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BIM & Digital Transformation in the Construction Industry

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Agenda

- Introduction
- Enabling BIM in the UK
- The Digital Transformation & Data
- The Digital Twins & Design

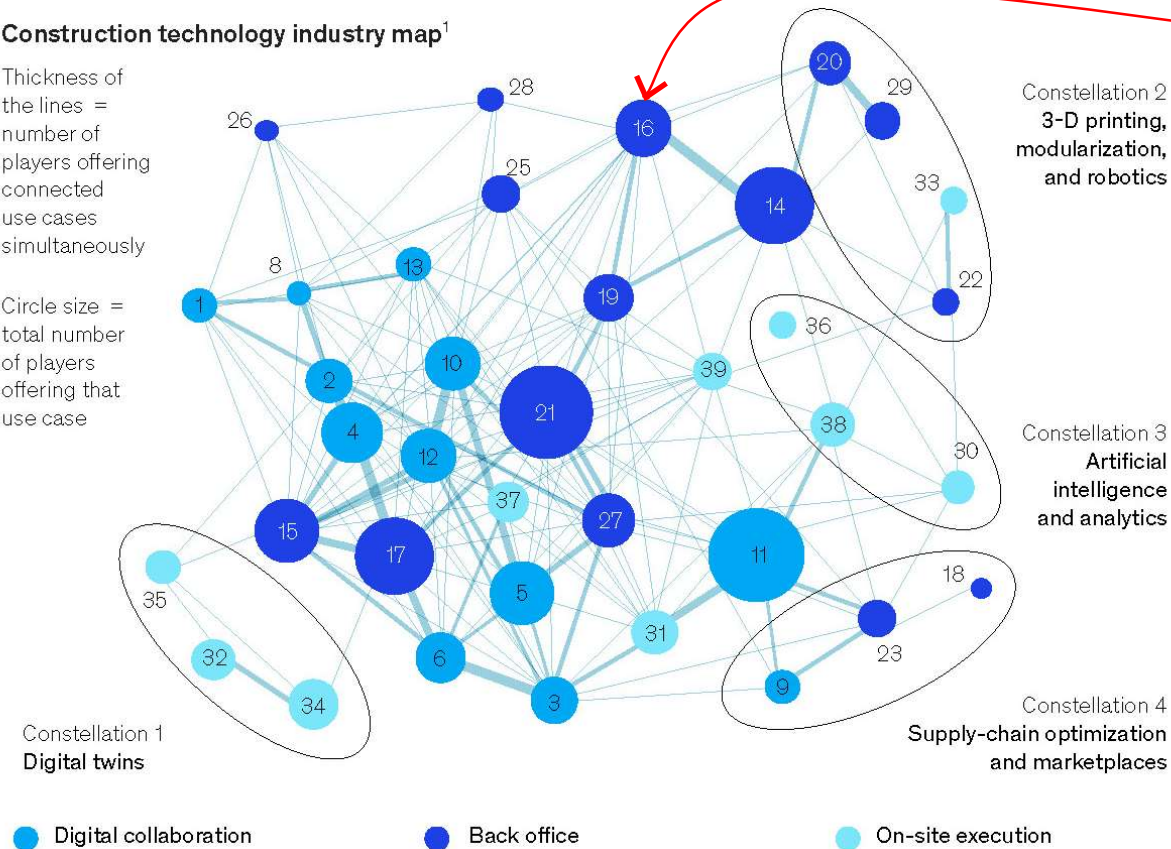
Digital Technologies: BIM is but one piece...

The largest construction industry clusters of use cases include 3-D printing, modularization, and robotics.

Construction technology industry map¹

Thickness of the lines = number of players offering connected use cases simultaneously

