is highly recommended for the delivery of **Smart Buildings**. BIM is a collaborative process to improve the specification and delivery of information throughout the whole asset lifecycle, which has been defined in the **ISO 19650** series of standards. Whilst BIM is not a technology in itself, the creation of the **Information Models** and the verified satisfaction of **Information Requirements** will require the use of appropriate software. The benefits of adopting the BIM process with regard to a **Smart Building** can include improved coordination and communication during the design and construction process which is likely to be technically complex due to additional systems, new use cases and changing technology. The RIBA 2020 Plan of Work has already adopted key elements of the BIM process, however reference to the UK BIM Framework is also advised to understand more about BIM.

Unlike the adoption of BIM, the successful delivery of a **Smart Building** does not necessarily rely on, or always directly benefit from the creation of a **Digital Twin**. There are undoubtedly emerging benefits of creating a **Digital Twin** of a **Smart Building** in parallel, however this should be investigated and discussed as early as possible in the context of the project requirements to understand whether this is a project objective which offers a desirable return on investment.

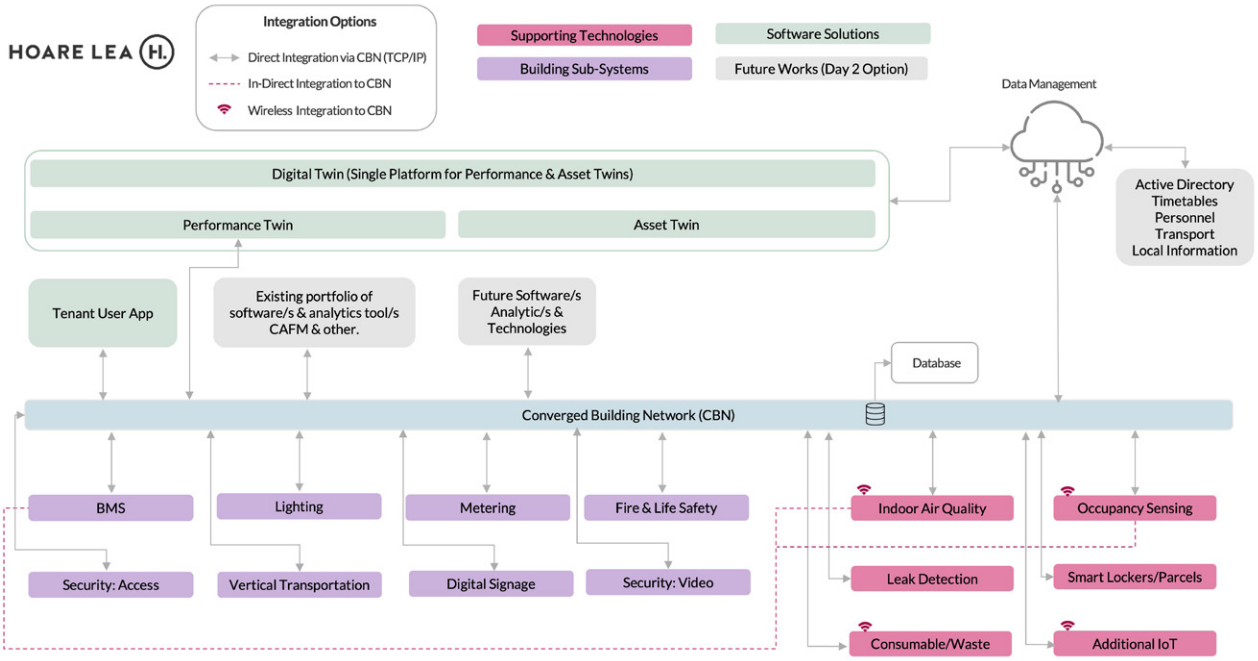
A **Digital Twin** is a virtual representation of an object or system that spans its life cycle, is updated from real-time data, and uses simulation, machine learning and optimised reasoning, to inform decision-making. This real-time data can be harvested from a **Smart Building**, which is a clear example of how a **Smart Building** and a **Digital Twin** can be mutually beneficial. However, it is important to note that there is no implied dependency on creating a **Digital Twin** to be able to benefit from the advantages of a **Smart Building**.

There are a wide range of **Digital Twin** use cases and opportunities at differing states of maturity and there are many useful resources for learning more, including the Digital Twin Hub, however to allow readers to benefit from this overlay it is beneficial to consider **Digital Twins** as constituted from two related concepts: **Asset Twins** – the building – and **Performance Twins** – the data the building generates.

An **Asset Twin** is a digital representation of a physical asset, such as a building or system and is usually based on the **Asset Information Model** generated by the **BIM** process. This digital representation can include geometry, location, connections and structured asset data. A well maintained **Asset Twin** will provide a comprehensive digital replica, which may be highly valuable when planning extensions or alterations to **Smart Buildings** or **Smart Building Systems**.

A **Performance Twin** may be regarded as the manifestation of the data generated by the **Smart Building technology**, alongside other inputs. **Performance Twins** provide benefit to those looking to integrate real-time data and analytics to simulate, predict, and optimise the operational performance and efficiency of an asset.

The comparison of the Performance Twin and the Asset Twin can yield crucial information and insight which can support proactive interventions and future enhancements, refurbishments or replacement of physical assets such as buildings or equipment.



Credit: © Hoare Lea

Smart Building Relationship to the National Digital Twin Programme

The National Digital Twin programme (NDTp) was convened to build upon the 2017 Data for the Public Good Report, to identify areas where data can improve how we build, manage and operate our built environment. One of the key datasets this programme has identified as a powerful future source of knowledge is the information that can be harvested from **Smart Building**.

However, the ambitions of the NDTp are constrained by the 'Gemini Principles', (Centre for Digital Built Britain, 2018) which set out core tenets about how data should be properly valued, managed effectively and stored and shared securely to ensure that all data usage from **Smart Buildings** and other sources will meet the thresholds for purpose, trust and function.

With this considered, it is unlikely that **Smart Building Data** will ever be published to a centralised data warehouse, or be accessed without the expressed permission of the data owner. Therefore, whilst there is much to be excited about in the prospect of a national **Digital Twin**, the founding values of security and public good, should offer confidence that the connection of **Smart Building data** is not an unmanaged risk to building operators who chose to do so.

Image: © iStock

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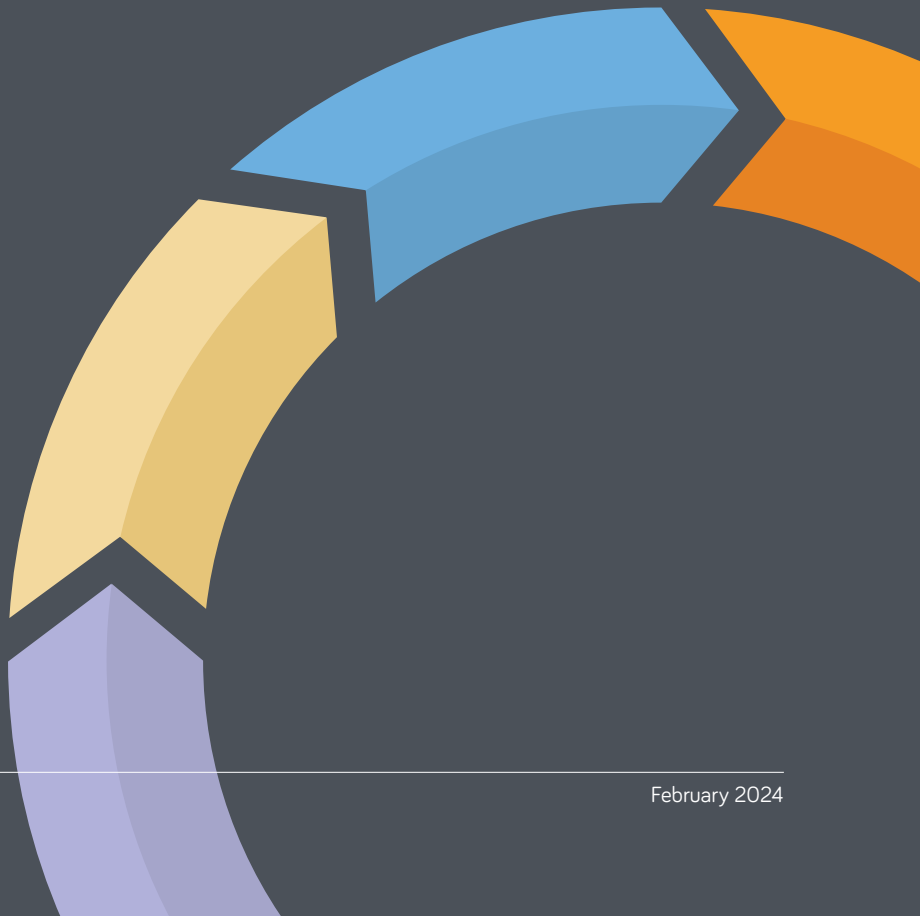
Smart Building Overlay to the Plan of Work



Stage 0

Strategic Definition

Outcome

Smart Building project confirmed as the best way of achieving the client's objectives

Whilst a **Smart Building** itself may not be a consideration at Stage 0, a **Smart Building** project should be based on a solid business case or client aspiration. Strategic discussion at this stage will therefore determine factors that influence whether a **Smart Building** is the required outcome.

Strategic discussion may also determine whether a building project is the best way of achieving the client's desired outcomes. Alternatives to a building project might be flexible working or relocation for commercial buildings, or more traditional approaches for residential projects.

Considerations which may influence whether a building project is required and that may lead to the review in Stage 1 or 2 that a Smart Building is appropriate, may include:

- Do lifecycle opportunities such as energy saving or extended life, impact commercial viability?
- What other benefits are being targeted, and can **Smart Building Technology** support or improve the outcome?
- What extent is there an appetite for digital innovation?
- Does the delivery of a Smart Building align with existing business and estate strategies?

