Geo-enabling BIM

The Big Five Challenges to Level 2

A discussion paper from

Survey4BIM

Building **stronger**, together

Introduction and Call to Arms

Over the next five years, building information modelling (BIM) will drive not just transformation of the built environment, but also the geospatial industry itself. Its successful implementation is dependent on collaboration and Survey4BIM has identified the five technical geospatial challenges to geo-enable implementation of BIM level 2.

The 'big five' are accuracy, meta-data, interoperability, level of detail and generalisation. At first glance, a geospatial professional might think it is all in hand, but if you look in the wider context of the UK BIM industry (or indeed internationally), all is not as it should be.

The vision for BIM is clear but its implementation in a geospatial context is not. These challenges are technical, and to a certain degree cultural, and ones where we believe the geospatial profession has a significant and unique contribution to add. The big five challenges are pressing and neglected in a geospatial context. If BIM does not solve these, there is a risk the geospatial industry will not only miss a huge opportunity to be a key player in BIM, but become complicit in watching it hit the rocks.

We are seeking expertise, leadership and sponsorship in each of these big five challenges. We believe geo-enabling BIM is a huge opportunity for the geospatial industry — not only to deliver commercial benefits for clients, for your business, for the UK industry, but to deliver the social benefits which BIM can enable. The targets are hugely challenging and currently at risk. If we combine our efforts and get involved now, we can play a huge part in turning this into a success for BIM and the geospatial industry.

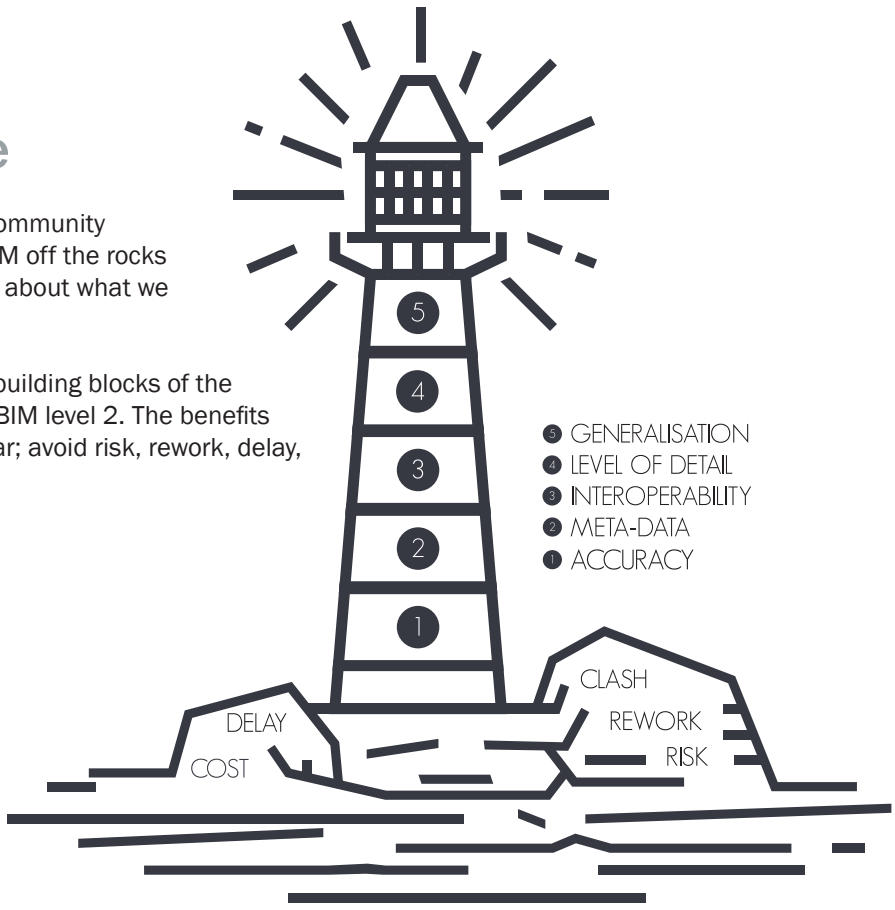
We have the chance to geo-enable BIM over the next five years. We truly hope you are going to be part of that.