Circle size = total number of players offering that use case

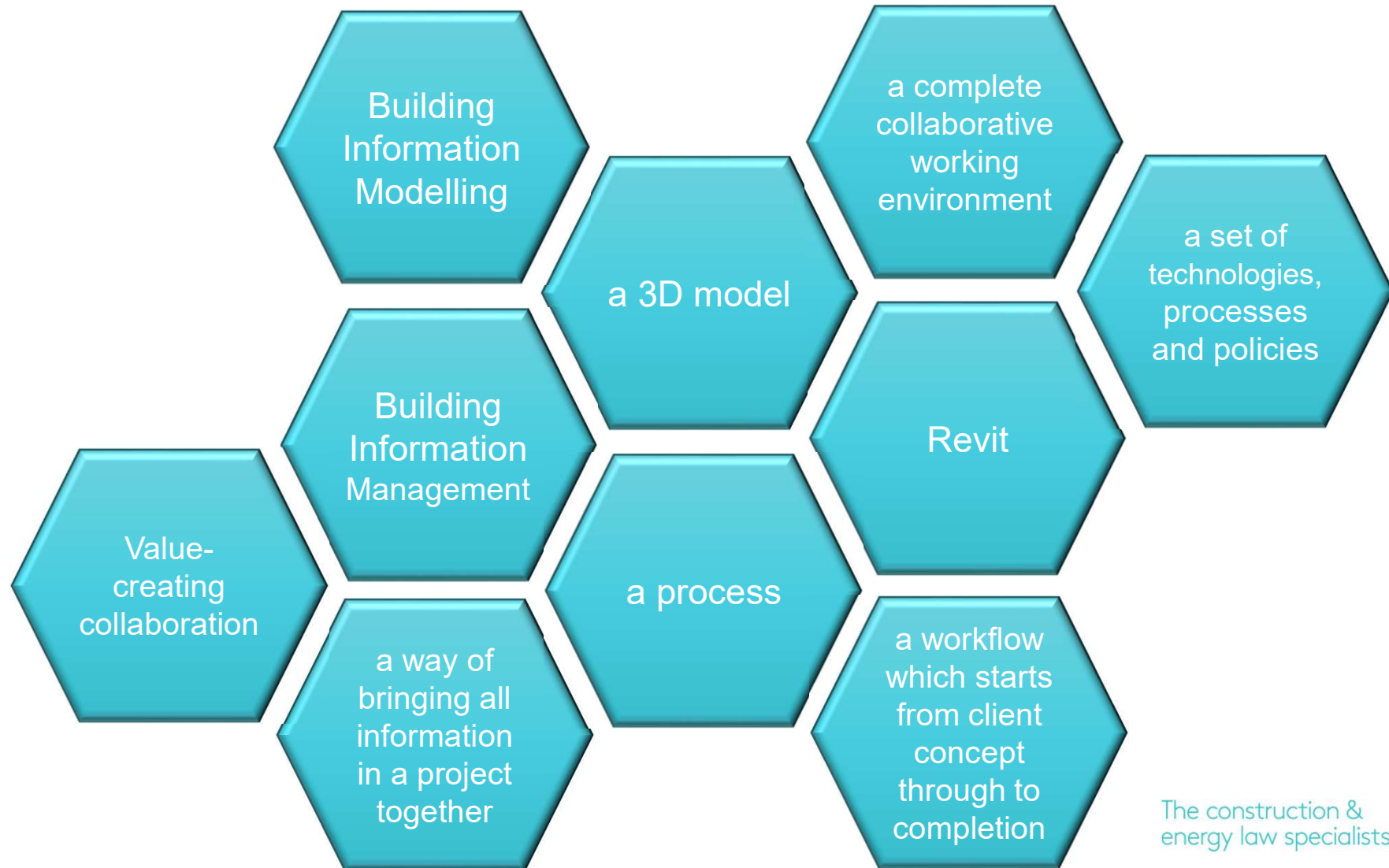


BIM

**Rise of the platform era:
The next chapter in
construction technology,**
October 2020, McKinsey

What is “BIM”?

Notoriously difficult to define...



What is “BIM”?

Building Information Modelling (BIM)

- *“use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions”*

BS EN ISO 19650-1:2018

In the 3rd Edition of the OED, due for publication in 2037, the word ‘run’ is expected to have 645 definitions.

What is “BIM”?

Building Information Modelling (BIM)

- “use of a **shared digital representation** of a built asset to **facilitate** design, construction and operation processes to form a reliable **basis for decisions**”

BS EN ISO 19650-1:2018

- Historically: 2D drawings, with designers and contractors handing over little more than as-built drawings at the end of a project.
- And now with BIM: 3D models, with connected and embedded data, and information to operate and maintain are provided at the end of the project to maximise performance and sustainability.

What is “BIM”?

Building Information Modelling (BIM)

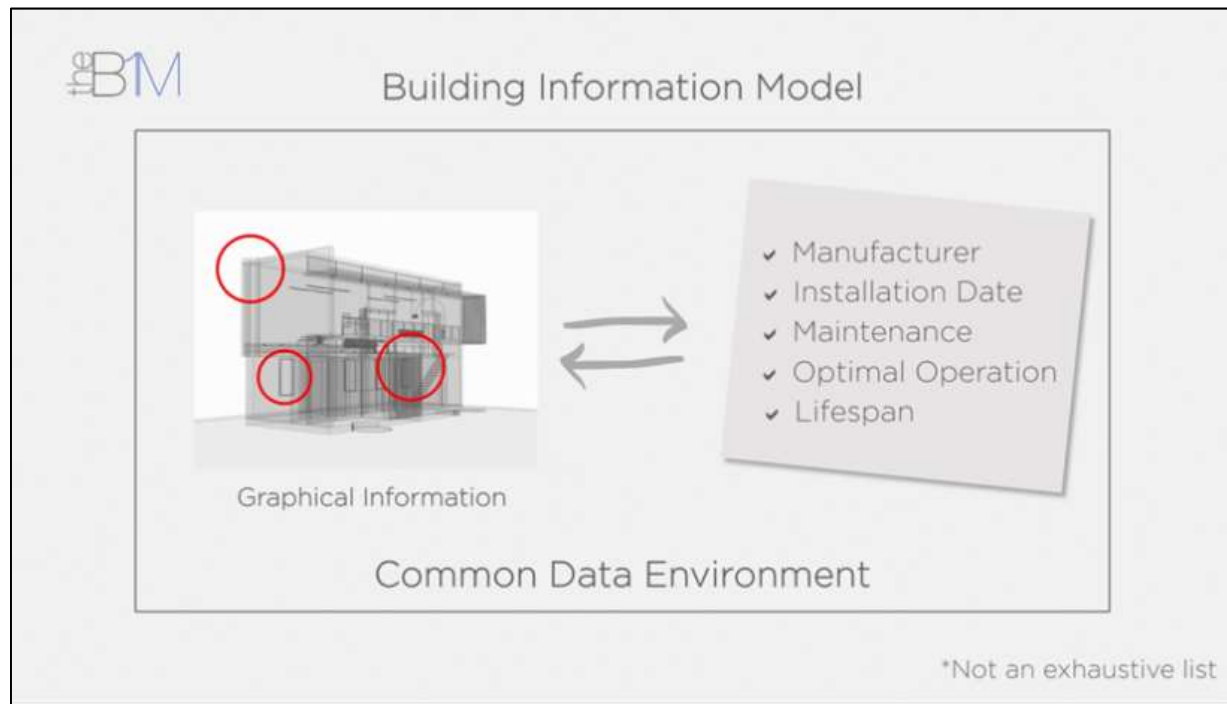
- “creating **information models** or data sets formed of graphical and non-graphical information in a shared digital space known as a **Common Data Environment (CDE)**. The information builds in richness as the project stages progress until the complete data set is handed over to the client at completion.”