Lessons learnt and feedback from current operational assets is a valuable source of information to answer these questions. Other inputs to the decision-making may include:

- Organisational energy/carbon commitments e.g. Net Zero
- Operational expenditure
- Attraction/retention/churn rates
- Competitor analysis
- Change in work patterns or methodologies
- Improving productivity

The whole lifecycle cost of the building should be considered at this earliest stage. This is especially pertinent to **Smart Buildings** as the impact of deploying some **Smart Building Technologies** may not deliver a return on investment until a number of years after handover, whereas others may pay for themselves quickly and many times over.

The client's aspirations may be driven by making a unique offering to the market (residential, commercial or industrial); providing a state of the art product and **Smart Building** beyond competitor's products.

A business case, justifying investment and inclusion needs to be developed during Stage 0, with desired outcomes identified that support the **Smart Building Strategy**. This should be developed in consideration with smart-related issues such as energy consumption and whole life cycle costing.

Stage 0 is the ideal time to start understanding **User Personas, User Journeys** and critical dependencies around the key concepts and requirements which inform whether a **Smart Building** is a desirable solution. This can be used to support a **Stakeholder Engagement Plan**.

Discussions in Stage 0 are likely to identify the need for specialist involvement in the project – at this point, it is then valuable to consider who can meet the competence needs and ensure there is budget to support their input throughout the works stages.

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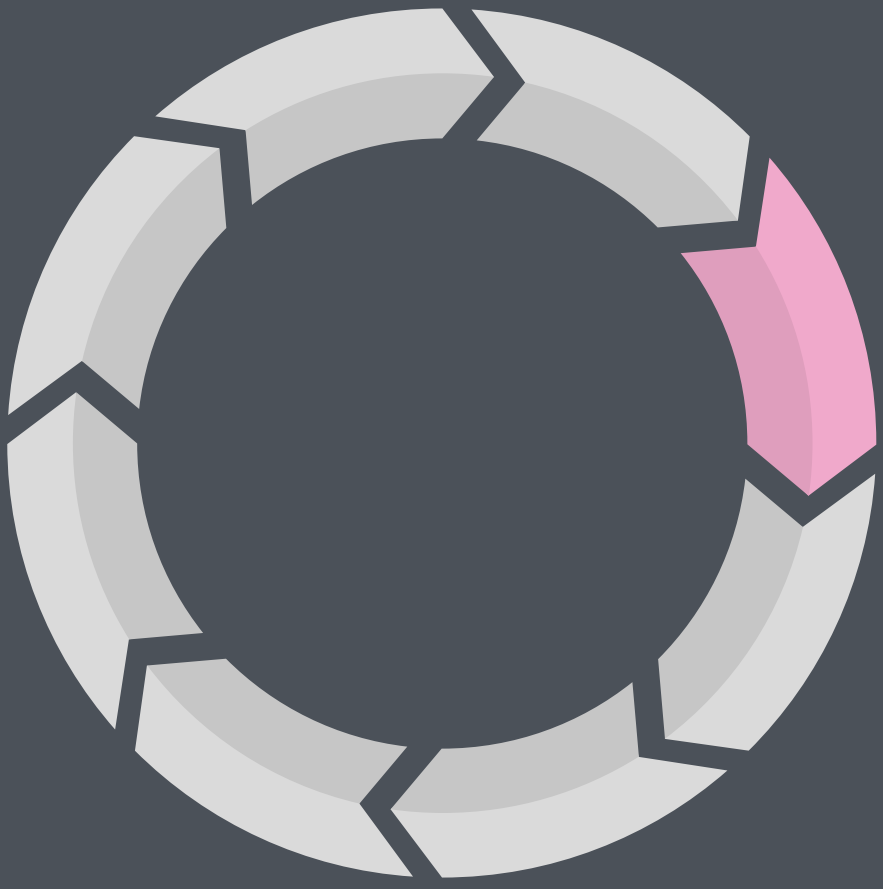
Stage 1

Preparation and Briefing



Outcome

Agree the Smart Building aspirations with the client

Digital enablement and the development of building services and management system technology means that most, if not all, building projects now have a degree of **Smart Building Technology**. It is important to consider at the earliest stage how **Smart** a building should be and start to form the strategy to decide what level of implementation would provide optimal benefits (and return on investment).

If not agreed in Stage 0, at the outset of Stage 1 there should be high-level business agreement that a **Smart Building** is desirable and aligns with the identified needs of the client, the building operator/owner, and end user. It should be recognised that for some projects it may involve going from zero to **Smart**, whereas others will go from **Smart** to smarter.

Whether the brief includes a **Smart Building** or a degree of **Smart Building** enablement, it is advisable to engage with a **Smart Building Specialist** to support the client team at this stage to ensure that the latest information regarding technology advancements can be included in the feasibility studies. They can advise on the potential impacts on key design parameters and other obligations such as the **Golden Thread of Information**, and guide the production of **User Personas** and use cases. A **Smart Building Specialist** will also be able to advise on specific opportunities and risks related to the **Smart Building** for capture within the brief.

Early appointment and inclusion of a **Smart Building Specialist** will therefore help ensure client aspirations and requirements in respect of **Smart Building Technology** are understood and feasible. Inclusion with the design development at Stage 1 will ensure the project brief is developed to support the project outcomes and contribute to early identification of opportunities and constraints, which may be managed more efficiently and effectively at this stage than later in the project.

Stage 1 is the ideal time to refine and define these aspirations into design objectives, **User Personas** and **Information Requirements** which will underpin the feasibility of delivering a **Smart Building**. Importantly, a high-level budget should be agreed to feed into the cost plan, to include not only the **Smart Building Technology** costs, but fees associated with any specialists to support the project aspirations.

To successfully deliver a **Smart Building** much work needs to be done in the early stages to estimate additional costs (CAPEX), and also comparing the operational costs (OPEX) with and without the **Smart Building Technology**. When considering the adoption of such technologies, appointing parties need to think in terms of Total Expenditure (TOTEX) which is the sum of CAPEX + OPEX.

The concept of developing **User Personas** is common in the design of software applications, as it allows the design team to rationalise the needs of many potential users into a manageable group of user types. These **User Personas** can then be used to create **User Journeys** and use cases as the design progresses. Capturing the list of **User Personas** should, where possible, include input from people who will be engaging with the **Smart Building** as it becomes operational and during its life. This includes those who may not use the building but interface with it such as those responsible for integrating it into a wider estates network.

During Stage 1 forming a **Smart Building User Group** is recommended which includes representation from those **User Personas** who will be interacting with the Smart Building Technology to ensure these voices are represented in the briefing and visioning process.

These **User Personas** would generally be split across a broad range of people that would interact with the building but the main groups we would expect to draw from would be:

- Building Operations/ Asset Management Team
- Building Owner (noting a possible distinction at project stage and post-handover)
- Incumbent Providers/ Suppliers
- Tenant representatives
- Transient visitors - maintenance/delivery/guests

The **Smart Building User Group** should answer the question "what is wanted from the building?" and focus on the following in order to develop a brief;

- **What outcomes do you want to achieve?** *i.e. aligned with business case/brief*
- **What value does it provide?** *This will be defined in Stage 0 and may be developed ahead of critical milestones (ie Core Statutory Processes or Project Milestones) e.g. reduce energy consumption*
- **What information is needed?** *i.e. what data do you want to harvest from the Smart Building. See advice on 'indicators' below.*
- **Who will use/ manage/ benefit?** *e.g. building visitors*
- **Who is required in the design and definition?** *e.g. Design Team and Plan for Use Champion etc.*
- **What technology is needed, and does it exist?** *e.g. CO2 sensors and monitoring system*
- **What asset information is needed?** *e.g. COBie/ Industry Foundation Class (IFC)/ other schema*
- **How can it be achieved?** *e.g. incorporate IOT sensors into BMS*
- **What are the key building user touch-points?** *e.g. how and where do they interact with the building?*

Other considerations include:

- Is there a requirement to meet Smart Building Certification?
- What are the Environmental, Social and Governance (ESG) ambitions?
- Who may be potential building users?
- Who will operate the building?
- Change management, how new technology introduction will impact existing ways of working?
- Set out clear aims & objectives of a Smart Building.
- Consider any bespoke building requirements which may be supported by technology.
- Consider the future proofing strategies for future refurbishments or changes of use.
- Consider the legislation for the management and use of data, including where and at what time the 'owner' may change.

To support readers in selecting which indicators to use, there are several useful Standards available, refer to Appendix D.

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Stage 2

Concept Design

Outcome

Smart Building Strategy approved by the client and aligned to the Project Brief

As the design starts to develop, the impact of the **Smart Building Technology** will become better understood, and the strategy for how passive or active the technology should be can be considered.

Smart Building Systems can be an influential and engaging element of the design and can have a considerable impact on the manner in which the end users of the building will interact with the environment.