Ian Bush, Chair, Survey4BIM

The Lighthouse

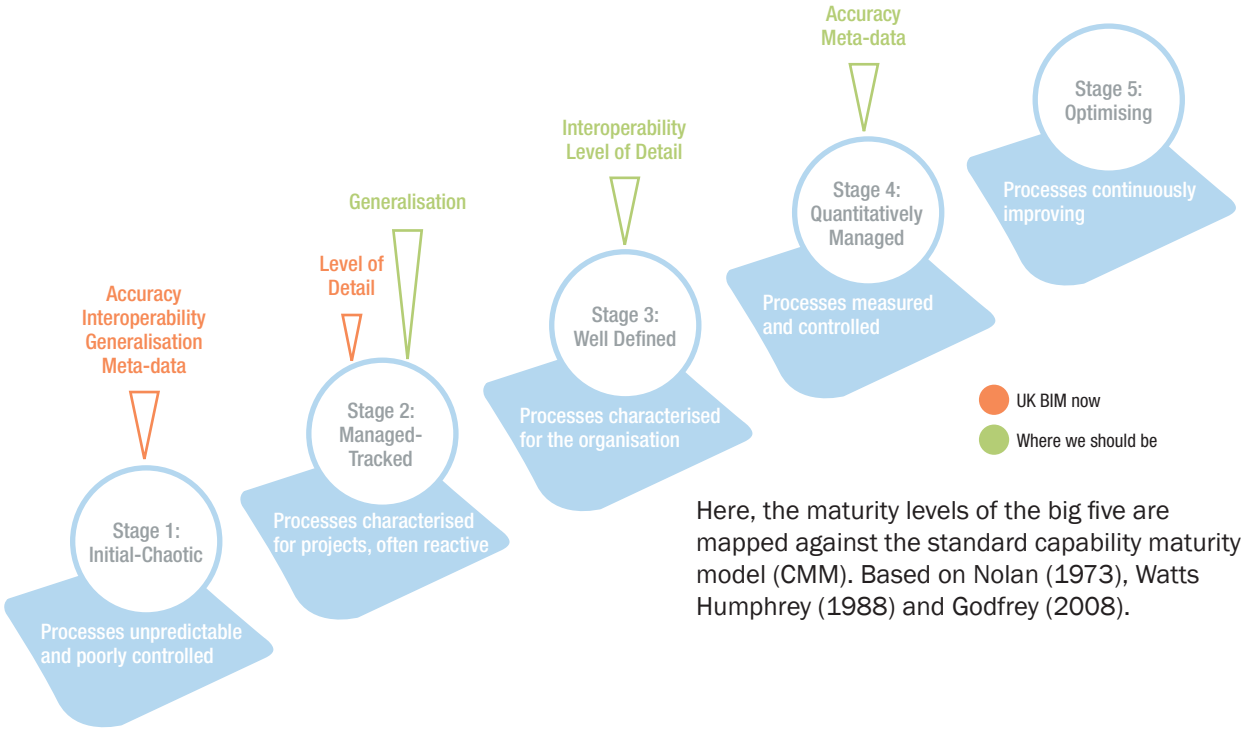
The analogy of the geospatial community building a lighthouse to keep BIM off the rocks is a good place to start thinking about what we need to do.

The big five challenges are the building blocks of the lighthouse that will geo-enable BIM level 2. The benefits of keeping off the rocks are clear; avoid risk, rework, delay, added cost and clash.