Fred Mills, www.theb1m.com

(“One of the 20 best educational YouTube Channels in the world” *The Times*, 21 Sept 2020)

What is “BIM”?

Building Information Modelling (BIM)



Fred Mills, www.theb1m.com

3D, 4D, 5D, 6D...

- **3D BIM: Geometry**

- Enhanced 3D visualisation of the entire project
- Streamline communication and collaboration
- Reduce rework, clash detection, etc.

- **4D BIM: Time & Scheduling**

- Add scheduling data to different components, generating accurate programme data for the project.
- Improve scheduling optimisation
- Visualise the impact of changes
- Enhance coordination

3D, 4D, 5D, 6D...

- **5D BIM: Cost Estimation & Budget Analysis**

- Real-time cost visualisation
- Improve cost reporting and budgeting with prediction
- Notifications of changes in costs

- **6D BIM: Facility Management | Sustainability**

- Linking attribute data to support Facilities Management:
 - * details about the components' manufacturer,
 - * when it was installed, required maintenance,
 - * how to operate at optimum levels to enhance performance,
 - * expected lifespan.
- Reduce energy consumption, optimise performance
- Value to the operation phase
- Detailed analysis of the impact of decisions

BIM: Benefits & Challenges

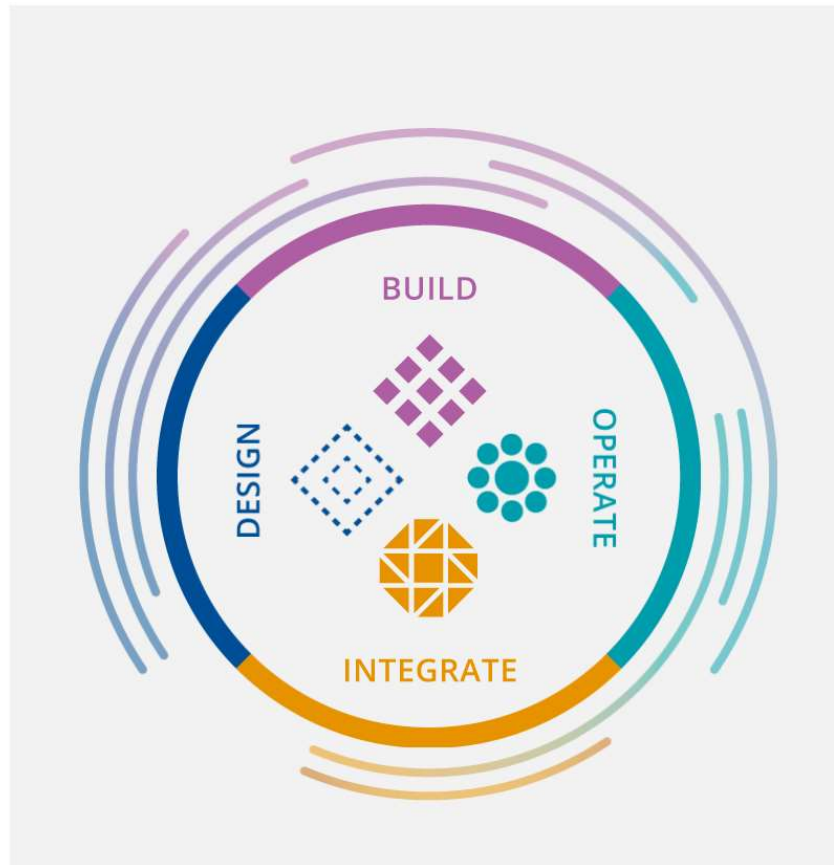
<i>Reported benefits</i>	<i>Perceived challenges</i>
Facilitates collaboration, early supply chain and operational team involvement.	Increased costs to implement?
Unlocks more efficient and transparent ways of designing, constructing, and maintaining built assets, over their whole lifecycle.	Interoperability?
Improves value in pre-commencement and construction phases.	Engagement and use throughout the entire supply chain?
Improves clash and potential defects detection.	Copyright or IP issues?
Can inform facility management, sustainability and whole lifecycle decision making.	Will future software solutions have the ability to access and interpret proprietary data?

Enabling BIM: UK BIM Framework

(www.ukbimframework.org)

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The BIM Process



Design – Deploy digital techniques to design better performing buildings, homes and infrastructure. Use good practice, secure by default, information management to get data right from the start.

Build – Exploit new and emerging digital construction and manufacturing technologies, processes and techniques. Secure, shared information, enabling clients, design teams, construction teams and the supply chain to work more closely together to improve safety, quality and productivity during construction.

Operate – Use real time information to transform the performance of the built environment and its social and economic infrastructure. Smart asset management to predict and avoid disruption of services. Digitalisation of existing assets and infrastructure.

Integrate – Understand how spaces and services can improve citizen quality of life. Feed that information in to the design and build of our economic and social infrastructure and the operation and integration of services they deliver.

Please click on the interactive graphic on the left to view the related standards for each step of the BIM Process.