The key to successful Stage 2 integration is to form a deep understanding of these three critical elements:-

1) end users
2) technology
3) proposed building space functionality

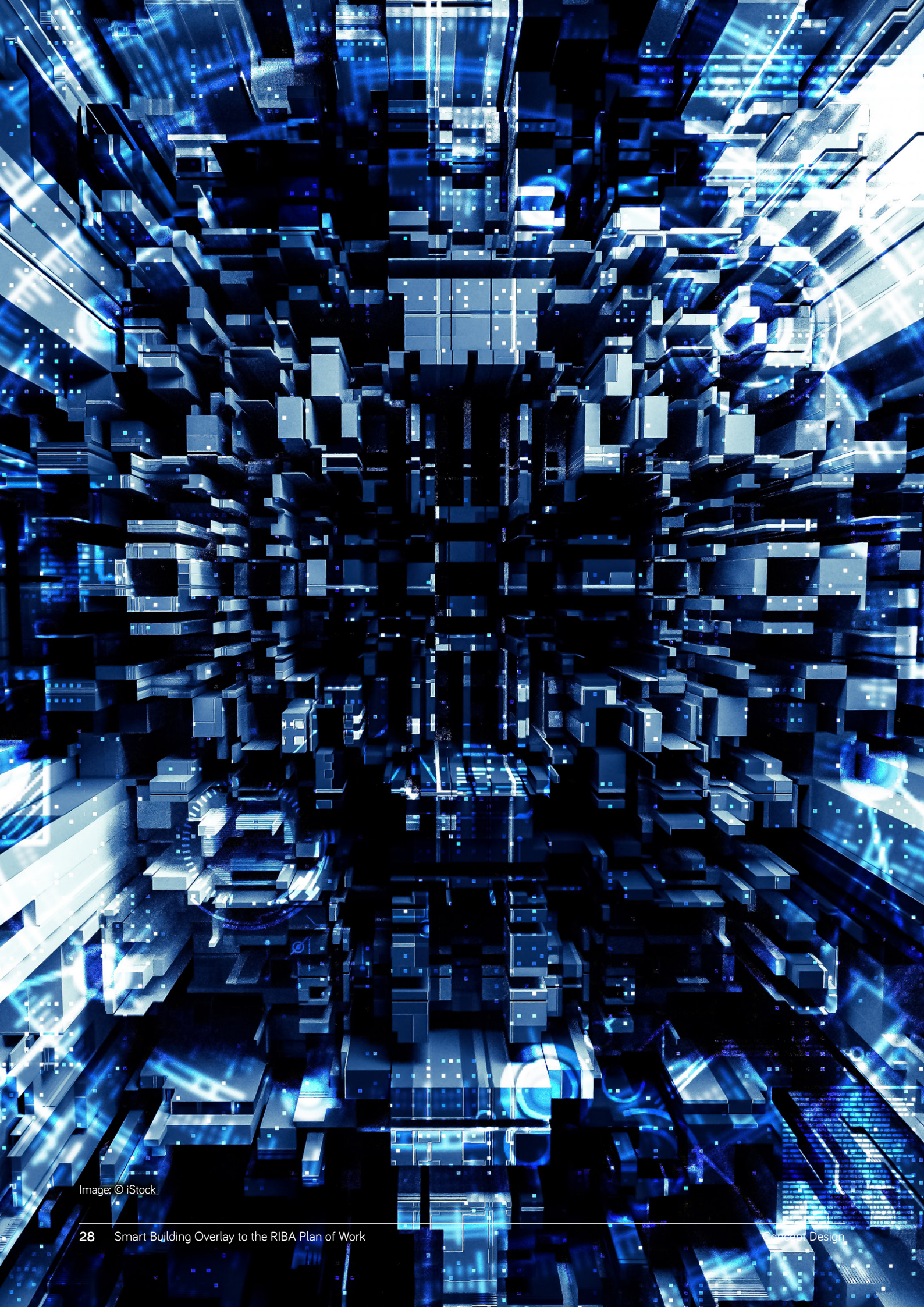
Stage 2 offers the opportunity to consider a wide range of technologies (physical and software) whilst reviewing their opportunities, advantages, disadvantages, and priority. It is also valuable at this stage to consider the potential for the extension of Smart Building systems by considering areas such as how easy is it to add or remove sensors from the building, and how likely is this? This type of design concept testing at Stage 2 will generate valuable design constraints and parameters to inform future stages.

Early relationships between the previously mentioned three elements is recommended to be identified within the concept design stage by the creation of **Smart Building User Journeys** based on **User Personas** identified in Stage 1. This is so that technology selection is measured against and driven via end user and space requirements. **Smart Building User Journeys** in return shall be utilised to build out an early **Use Case Matrix**.

Overall Stage 2 should be treated as an opportunity to brainstorm multiple user centric technological possibilities in a managed way, considering yesterday's, today's and tomorrow's requirements, needs and wishes.

As early as possible in Stage 2, an outline list of prioritised smart building uses and users should be prepared and a high level **Smart Building Strategy** prepared to include;

- Develop User Journeys
- Develop Use Case Matrix
- Business objective and goals, aligned with use cases
- Technology selection (priority high, medium, low)
- Systems/Subsystem list/Softwares
- Introduction to Smart Building Platforms (Including Asset Twin & Performance Twin)
- Introduce data schema, naming convention and metadata
- Response to/ production of Built Asset Security Strategy (Cyber Security)



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Stage 3

Spatial Coordination

Outcome

Smart Building design coordination ahead of planning application.

Stage 3 is of fundamental importance to the success of a **Smart Building** delivery as the defined list of user journeys will be tested against a spatially-coordinated set of federated design models and the cost plan. Whilst **Smart Building Technology** is typically relatively small compared to other building services, coordination is important to ensure there is sufficient space, range and connectivity for hardware and end-user devices. Managing co-ordination effectively in Stage 3 will minimise impact on design changes (especially post planning application determination) and also represents an ideal point in the project for a **Smart Building** design freeze.

As smart building concepts and technologies impact multiple different systems and disciplines within built environment design, early engagement with all relevant project design stakeholders shall be undertaken, engagement with parties such as the **Information Manager**, Architect, Mechanical, Electrical and Plumbing consultant (MEP), Structural Engineer, Sustainability specialist, ICT/IT, Security Advisor, Fire Engineer, Lighting consultant, and others subject to selected technology, and its impact on other systems/disciplines.

Stage 3 shall be utilised to agree the final list of preferred **Smart Building Technologies**, whilst also establishing scope, quantities and high-level technical requirements for each type of technology to enable costing. It is also an opportunity to consider whether the project would benefit from a **Master Systems Integrator (MSI)**, to coordinate multiple solutions effectively.

Stage 3 is utilised to understand **Change Management** impact on overall proposed design, this may include but is not limited to new ways of working for end users and new process/approach introductions for the **Asset Management Team**. Wherever possible, such stakeholders shall be consulted and taken along the **Smart Building** journey, as they are the ones who will use and operate it.

The **Smart Building User Journeys** shall be progressed and built into a **Use Case Matrix** which captures all Use Cases, Personas/End Users, technologies, systems, software and business drivers in a single matrix, to achieve a relationship matrix and highlight overall performance requirements of the smart building. Ideally, the **Asset Management Team** will be appointed at this stage to support these developments.

A high level **Smart Building Architecture** encapsulating the overall smart 'ecosystem' of solution, hardware and software, shall be produced at Stage 3. This should include for service zones, general positioning within the building fabric and future system extension capacity planning.

A significant consideration shall be paid to the **User Interface Platforms** i.e. how the building users interact with the technology, whether that may be End User App, **Digital Twin** or other software solution operational and design requirements of such softwares shall be captured. This should be captured in the **Plan for Use Strategy** to support the mangement, maintenance and operation of the **Smart Building Technology**.

Performance Twin (live data) and/or Asset Twin (static data) (two components of a **Digital Twin**), are proposed as a solution part of the project, consideration of BIM requirements must be undertaken, where the **Information Manager** shall be engaged to establish **Information Exchange Requirements** and associated BIM documentation, as well as incorporating information relevant to meeting any regulatory requirements.

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Stage 4

Technical Design

Outcome

Complete the Smart Building design and specification.

The completion of the technical design and definition of required standards, processes and methodologies for a **Smart Building** will require significant **Smart Building Specialist** input at Stage 4 (and possibly Stage 5 subject to specialist supplier design).

The appointment of a **Master Systems Integrator (MSI)** to work alongside the **Smart Building Specialist** and the wider design team at this stage will ensure the technical viability of the **Smart Building** design. The contractor shall ensure their proposals align with the **Smart Building Strategy** and any necessary revisions made as soon as possible as it is extremely challenging to make changes to this strategy during the construction phase.

If not already appointed, an **Asset Management Team** must be nominated. It is likely that through the implementation of a **Smart Building**, the **Asset Management Team** will need to adapt to different ways of working, and a level of upskilling may be required. In addition, the **Asset Management Team** will play a vital role in the **Plan for Use Strategy**.

At this stage, the **Asset Management Team** will need to begin engaging with their various systems (CAFM/ **Digital Twin**/CDE/as examples) and trialling data exchanges where possible for integration and suitability.

Regardless of the chosen procurement route it is advisable to deliver descriptive information (performance based) rather than prescriptive information where possible about **Smart Building** systems in the final specification, however this information should be sufficiently detailed to fully communicate compatibility constraints. It is also advised that the specified **Smart Building Technologies** are prequalified by the **Master Systems Integrator (MSI)** either through a rigorous desktop exercise or through factory mockups by the supply chain to ensure compliance with the security and performance requirements of the **Smart Building Strategy**.

Specialist subcontractors should be appointed as soon as possible to ensure all **Smart Building System** designs are prepared and coordinated during Stage 4.

With **Smart Building Technology** rapidly evolving, decisions on final specification of hardware and software may have been postponed for as long as possible: Stage 4 is the final opportunity to make these choices so that detailed design, detailed coordination and procurement can take place along with any statutory applications ahead of construction works; all of this must be completed in order to conclude Stage 4.