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Enabling BIM in the UK

Mark Pantry
Senior Associate



Enabling BIM: UK BIM Framework

www.ukbimframework.org

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The approach for implementing BIM in the UK using the framework to manage information provided by the BS EN ISO 19650 series. Including:

- the published standards called upon to implement BIM in the UK
- the UK BIM Guidance Framework
- useful links to other resources

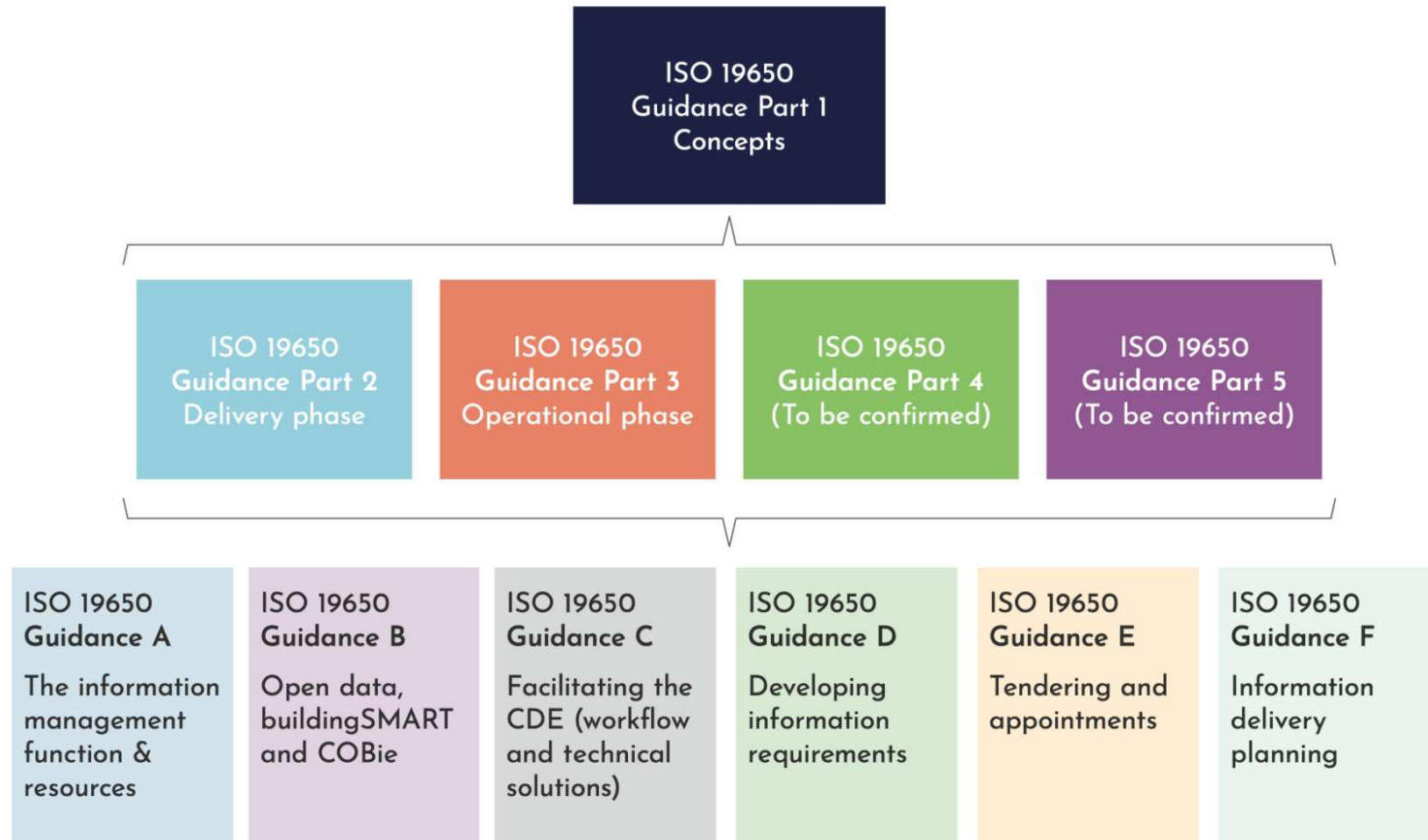
UK BIM FRAMEWORK



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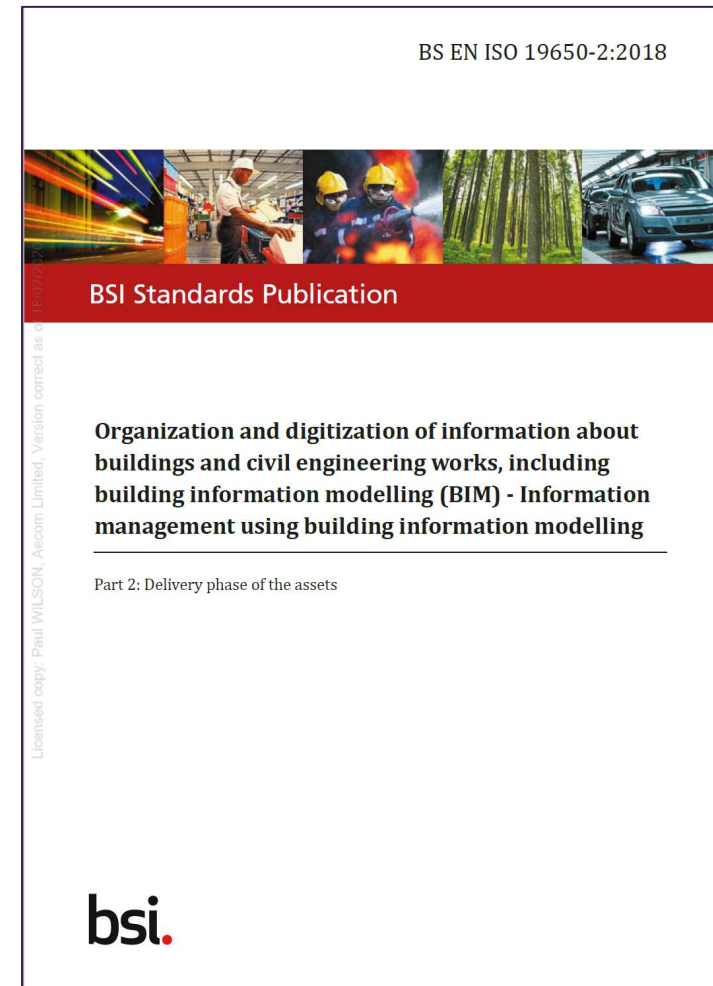
BS EN ISO 19650

www.ukbimframework.org/standards-guidance



Enabling BIM: BS EN ISO 19650

- Series of international standards
- Management of information
- Defines processes, principles and requirements for the effective management of information during delivery and operational phase of assets when BIM is used
- Based on UK 1192 series



Enabling BIM: BS EN ISO 19650

- Applicable to assets and projects of all sizes and complexity, but apply proportionately and appropriately

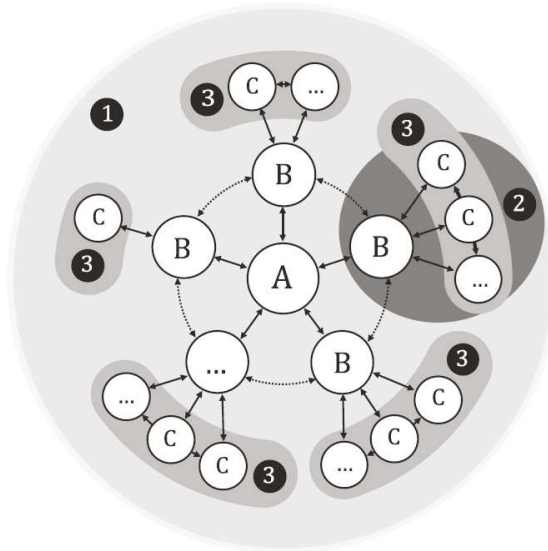
BS EN ISO 19650 Series	
19650 – Part 1	Concepts, principles and recommendations on how to manage building information
19650 – Part 2	Specific requirements for information management during delivery phase
19650 – Part 3	Specific requirement for information management during the operational phase
19650 – Part 5	Requirements for the security -minded management of sensitive information
PD-19650 – 0	Transition Guidance

Enabling BIM: BS EN ISO 19650

- ISO 19650 Part 2 and Part 3 define the requirements for the delivery and operational phases, respectively.
- National Forewords and Annexes defined the standards and requirements which must be met in a particular region.
 - Aims to work globally for different cultures and different jurisdictions, where standards and processes are inherently different.
 - Example: Part 2 requires information to be classified. The UK National Annex states Uniclass 2015. This of course may be different in different countries.
- *<https://ukbimframework.org/standards-guidance/>*

Enabling BIM: BS EN ISO 19650

- Terminology: Appointing Party, Lead Appointed Party, Appointed Party



Key

- A appointing party
- B lead appointed party
- C appointed party
- ... variable amount

1 project team

2 illustration of a delivery team

3 task team(s)

↔ information requirements and information exchange

⋯↔ information coordination

The new Information Protocol

- BS EN ISO 19650-2:2018 requires an Information Protocol
- The only protocol designed to work the with BS EN ISO 19650.
- Building on the CIC BIM Protocol



Key features of the Information Protocol

- Information Particulars
- Terminology aligns with 19650
 - Appointing Party
 - Lead Appointed Party
 - Appointed Party
- Need incorporation clause
- No defined “Information Manager”
- Order of precedence (Clause 1.6)

Information Protocol to support BS EN ISO 19650-2 the delivery phase of assets May 2020 | 10

Information Particulars

Term	Particulars
Appointment	[Describe appointment and Parties]
Appointing Party	[the Appointer] OR [Appointing Party entity]
Lead Appointed Party	[Party] OR [the Appointer] OR [Appointee]
Appointor	[Party]
Appointee	[Party]
Works	[Describe]
Level of Information Need	[Refer to document/part thereof]
Exchange Information Requirements	[Refer to document/part thereof]
BIM Execution Plan	[Refer to document/part thereof]
Project's Information Production Methods and Procedures	[Refer to document/part thereof]
Project's Information Standard	[Refer to document/part thereof]
Master Information Delivery Plan	[Refer to document/part thereof] OR (if not applicable to Appointee) [N/A]
Task Information Delivery Plan	[Refer to document/part thereof] OR (if not applicable to Appointee) [N/A]
Risk Register	[Refer to document/part thereof]
High Level Responsibility Matrix	[Refer to document/part thereof]
Mobilization Plan	[Refer to document/part thereof]
Security Management Plan	[Refer to document/part thereof]

Key features of the Information Protocol

- Clause 3: Obligations of the appointing party
 - Information Particulars to be review and updated (if necessary) as and when required
 - Note: if updated, consider the Appointee's rights in accordance with their Appointment – more time or money?

3.1 The Appointing Party shall save to the extent that such obligations are within the scope of the Appointee's obligations under the Appointment, arrange for:

3.1.1 the Information Particulars to be reviewed and updated (if necessary) as and when required until the completion of the Works. The Appointee's rights (if any) following any such update after the date of the Appointment shall be assessed in accordance with the Appointment and this Protocol; and

Key features of the Information Protocol

- Clause 5: CDE Solution and Workflow
 - Appointing Party establishes, implements and configures CDE, unless the Appointment says otherwise
 - Access to CDE (Clause 5.5)
 - *Trant Engineering v Mott MacDonald Ltd* [2017]

5.5 The Appointor shall arrange for the Appointee to have reasonable access to the information in the CDE Solution and Workflow as provided in the Information Particulars i) insofar as necessary to perform its obligations under this Protocol and the Appointment and ii) for such period as the Appointee is liable under this Protocol and/or the Appointment in order to access a record of the information in the CDE Solution and Workflow.