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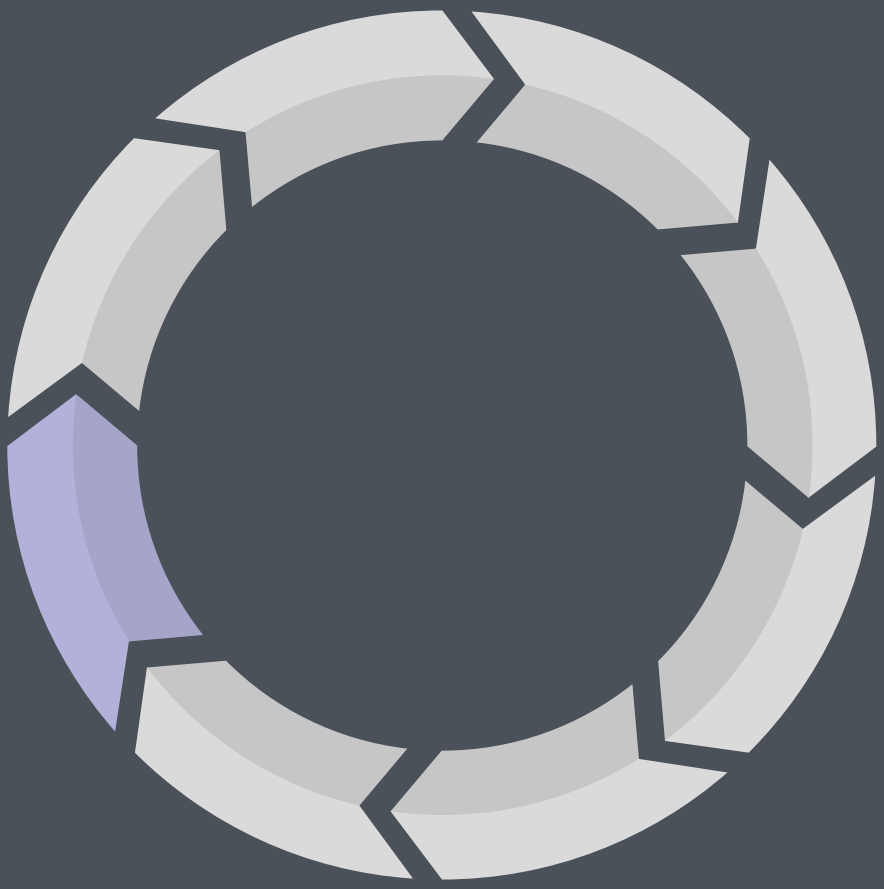
Stage 5

Manufacturing and Construction



Outcome

Build, test and commission the Smart Building.

With the detailed design and prequalification of systems and components completed during Stage 4, the priorities for Stage 5 are ensuring the installation of **Smart Building Systems** is highly controlled and the collection of **Structured Information** (such as COBie or IFC etc) to meet the commission and operational requirements. Whilst design should be complete in Stage 4, the production of installation information (in the form of supplier design, specialist design and or handover information) may take place in Stage 5.

In many scenarios it is appropriate to build and test **Smart Building Systems** in a factory environment before site installation. This allows for entire systems to be tested prior to delivery; this activity should be included in the construction programme to ensure that delivery of this specialist equipment is optimised.

It is recommended that asset tagging is performed under factory conditions where possible, which may require coordination with the room naming strategy to ensure physical device locations match exactly with any data provided on or by the **Asset Tag**.

A high level of **Information Management** is required in Stage 5 to ensure accurate asset information is captured, validated and verified. A professional and planned approach to **Information Management** is especially important where **Smart Building Systems** are concerned as once installed it can be challenging to survey and recapture information. To ensure sufficient quality and completeness of the data needed to allow the **MSI** to commission the **Building Operating System (BOS)** and populate end user systems such as Computer Aided Facilities Management (CAFM), it is recommended that a client-side **Information Manager** is appointed to work with the Contractor's **Information Manager**. Together they will ensure the **Information Requirements** are not only being met but the **Information Exchanges** are supporting the necessary client needs ahead of handover.

The thorough documentation and commissioning of **Smart Building Systems** prior to handover is fundamental to support training and familiarisation activities as part of a the **Plan for Use Strategy**.

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Stage 6

Handover

Outcome

Finalise 'Post Completion Smart Building Optimisation Strategy'

Stage 6 for **Smart Buildings** requires more planning and extra dedicated training compared to a traditional building so that the systems are configured to the end users' needs as well as fully understood by the **Asset Management Team**. Providing a **Building User Guide** will support this. Failure to onboard **Smart Building Technologies** could result in the building running inefficiently or delivering a frustrating experience for users and operators. A key activity in Stage 6 is to ensure that administrator passwords and other appropriate intellectual properties are included in the handover.

Earlier investments of time and effort as part of a **Plan for Use** framework will ensure that there are members of the **Asset Management Team** who are fully aware of the user journeys the systems have been designed and configured to support. This approach will allow for **Aftercare and Post Occupancy Evaluation** regarding **Smart Building Systems** to be aligned with the agreed objectives and aspirations of the **Smart Building** design.

A **User Acceptance** period of end-user and operational **Smart Building Applications** and their ability to control the building should be undertaken. If the applications have not been procured through the main contract any issues regarding functionality will need to be analysed to determine whether it is the **Smart Building Systems** or the software applications which require adjustment.

If the **Smart Building** offers applications to visitors or other building users, a dedicated system for gathering feedback should be considered, along with the task owner.

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Stage 7

Use

Outcome

Use and refine 'Post Completion Smart Building Optimisation Strategy'.

Smart Building Systems can start generating visible benefits for the building operator as soon as they are in use, whereas many other building systems go relatively unnoticed until they require maintenance. To maximise these benefits there is a need to focus on tuning and monitoring over a period of at least 15 months to ensure there is a minimum of three months of baseline data, plus 12 months to allow all seasonal impacts to be considered. This tuning may require the appointment of specialists, however the **Asset Management Team** should be involved in the process to ensure that asset specific knowledge is transferred.

Through analysis and use it may become apparent that additional technologies or adjusting the usage of spaces or equipment could add further benefits. The focus on future proofing advised earlier in this document will hopefully remove the need for significant further investment.

One of the key benefits of a **Smart Building** is that all manner of data points - from building occupation statistics to CO_2 buildup areas – can be analysed and acted upon more effectively than possible in traditional buildings. This allows for more responsive management and automation of systems which can yield significant savings and improvements in occupant comfort and wellness. Although this may be driven by machine learning applications in the future, much of this analysis currently requires manual data interrogation. As such, it is important to fully train and resource the operational team as well as working closely with any software providers to ensure the **User Experience** is meeting expectations.

The upkeep and maintenance of the asset information, information models and associated statutory and operational and maintenance documentation, should be planned for and resourced appropriately, as well as being a fundamental aspect of any future refurbishment or extension. When updating asset information it is important to understand the knock-on effects on systems to ensure that the wider ecosystem remains aligned.

Although this document is not focussed on the creation of **Digital Twins**, it is worth noting that the use of a **Digital Twin** for operational activities will almost certainly increase the reliance on good quality trusted and verified information.

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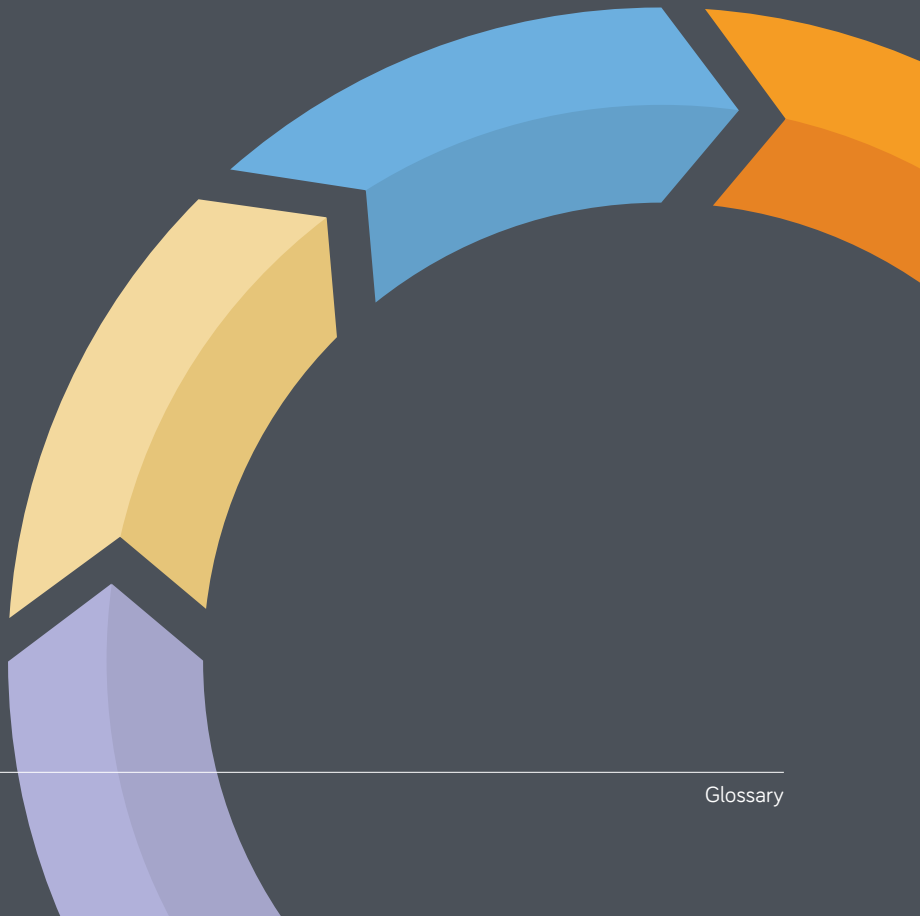
3.

Glossary



Glossary

Key term	Definition, overview or description
Aftercare	The RIBA Plan of Work refers to initiatives aimed at making the use of the building, or subsequent buildings, more effective, including improving the performance of the building systems. Tasks may include gathering feedback on project performance and building performance from post occupancy evaluations. Where smart buildings are concerned, over and above the usual user surveys and system tests, there is the opportunity to evaluate the smart building technology and applications against system performance design information, and any future requirements for refinement and optimisation.
Asset information	Asset information encapsulates all information and data that supports the life and maintenance of assets plus all enablers including asset inventory, classification of assets, attributes of these assets, location and spatial information of assets, relationships between assets, design models and should be included in all relevant handover and regulatory requirements.
Asset management team	The asset management team (also known as the facilities management team) are responsible for developing, operating, maintaining, upgrading and disposing of an asset using the most effective and efficient means, as defined in the 2020 RIBA Plan of Work Overview. Operations and maintenance functions integrate people, place, and processes within the built environment with the purpose of improving the quality of life of people and the productivity of the core business. For example, providing a summary of all key information about a building, including the health and safety file and fire safety information, which are regulatory requirements; landscape ecological management plans (including play equipment), adoptions and more. these functions are undertaken by the asset management team who are the primary users of the building manual. The building manual and building user guide includes information that can be used to ensure that asset management is effectively implemented and might contain tasks that the users must consider to get the most out of the building
Asset tag	Asset tags are labels that identify equipment. This can take many forms including a unique serial number, QR code, barcode or radio-frequency identification (RFID) tag, that creates a seamless link between the physical and digital asset. The code affixed on an asset tag can then be replicated in the digital twin, thus creating a link between the physical and the digital asset.
BIM (Building Information Model/ Building Information Modelling)	BIM is a process for creating and managing information on a project throughout its whole life cycle. As part of this process, a coordinated digital description of every aspect of the built asset is developed, using a set of appropriate technology.