BIM and the JCT Contracts

- BIM Protocol included in the Contract Particulars:

1.1	Base Date	_____
1.1	BIM Protocol (where applicable) <i>(State title, edition, date or other identifiers of the relevant documents.)</i>	_____ _____ _____ _____
1.1	Date for Completion of the Works <i>(where completion by Sections does not apply)</i>	_____
	Sections: Dates for Completion of Sections ⁽¹¹⁾	Section _____ : _____
		Section _____ : _____
		Section _____ : _____

BIM and the JCT Contracts

- Definition of Contract Documents:
 - “the Agreement and these Conditions, together with the Employer’s Requirements, the Contractor’s Proposals, the Contract Sum Analysis and (where applicable) the BIM Protocol.”
- Clause 2.1
 - General obligations when the Contractor is carrying out the Works
 - “The Contractor shall carry out and complete the Works in a proper and workmanlike manner and in compliance with the Contract Documents...”

BIM and NEC

- Optional Clause X10: Information Modelling
- Inserts additional provisions into the NEC4 Contract:
 - ownership of information
 - liability for errors
 - management of information interfaces

Liability

X10.7 (1) The following are *Client's* liabilities.

- A fault or error in the Information Model other than a Defect in the Project Information.
- A fault in information provided by Information Providers other than the *Contractor*.

(2) The *Contractor* is not liable for a fault or error in the Project Information unless it failed to provide the Project Information using the skill and care normally used by professionals providing information similar to the Project Information.

(3) The *Contractor* provides insurance for claims made against it arising out of its failure to provide the Project Information using the skill and care normally used by professionals providing information similar to the Project Information. The minimum amount of this insurance is as stated in the Contract Data. This insurance provides cover from the *starting date* until the end of the period stated in the Contract Data.

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Digital Transformation & Data

Dr Stacy Sinclair
Partner | Head of Technology & Innovation

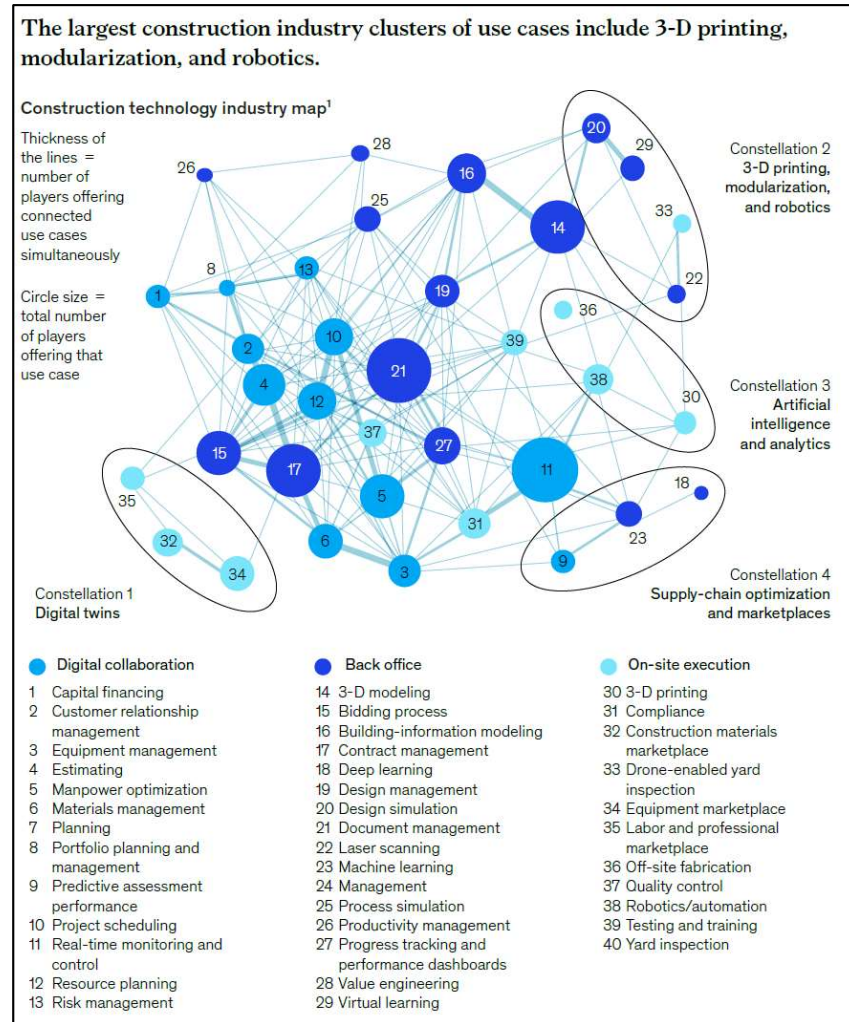
New Digital Technologies

- What is here and what is on the horizon?
- The importance of data
- Issues to consider

Digital Technologies: Already a reality

Construction Tech

- Robotics
- Drones (UAVs)
- The Connected Jobsite
- 3D Printing
- VR / AR
- Digital Twins
- Smart Buildings
- AI/Machine Learning
- IoT, sensors



Rise of the platform era: The next chapter in construction technology, October 2020, McKinsey

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The importance of data

The data...

Drone and video footage, photos, texts, WhatsApp, Slack, emails, Teams chats, BIM models, contracts, sub-contracts, sub-sub-contracts, specifications, schedules, site diaries, turnstile/biometric clocks, CDE, shared project platforms, timesheets, asset databases, electronic invoicing and payment records, weather records, correspondence, order forms, social media, programmes, etc...

“...a watershed moment...”

(WEF, *Digital Transformation: Powering the great reset*)



Digital Technologies: Already a reality

Construction Tech: Digital Twins

- Again, various ideas exist as to the definition:

*“A realistic digital representation of something physical.
What distinguishes a digital twin from any other digital model is
its connection to the physical twin.”*

(Centre for Digital Built Britain)

- Real-time data feeds and sensors are critical to the success.
- The National Digital Twin programme (NDTp)



Digital Technologies: On the horizon?