Key term	Definition, overview or description
Brick	Brick is an ontology-based metadata schema that captures the entities and relationships necessary for effective representations of buildings and their subsystems.
Building Operating System (BOS)	A Building Operating System (BOS) is the core software platform of all connected building solutions. This 'middleware' is the bridge between the building equipment and external applications.
Construction-Operations Building information exchange (COBie)	The advanced asset register developed as an output from the BIM process at each work stage, most likely by the information manager.
Common Data Environment	A Common Data Environment (CDE) is a central repository where construction project information is housed. It is the single source of information for the project. It is used to collect, manage, collaborate, and share project information with the project team. A CDE is updated throughout the project life cycle. An important distinction to make is that a CDE alone is not a complete Information Management Platform as described as part of the UK BIM Framework.
Computer Aided Facilities Management (CAFM)	CAFM software enables asset management teams to plan, execute and monitor all activities involved in reactive and planned preventative maintenance, space and move management, asset management, operational facility services, room reservations and other customer service.
Data structures	Data structure is a data organisation, management, and storage format for data that enables efficient access and modification. More precisely, a data structure is a collection of data values, the relationships among them, and the functions or operations that can be applied to the data. There are a number of emerging data structures in the built environment, such as COBie or brick, which all provide value in different ways. Data may be collected in one structure and transformed into another at different stages of the smart building life cycle.
Descriptive information	A descriptive specification which sets out the performance level required and characteristics of a system or component.
Digital Twin (DT)	Whilst there is no official definition of a digital twin, its reference in this document refers to a virtual representation of an object or system that spans its life cycle, is updated from real-time data, and may use simulation, machine learning, and reasoning to help decision-making.
Engagement plan	A written document outlining engagement scope, purpose, aim(s) and objectives, relevant policies, engagement study area, stakeholder engagement map and register, desktop study, appraisal of impact on protected characteristic groups. This may be developed alongside the project plan and updated throughout the project as necessary.

Key term	Definition, overview or description
Entity	An entity is a digital representation of any physical, logical or virtual item; the actual "things" in and around a building. Brick defines how entities can be classified and related to one another. There are several flavors of entities: Physical entities: anything that has a physical presence in the world.
Golden Thread	The Golden Thread[4] is both the information that allows you to understand a building and the steps needed to keep both the building and people safe, now and in the future. A Golden Thread is a digital record of the life cycle of building systems and components from design intention to the present, and provides a log of actions and decisions specifically for higher-risk buildings (though the principles align well for all projects, as well as with the CDM 2015 requirements for the health & safety file.
Information exchanges	Information exchange means that people or other entities pass information from one to another at scheduled events, in agreed formats.
Information management	Information management is the collection, storage, curation, dissemination, archiving and destruction of documents, images, drawings and other sources of information (see ISO 19650) (also reference Golden Thread).
Information manager	The information manager is responsible for maintaining, accepting, and rejecting information within the Common Data Environment (CDE), enabling integration and coordination of information within the information model. Ensuring the right data is captured in the right format and at the right work stage in the project. Preferably independent of the project, so free from bias.
Information model	An information model is developed and maintained by the design team during the design and construction phase of a project in response to requirements set out in Exchange Information Requirements (EIR), and maintained throughout the building life cycle by the asset management team.
Information requirements	According to ISO 19650 series, information requirements specify for what, when, how and for whom we should produce data.
IOT	The Internet of Things (IoT) describes the network of physical objects - "things" - that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.
IOT sensors	Often referred to as a smart sensor, an IOT sensor is a device that takes input from the physical environment and uses built-in computer resources to perform predefined functions upon detection of specific input and then process data before passing it on. For example a smart sensor can count the number of occupants in a space and trigger the lights to flash if the room becomes over-occupied.

[4] https://www.gov.uk/government/publications/building-safety-bill-factsheets/golden-thread-factsheet

Key term	Definition, overview or description
ISO 19650	The ISO 19650 standard is an international standard for managing information over the whole life cycle of a built asset using Building Information Modelling (BIM).
Metadata	Metadata is the summary and the description about your data that is used to classify, organise, label, and understand data, making sorting and searching for data much easier.
Master Systems Integrator (MSI)	MSI's make sure all systems communicate properly, they collaborate with building owners to ensure systems information will be accessible and usable, and they develop software layers responsible for integration, aggregation, and communication of the building systems.
Object naming convention	A naming convention is a convention (generally agreed scheme) for naming things, allowing useful information to be deduced from the names based on regularities. For smart buildings this may include metadata naming and tagging (Haystack, Brick Schema, Digital Building Ontology, etc.) An object naming convention is the agreed naming structure applied to building objects mainly created in the Building Information Model, which can be applied to a wide range of objects (doors, actuators, sensors, etc.). An effective object naming convention is both machine readable and human readable so it can be understood from its physical asset tag, as well as identified in the digital realm as a unique object with its own maintenance and performance history.
Ontology	An Ontology is a way to describe things and the relationship between things. Ontology, in layman's terms, is the classification of entities by defining a set of concepts through which they can be classified and showing the relationships between them. Similarly, within smart buildings ontologies are used to link data, connect entities, and understand their relationships. (Haystack, Brick Schema, Digital Building Ontology, RealEstateCore etc.) An example – whilst penguins and song birds are very different, they can both be identified as bird relatives by their wings, beak and feathers.
Plan of Work	The RIBA Plan of Work is guidance published by the Royal Institute of British Architects (RIBA). Split into a number of key project stages, the RIBA Plan of Work provides a shared framework for design and construction that offers both a process map and a management tool.
Plan for Use Strategy	Plan for Use is the RIBA's interpretation of the Soft Landings Framework produced by the Usable Buildings Trust and the Building Services Research and Information Association (BSRIA) and is embedded within the 2020 RIBA Plan of Work. Its aim is to encourage a more outcome-based approach to briefing, design, construction, handover and aftercare throughout the construction industry. This is a key element of the design and construction process and maintaining the "golden thread" of the building purpose through to delivery and operation, with early engagement of the end user and inclusion of a Plan for Use champion on the project team, and commitment to aftercare post construction. BS8536 Design and construction for operability also offers guidance on this.

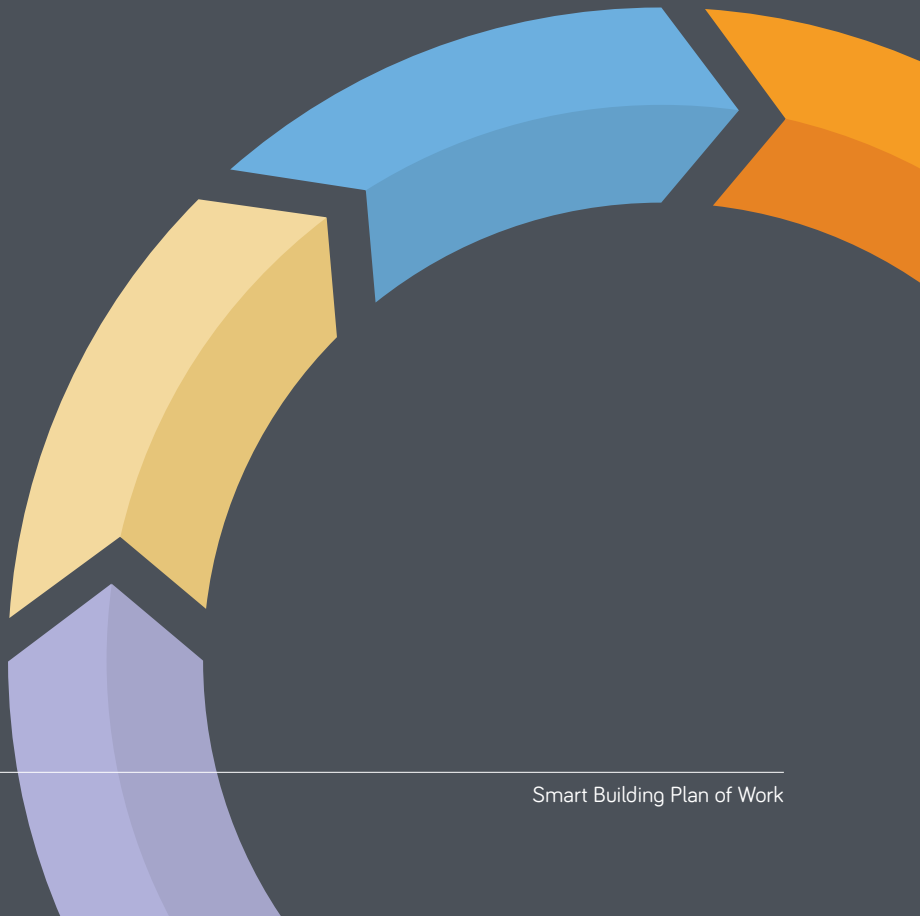
Key term	Definition, overview or description
Post completion smart building optimisation strategy	A process to address findings of the post occupancy evaluation with the view to implement changes to fine-tune the smart building configuration to optimise building performance. This strategy should be a natural extension to the agreed testing and commissioning approach, and any changes to systems should be captured as verified asset information.
Post Occupancy Evaluation	Post occupancy evaluation is a formal exercise which takes place at set intervals following building handover to see how the building performs and seeks the experience of building users.
Prescriptive information	Detailed specification information describes the materials, methods, and installation methods required for a particular component or system.
Smart building	A smart building is one that uses technology to enable efficient and economical use of resources, while creating a safe and comfortable environment for occupants. Smart buildings may use a wide range of existing technologies and are designed or retrofitted in a way that allows for the integration of future technological developments. Sensors (IoT or other), building management systems, artificial intelligence (AI), and augmented reality are amongst some of the mechanisms and robotics that may be used in a smart building to control and optimise its performance.
Smart building applications	Smart building applications (or apps) are software implemented to simplify tasks like controlling building temperature, security and maintenance through mobile devices and computers, climate control, including temperature, humidity, vibration, etc. CO_2 monitoring, electrical usage, and more. These apps may be desktop applications or mobile device applications, and can include more front-of-house/ end-user applications associated (for example, tenant applications).
Smart building specialist	Smart building specialists help clients to understand the digital landscape and the value that technology and digital services can bring to a development in increased revenue, reduced bottom line costs, increased productivity and sustainability, and greater end-user experience.
Smart building strategy	A smart building strategy defines how the building will be delivered to achieve four key capabilities: • Connecting humans • Proving enhanced control of facilities and operations • Supporting ways to collaborate digitally • Enabling owners to conserve resources
Smart building system	A smart building involves the installation and use of advanced and integrated building technology systems and software. These systems include building automation, life safety, telecommunications, user systems, and facility management systems.