Construction Tech: Smart contracts/clauses & blockchain

- Automatically monitor, execute and enforce a legal, contractual obligations, through the use of computer code.
- In the event of X, Y will happen.
- No good if human intervention or human decision is required.
- Example: the Weather Ledger (Digital Catapult)
 - IoT and distributed ledger technology to automate the execution of weather-related clauses in standard NEC contracts.
 - Sensors are used on site, data and databases collected and connected.
 - Not automation of the entire of the contract, but rather elements of the weather-related clauses using blockchain and smart contract technology.

The importance of data

The data...

- The increased use of new technologies has highlighted the significance and importance of data and data management.
- Collaborative tools to improve data management and workflows internally, with clients, with lawyers, with other project team members.
- Consider data issues throughout the course of the project and afterwards:
 - “*access to data*”
 - “*data usage and expectations*”

The importance of data

Access to data

- Consider throughout the course of the project and afterwards:
 - Who has the right to access the platform? Even in the event of non-payment?
 - Will the platform exist in 6-12 years' time?
 - Who hosts/licenses the platform(s) during the project and after?
 - Is the data backed-up and/or extracted on completion of the project?
 - ***Trant Engineering Limited v Mott MacDonald Limited*** (2017)

The importance of data

Right to use the data / database

- ***77m Limited v Ordnance Survey Limited*** (2019)
 - Did 77m infringe on OS's database rights, if it had any such rights, when it created a dataset called "Matrix", which consisted of geospatial coordinates and addresses in Great Britain, a competitor of OS's product called AddressBase?
 - 77m used at least 18 datasets from different sources to do so, several of which came from OS.
 - Yes – OS did have database rights as it had substantially invested in a verification process, and 77m did not have a license to use it.

The importance of data

Right to use the data / database

- The use of other companies' data and databases in design and construction, or for the purpose of developing new products and processes to do so, is part and parcel of construction and energy projects.
- Whether a company has rights over particular datasets depends on the facts.
- ***Software Solutions Ltd v 365 Health and Wellbeing Ltd*** (2021)
- Important to understand what licenses, both express and implied, are in place prior to embarking on the development of new innovations and advancements in technology.

The importance of data

Data usage and expectations

- What data will be used to value the works?
- ***Premier Engineering (Lincoln) Limited v MW High Tech Projects UK Limited (2020)***
 - Premier provided labour to MW – charged on an hourly rate.
 - Premier considered that it was underpaid £1.3m.
 - Timesheets and turnstiles records did not align – biometric clocks introduced. All three told a different story. What data was to be used to evidence the hours worked: timesheets, turnstiles or biometric clocks?
 - Judgment: an agreement between the parties that timesheets and biometric clocks would be used to calculate payments and not the turnstile data.

The importance of data

- Getting it right at the outset:
 - Alignment of the contract and the procurement route with the expectations for technology and collaboration
 - Alignment of mindsets – embed with contractual documentation
 - Early communication and involvement of the legal team – not simply a rubber stamping exercise
- The importance of clarity and consistency in contracts – documenting what has been agreed

Level of detail? Deliverables? What and where are the contract documents?

How are the parties measuring and valuing the works or labour?

What does the contract require? Eg, FIDIC 2017 Sub-Clause 20.2 (“Contemporary Records”)

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Digital Twins & Design

Jeremy Glover
Partner



What is a Digital Twin?

- A digital replica of a physical asset, process or system in the built or natural environment.
- A virtual representation of a physical building as it is constructed.
- A digital representation designed to provide a simulated (and safe) environment to test and monitor a building as it is constructed.
- Uses real-time data (e.g. from sensors placed on the physical twin) and applies analytics, machine-learning and AI to environment to record and test a project as it is constructed.
- The Government is promoting the development of a National Digital Twin (NDT) of the UK built environment.

<https://www.cdbb.cam.ac.uk/what-we-do/national-digital-twin-programme>

The development of a National Digital Twin

*“Digital twins are **realistic digital representations** of physical assets [...] that can be used to **monitor and predict performance**, feeding out insights and interventions. These insights lead to better interventions and unlock real-world value from assets through **financial savings, improved performance** and services, and **better outcomes** for society. Digital twin technology already exists and is increasingly being introduced across industry, however there is an opportunity to gain more valuable insights about the entire built environment as an interconnected system if digital twins are developed to be **interoperable, secure and connected**. The introduction of a National Digital Twin, that connects the digital twins together, will enable us to use collective innovation to progress society, the economy and the environment **for the public good.**”*

Centre for Digital Built Britain

CDBB/NDT Legal Roundtables: Key Takeaways

- Current gap in governance (e.g. as to who owns what, who will have to do what, and how the project will be rolled out) could be filled with legislation or mandatory action at Government level.
- Some lessons learned from the implementation of BIM in the legal sector but much remains unchanged. The contractual landscape remains immature.
- The Winfield Rock report highlighted gaps in the understanding and domain knowledge of BIM and Digital Twins in the legal profession, which has not yet been resolved.

CDBB/NDT Legal Roundtables: Key Takeaways

- Current standard forms and traditional methods of procurement will need to adapt to be more collaborative/achieve interoperability.
- Uncertainty around IP management and ownership of amalgamated data e.g. the liability of parties who upload data that is not exclusively their own, the unintended sharing of data, etc.
- Liability uncertainty will place increasing constraints on collaboration and is a barrier to progress.

Digital Twin Sensors

- Sensors connected to the physical product collect data and send it back to the digital twin.
- During operation of a building might detect when components need changing or repairing.
- Given that the output from these sensors is so critical, establishing the brief both for these sensors and what they feed into is very important.
- Long term extend the digital twin concept to encompass digitally modelling assembly lines helping to boost productivity and efficiency.
- The way the construction industry frames the definition and use of digital twins is not always the same as the manufacturing industry.

Top causes of disputes on construction projects in Continental Europe?