Key term	Definition, overview or description
Smart building technologies	Hardware and software used in smart building systems to gather, transmit, analyse, display, or control data and/or other systems. Examples: Internet of Things (IoT), Artificial Intelligence/Machine Learning (AI/ML), Building Automation, Building Information Modelling (BIM), Augmented Reality (AR), Building Operating System (BOS).
Smart building technology architecture	A smart building technology architecture is a diagram which explains the relationships between the elements of a smart building which describes key systems such as sensor networks, hubs and controllers.
Soft landings	See 'Plan for Use Strategy'.
Structured information (also reference 'data structure')	Information which has been set out in such a manner that it can be consumed and analysed using a digital method. This may be a database populated to meet a schema, a well formed spreadsheet template, or even a data rich model.
UK BIM Framework	The UK BIM Framework is the overarching approach to implementing BIM in the UK, using the framework for managing information provided by the ISO19650 series. The UK BIM framework sets out the requirement of meeting the Information Management Mandate in the UK, and is an open resource for anyone looking to implement best practice regarding BIM and Information Management.
Use case matrix	A use case matrix is a method of capturing the potential users for a smart building in a spreadsheet style approach to allow for information to be captured in a standardised manner to make prioritisation easier.
Users	Smart buildings put focus on designing the experience of buildings for users – making them human-centric rather than technology-centric.
User acceptance	User acceptance is performed by the end user or the client to verify/accept the smart building system before moving the system to the 'live' environment. User acceptance is often structured around the smart building user journeys to ensure the information flows and activities which were intended have been delivered successfully.
User Experience (UX)	User experience encompasses all aspects of the end user's interaction with the building. The first requirement for an exemplary user experience is to meet the needs of the client, end user or stakeholder with no unnecessary steps or delays.

Key term	Definition, overview or description
User interface platforms	User interface platforms refer to any software solution through which the user engages with the building and its data, this includes but is no limited to: • Smart building platform, building operational platform, integrated building management system, performance twin – commonly used terminology for a single platform which integrates multiple building sub-systems and supporting technologies. • User app: mobile application enabling all building user to engage, control & feedback on building operation. • Digital twin: introduced previously form part of user interface platforms.
User journeys	Making use of the identified building user personas, smart building user journeys map out the different ways in which different user personas can interact with the smart building to improve their end-user experience, helping to establish the smart building strategy.
User personas	User personas are semi-fictional characters based upon expected building end-users or other stakeholders – in other overlays, they are also referenced as a 'user group'. The purpose of user personas in the process of delivering a smart building is that the most important activities can be prototyped through from the position of the intended user. A user persona focused approach can support the successful development of a smart building by feeding user focussed design parameters into the earliest stages of the project.

A.

Appendix A: Smart Building Overlay to the RIBA Plan of Work

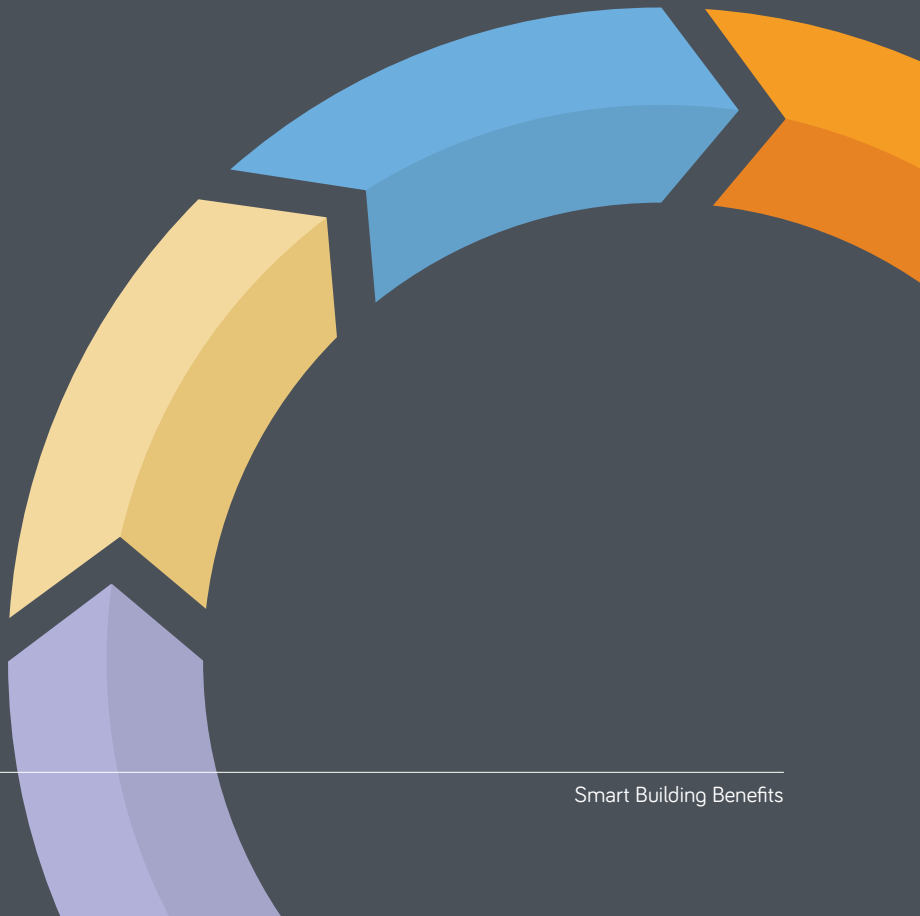


Smart Building Overlay to the Plan of Work

	Strategic Definition	Preparation and Briefing	Concept Design	Spatial Coordination	Technical Design	Manufacturing and Construction	Handover	Use
Core Smart Building Tasks	Identify a **Smart Building** opportunity. Develop **Smart Building** business case. Asses need to for **Smart Building Specialist** support. Develop the **Smart Building Strategy**. Identify **User Personas** to form a **User Group** that may contribute towards the **Engagement Plan**. Review **Feedback** (lessons learnt) from previous projects and case studies.	Appoint a **Smart Building Specialist(s)**. Incorporate **Smart Building** aspirations in **Project Brief** and **Project Outcomes**. Consider **Cyber Security** risks. Capture additional responsibilities and mitigate scope gaps through **Project Brief**. Identify smart building leadership team and stakeholders. Develop **Smart Building User Journeys** and form the **Smart Building User Group**.	Develop **Smart Building User Journeys** and implement **Smart Building User Group**. Create a **Use Case Matrix**. **Smart Building Specialist(s)** integrated as member(s) of the Design Team. Contribute to the review and updating of the stakeholder **Engagement Plan**. Perform **Information Security Triage**. Outline **Technology Procurement Strategy**. Establish **Smart Building** impact on **the Plan for Use Strategy**.	Review and appraise the **Smart Building Technology**. Finalise **Smart Building User Journeys** and update the **Engagement Plan**. Maintain the **Use Case Matrix**. Define performance criteria. Confirm **Technology Procurement Strategy**. Introduce Asset Management Team to the **Smart Building Strategy** and include the **Smart Building** in the **Plan for Use Strategy**.	Finalise **Smart Building Design**. Ensure final specification is fully coordinated for **Smart Building Technologies**. Finalise **Smart Building User Journeys**. Complete the **Design Responsibility Matrix**. Establish the **Smart Building Procurement Strategy**. Review Contractor returns for **Smart Building Technology** delivery. Factory test potential **Smart Building Systems**.	Transition from desktop and factory testing to on-site prototypes to prove **Smart Building User Journeys**. Progress **Asset Tagging** and onboarding. Draft **Post Completion Smart Building Optimisation Strategy**. Ensure the **Smart Building Outcomes** at design, are delivered. Prepare **Smart Building Guidance** for Handover and User Guide. Identify **Smart Building** training requirements.	**Smart Building User Training**. Provide additional **Early life support** to ensure systems are supporting **Smart Building User Journeys**. Perform **User Acceptance Testing**. Gather **Feedback**.	Use and refine the **Post Completion Smart Building Optimisation Strategy**. Ensure user journeys are included in the **Operational Strategy**. Establish user feedback process (refer to the **Plan for Use Strategy**). Undertake **Post Occupancy Evaluation** of the **Smart Building** performance and delivery against the **Smart Building Outcomes**.
Technical Smart Building Tasks		Identify **Information Security** approach (ISO19650-5).	**Information Storage** Strategy (ISO19650-3). Agree **Integration Architecture** Principles. Agree **Message Data Schema**. Develop **protocol/ broker specification**. Define **Disaster Recovery Plan**.	Define **Information Security Plan** (ISO19650-5). Carry out **Off-Site Prototyping**. **Appoint technology providers** to develop detailed design.	Produce **Smart Building Testing and Commissioning Plan**. Produce Software/ Hardware Update and Maintenance Plan.	Carry out installation data drop + IP allocation (resolution between design model & as-built model). Undertake **Penetration Testing**. Carry out **Operational Readiness Trials** (failure responsiveness).	Ensure aftercare technical support strategy for Asset Management Team. Ensure **Smart Building** software and hardware licensing/ subscription is in place and renewal requirements highlighted for Asset Management Team.	Provide trend analysis of building performance and comparison between buildings. Provide data insights and exploit data outputs.

B.

Appendix B:
Smart Building Benefits



General outcomes: people-orientated / space & energy efficiency / responsive management / regularly improved / real time building performance monitoring / enhanced experience

User

End users will have a human-centric experience interacting with the building

- Frictionless user/tenant/ staff/occupant experience
- Convenient building access
- Improved occupancy efficiancies
- Empowered occupants
- Pro-active support
- Efficient user interactions with building
- Greater awareness of facilities & services
- Positive relationships with other users
- Easier communications
- Enhance relationship with landlord
- Improved health & wellbeing
- Minimal disruption
- Improved occupant safety
- Data transparency
- Live or work in a sustainable, energy efficient, and health-conscious environment.

Operator

Those who operate the building will benefit from streamlined workflows and enhanced productivity

- Improved asset operability
- Improve operational efficiency
- Opportunity for automation to streamline processes
- Easier system upgrades over the building lifecycle
- Monitored and managed – easier and quicker to support
- Ability to monitor building performances in real-time
- Consistent standards
- Agile building operation
- Facilitate communications with end users
- Increase building up time
- Minimise disruptions
- Positive relationships
- Better understanding of how people use the building
- Efficient workflows
- Easier, more accurate and timely re-ordering of stock
- Provide proactive support, prior to identification of any faults or complaints
- Access building performance
- Eradicate siloed working
- Identify and reduce repeat equipment failures
- Access to all relevant information
- Broadened skill sets
- Single source of data
- Work in a sustainable energy efficient, and health-conscious environment

Manager

Have usable data and performance analysis will spot trends and opportunities

- Capture meaningful insights
- Flexibility of digital capability
- Improved employee productivity
- Increase energy efficiency
- Reduced operational expenditure
- Extended component lifecycles
- Cheaper system upgrades over the building lifecycle
- Ability to monitor building performance in real-time
- Consistent standards
- Lean building operations
- Improved ease of communications
- Minimise disruptions
- Efficient workflows
- Better understanding of how people use the building
- Digitise feedback processes – opportunity to improve
- Avoid complaints by proactive action
- Assess building performance
- Enhance life safety
- Eradicate inefficiencies
- Eradicate old legacy methods
- Eradicate siloed working
- Better informed equipment selection and maintenance
- Better consistency
- Access to all relevant information
- Agile, skilled team
- Reduce waste
- Single source of data

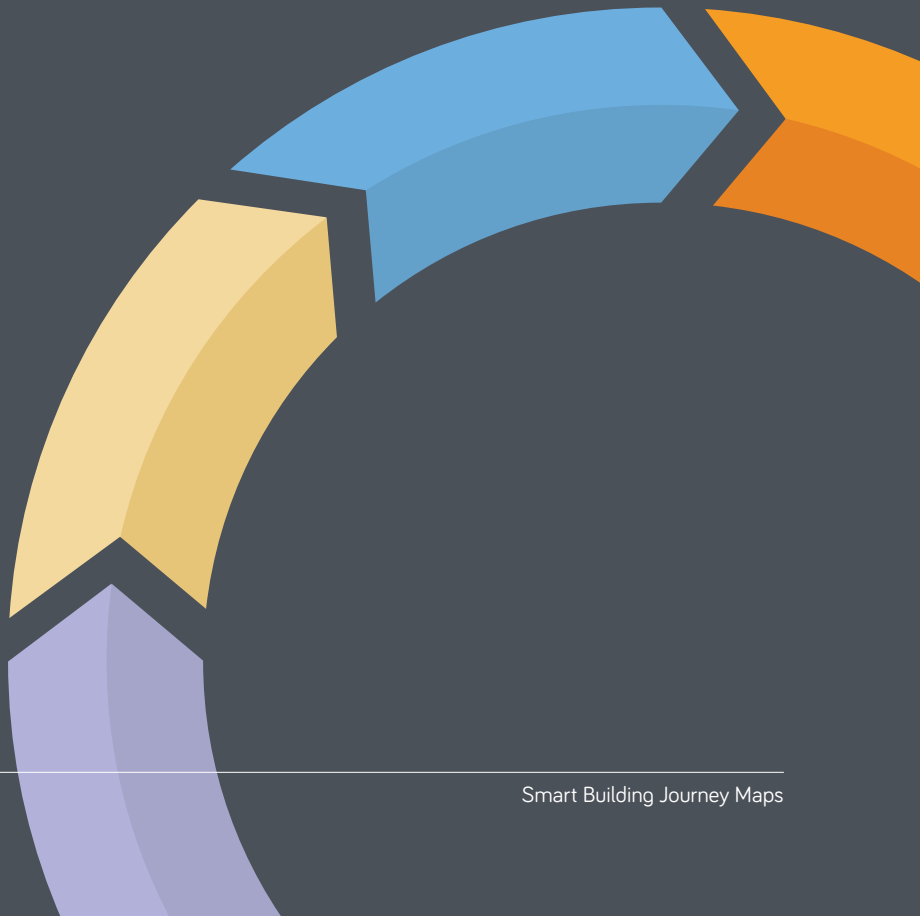
Owner

Owners will attract tenants, increase asset value and benefit from new revenue streams

- Enhanced brand
- Alignment with organisation values
- Attract tenants/occupants
- Increase asset attraction/ value
- Better understanding of customers' habits
- Increased energy efficiency
- Decreased carbon footprint
- Reduced operational expenditure
- Cheaper system upgrades over the building lifecycles
- Ability to compare data across assets and exploit trends
- Establish new revenue streams
- Increase revenue opportunities
- Better communications with end users
- Increase building up time
- Provide enhanced end user interactions and content to support brand reinforcement

C.

Appendix C:
Smart Building Journey Maps



Smart Building Journey Maps

Human Centric

End users of the building who will gain benefit through greater building digital experiences.

Operational Focus

Operations users of the building whose efficiency and productivity increases through enhanced workflows.

Management Enterprise

Access to rich data for enhanced performance and operational analysis while also for wider digital exchanges.

Owner Investors

Increase asset value, enable additional revenue streams, attract tenants and deliver to ESG

End Users - the Human Centric Experience

People choose to come to the location because of the experience, the environment, the buzz and the convenience.

Deploying building intelligence provides an opportunity to ENRICH the human centric experience, support wellbeing and provide a frictionless interaction with the location.

- The journey starts from home
- The arrival experience at the location
- The current relevant news for events, sales, exhibitions
- Getting about the place with wayfinding and digital signage
- Simple frictionless interaction, with relevant tailored information

Credit: © Hoare Lea

Smart Building Journey Maps

Human Centric

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Operational Focus

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Management Enterprise

Access to rich data for enhanced perforance and operational analysis while also for wider digital exchanges.

Owner Investors

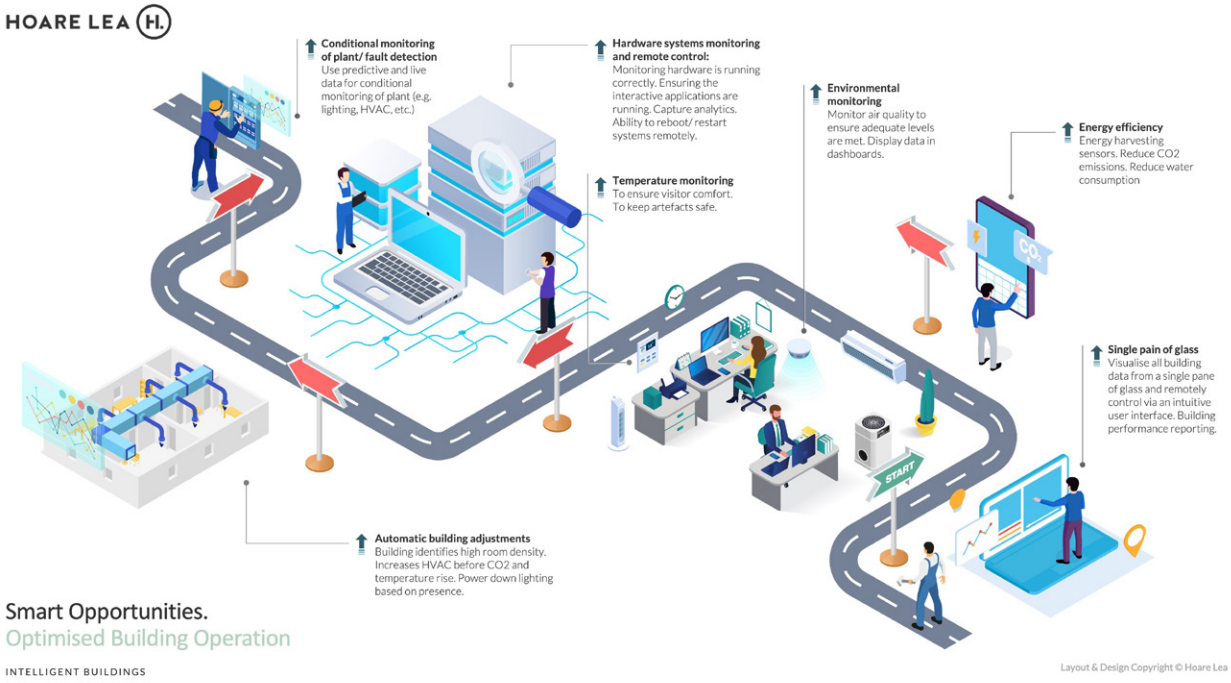
Increase asset value, enable additional revenue streams, attract tenants and deliver to ESG

Operations – resource and consumption efficiencies

Operating a property requires an understanding of the systems, issues before they escalate and a dynamic approach to maintenance.