Rank	Cause
1	Errors and/or omissions in the contract documents
2	An unrealistic contract duration or completion date
3	Failure to properly administer the contract

Arcadis - Global Construction Disputes Report 2020

Design: Information Protocol

- Clause 1.7 of the Information Protocol:

“The Appointor and the Appointee shall exercise the Required Standard in performing their obligations under this Protocol and notwithstanding any other provision of this Protocol the Appointor and the Appointee shall each have no greater obligation under or in connection with this Protocol than to exercise the Required Standard.”

- Required Standard means the level of skill and care applicable to the party’s equivalent obligation under the Appointment.

-

Design Obligations: NEC & FIDIC

- FIDIC Yellow Book 2017 sub-clause 4.1:

“When completed, the Works (or Section or Part of major item of Plant, if any) shall be fit for the purpose(s) for which they are intended, as defined and described in the Employer’s Requirements (or, where no purpose(s) are so defined and described, fit for their ordinary purpose(s)).”

- NEC 4 X15.1:

“The Contractor is not liable for a Defect which arose from its design unless it failed to carry out that design using the skill and care normally used by professionals designing works similar to the works.”

But what does the Scope/Works Information/Employer’s Requirements say?

Design Obligations: NEC4

Core Clause 11.2(16):

“Scope is information which:

- *specifies and describes the works; or*
- *states any constraint on how the Contractor Provides the Works and is either*
- *in the documents which the Contract Data states it is in or*
- *in an instruction given in accordance with this contract.”*

Core Clause 20.1:

“The Contractor Provides the Works in accordance with the Scope.”

Traditional obligations of the designer

- The importance of the design brief;
- The duty to review the design;
- Errors;
- Duty to warn;
- Knowledge of standards and codes;
- Delegation.

Contract Risk Management

- No matter what contracts, protocols, guidance notes, or otherwise are required on a particular project, it is important to understand your obligations, liabilities and limitations within each document;
- If the contract documents do not align with each other and/or are not considered sufficiently in detail, this can lead to ambiguity and uncertainty;
- With regard to digital design, the devil is in the detail. All contract documents need to align obligations clearly;
- Make sure you understand what you are being asked to do as depending on the terms of your contract, these could be binding documents with obligations contained therein which you need to understand and be alert to.

Conclusions

“... design needs to be properly integrated with construction and performance in use.”

John Egan – 1998 – Rethinking Construction

“Investment in high quality design, by an integrated team, is crucial to the success of any construction project. It is at the outset of a project that the vast majority of value can be created through design and integration.”

John Egan – 2002 – Accelerating Change

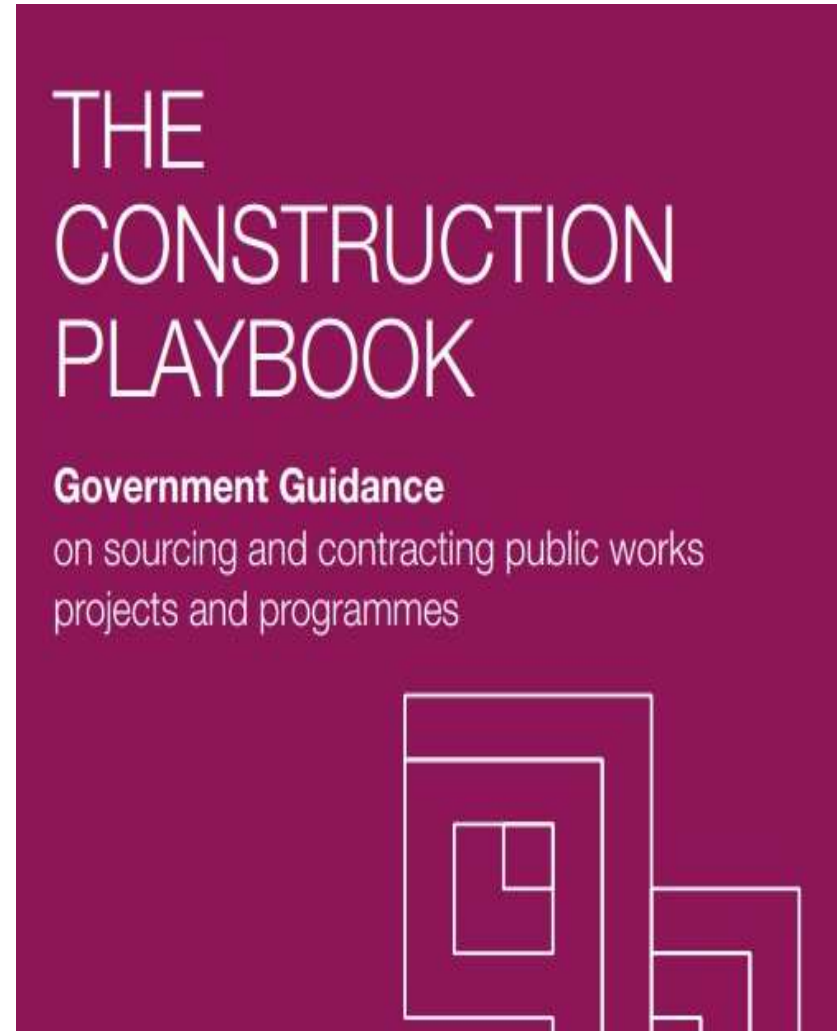
UK Government: *Construction Playbook* **FENWICK ELLIOTT**

14 “Key Policies” including:

- Portfolios and longer term contracting
- Modern Methods of Construction (MMC): harmonise, digitalise and rationalise demand
- MMC: further embed digital technologies
- Early supply chain involvement
- Outcome-based approach

People (and Governance)

Successful relationships



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Thank you.

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Dr Stacy Sinclair, Partner
Mark Pantry, Senior Associate