Deploying building intelligence provides an opportunity to ENHANCE the operational efficiencies, support energy consumption reductions, down time reduction and resource effectiveness including supply chain and supporting package management.

- Open System integrations, sharing information
- Open architecture with appropriate structured components
- Single pane of glass for overall visualisation
- Supply chain and workload integration incl. dynamic maintenance



Credit: © Hoare Lea

Smart Building Journey Maps

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Owner Investors

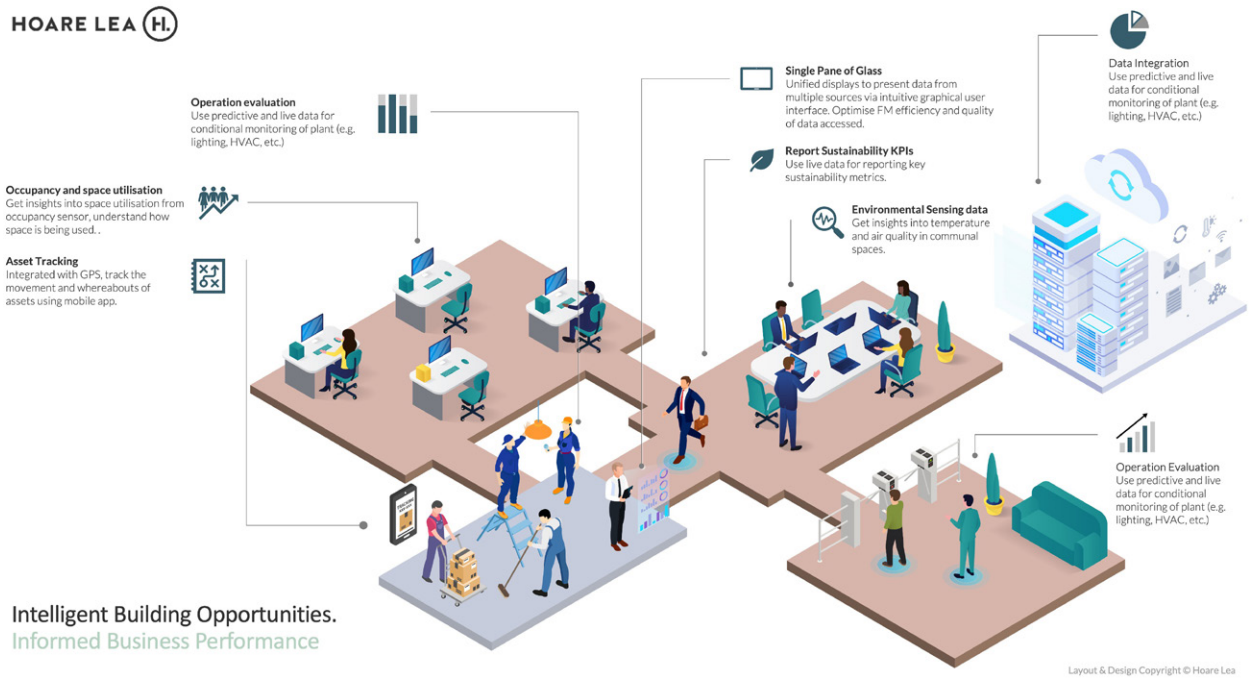
Increase asset value, enable additional revenue streams, attract tenants and deliver to ESG

Management – information and evidence

Management of a building requires an understanding of the environment, an understanding of the visitor and occupants' behaviour patterns.

Deploying building intelligence provides an opportunity to create an ecosystem that delivers evidence and analytic modelling through connectivity, measurement and a detailed granular view of the property.

- Raw data and aggregated data
- Evidential analysis and insight
- Open structured, connected systems, sensors, applications and apps.



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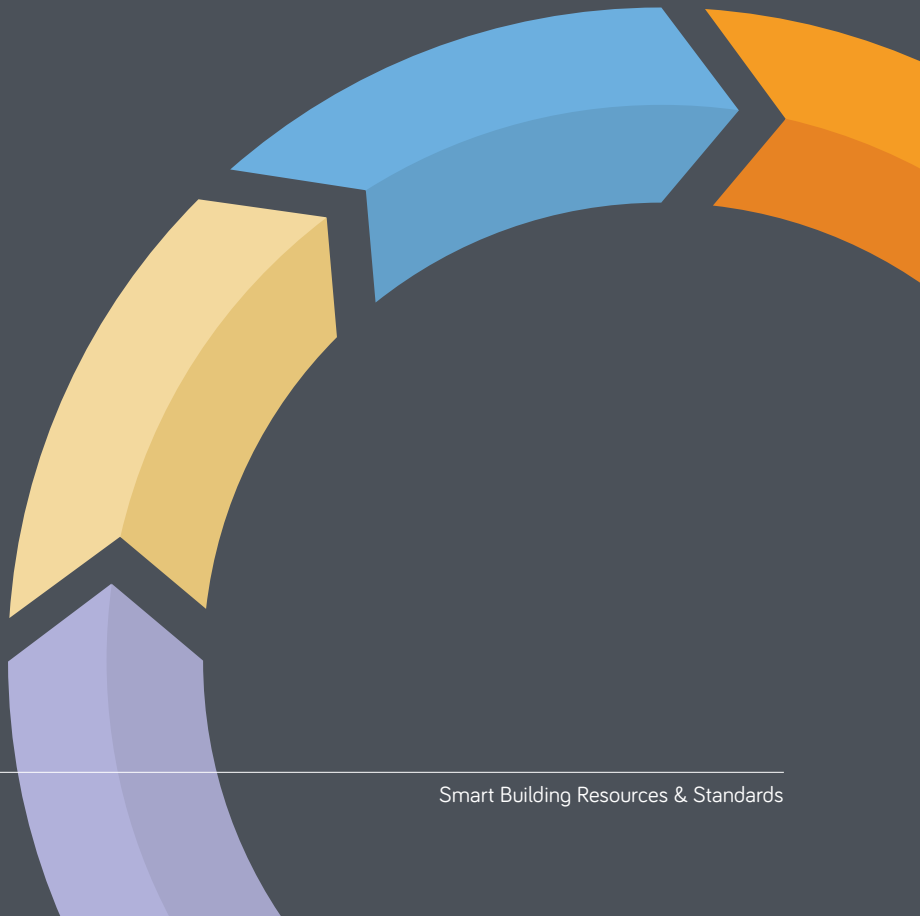
D.

Appendix D: Smart Building Resources & Standards



Smart Building Resources & Standards

Resources

- Gemini Principles, Centre for Digital Built Britain, 2018)
- RIBA Engagement Overlay to the Plan of Work
- RIBA Inclusive Design Overlay to the Plan of Work
- RIBA Plan for Use Guide
- RIBA Plan of Work & Plan of Work Overview
- RIBA Security Overlay to the Plan of Work

Standards

- BS ISO 19650 Managing information with Building Information Modelling (BIM)
- BS ISO 37122 (Sustainable cities and communities. Indicators for smart cities)
- BS ISO 21678 (Sustainability in buildings and civil engineering works. Indicators and benchmarks.)
- BS EN 15978 (Sustainability of construction works. Assessment of environmental performance of buildings.)
- BS EN 15643-3 (Sustainability of construction works. Assessment of buildings. Framework for the assessment of social performance)
- BS EN 15643-4 (Sustainability of construction works. Assessment of buildings. Framework for the assessment of economic performance

Afterword

For brevity, and reinforcement of key concepts, the RIBA Plan of Work is set out on a single page and therefore has limitations on the amount of information that can be conveyed, although the supporting Overview provides guidance on a wide range of topics and includes a glossary of terms to provide further clarity.

Overlays to the RIBA Plan of Work therefore provide crucial supplementary knowledge and advice on a specific topic. They are not intended to dilute the intent of the RIBA Plan of Work, nor the tasks set out for each stage. Indeed, the reverse is the case: by setting out information on a specific topic the intent of the RIBA Plan of Work is reinforced and the means of signalling knowledge and scaling better outcomes for the topic are achieved.

The Smart Building Overlay therefore brings crucial guidance on a topic that is delivering better outcomes for projects of all scales, from homes to hospitals.

The RIBA Plan of Work maps out the stages that occur over the life of a building. Although the stages place emphasis on the delivery of a new or refurbished asset, the process is circular underlining the importance of how a building adapts during its life as part of circular economy principles. As stage 7 nears its end, a client will use stage 0 to consider the next phase of a building's life from light touch updates to demolition, although the latter is increasingly being discouraged to reduce the embodied carbon associated with each iteration.

Stage 7 was also added to the RIBA Plan of Work in 2013 acknowledging the increasing interface between the capital and operational phase. It has long been understood that whole life thinking implemented during the briefing, design and delivery stages reduces whole life costs, although in many instances budget constraints limit what is possible in the capital phase. In recent years, many clients have seen significant benefits from leveraging CAFM (computer aided facilities management) aligned to data inputs delivered from BIM at handover, shifting from reactive to proactive maintenance regimes to reduce the operational costs of a building.

Smart Building solutions move beyond asset management, providing benefits to owners and users of a building and by connecting more building systems, from access and alarms to client centric aspects such as room booking or the tracking of mobile assets, new value propositions are possible. More importantly, Smart Building Technologies deliver not just financial savings but also the significant reduction of operational carbon and they are therefore crucial to the built environment industry aiding the drive towards net zero.

To be successfully implemented to deliver the maximum benefits during stage 7, solutions must be considered from the outset and during each subsequent stage. Topics such as information technology (IT), project handover and the many others set out in this overlay all need considered. The speed of technological change makes this challenging and due to the time lag between the early design stages and handover, it is important to ensure that the delivered solution is agile enough to receive and/or plug in the latest software as a building nears occupation and, of course, during its life. This overlay considers these crucial points.

Smart Building considerations are an important topic for the lead designer to consider and coordinate, and I am delighted to have assisted in the delivery of the Smart Building Overlay to help provide greater clarity on the items that need to be considered.

Dale Sinclair
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