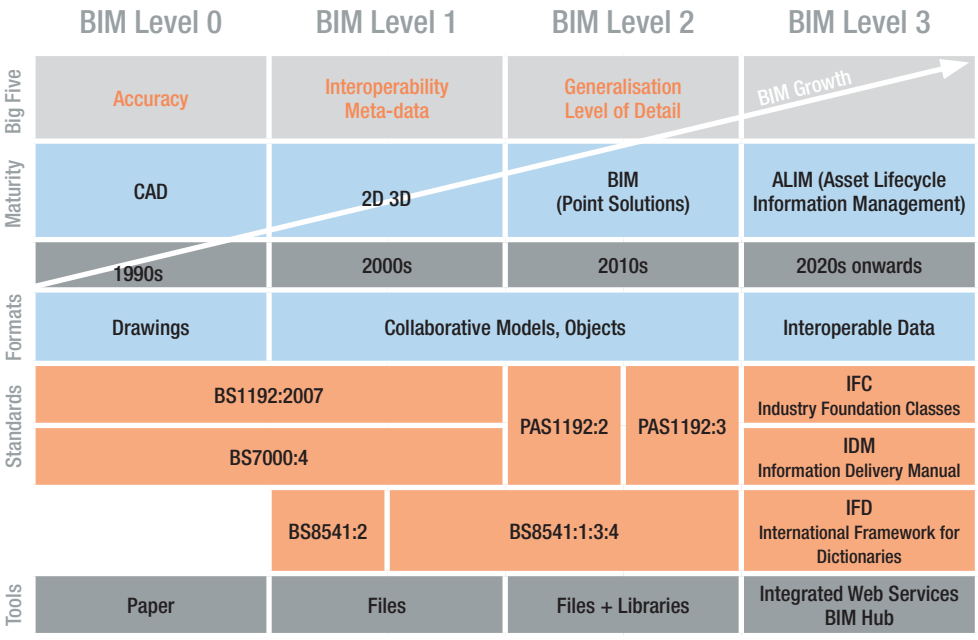
Maturity Models

By looking at maturity models and roadmaps, we can plot where our five challenges currently are and where they should be. We have assessed each of the big five in three ways. Firstly, what is the maturity of each process in the context of the UK BIM industry? Secondly, where should it be to enable BIM level 2? Thirdly, where on the BIM road map should this maturity be achieved?



Here, the maturity levels of the big five are mapped against the standard capability maturity model (CMM). Based on Nolan (1973), Watts Humphrey (1988) and Godfrey (2008).

Following this assessment, we can see what efforts are needed to either push this forward or catch up and, in particular, where the geospatial industry can focus its efforts and have the greatest impact on BIM's success. Accuracy in particular has a backlog of progress to be made before becoming geo-enabled. Whereas level of detail and generalisation are just about on track.



Here, the maturity levels of the big five are mapped against the BIM roadmap. Based on the BIM maturity model by Bew and Richards (2013).

Accuracy

Accuracy in a geospatial sense is specific and well defined. In a BIM context it is rarely, if ever, so well defined other than using the term 'accurate data'. The impact of inaccurate data can have serious repercussions on project success for the client and all involved at any stage.

Geospatial accuracy preserves designs through to construction and operation in the real world. It underpins the ability to define the level of detail and generalisation. To support BIM level 2 the concept of accuracy for geospatial data needs to be explicit and pinned down in terms of defined measurement, grid, currency and confidence.

How do we get there?

BIM level 2, as defined by the BIM Task Group, is: "File based collaboration and library management... a series of domain specific models (for example, architectural, structural, services) with the provision of a single environment to store shared data and information."

This data can be combined in order to make a federated BIM model, on which validation checks can be carried out. These checks include clash detection, areas, volumes, measurements, tolerances and design compliance. All of these aspects are affected by the definition of geospatial accuracy. We believe that to get to the required level of maturity, the following steps should be considered:

- Project stakeholders need to be more informed on the definition of geospatial accuracy and the impact it has at all stages of the asset and project lifecycle.
- The definition of geospatial accuracy needs to be explicit in terms of defined measurement, grid, currency and confidence, and be quantitatively managed.
- BIM standards, processes and technology need to support communication of the definition of geospatial accuracy effectively to all participants.
- BIM data needs to include geospatial accuracy attributes which are transferable through all stages of the Digital Plan of Works.

First steps

Two actions have been prioritised as having the greatest impact in the immediate future:

- Survey4BIM will set up a working group to define the best standard for consistent accuracy.
- Survey4BIM will work with the Open Geospatial Consortium to establish a common approach to meta-data accuracy and attribution.

What we are considering

Survey4BIM believes the following further action is needed:

- Research into which, if any, international groups are tackling the geospatial accuracy definition question, what their current interpretation is and how that could affect surveying for BIM. (This includes the work of the Open Geospatial Consortium, Association for Geographic Information, World Bank, BuildingSmart and American Institute of Architects.)
- Research into what software currently allows or supports geospatial accuracy attribution.
- A survey of professional organisations and BIM software vendors on how they currently support geospatial accuracy definition and what they believe is needed for BIM level 2.
- Definition of the key attributes needed to determine geospatial accuracy and what coding or classification would work with geospatial data.
- A shortlist of available accuracy standards in the UK and internationally.

Interoperability

Different file formats of data need to be consistent and usable in a variety of software, based on multiple components of data definition including geometry, accuracy, spatial allocation, generalisation and entities. Interoperability and exchange of geospatial data varies depending on the deliverable required and the software used. Some data transformation programs result in poor quality data. Two common problems can arise — (i) different file formats that are not consistent and usable within a variety of software formats; and (ii) different coordinate reference systems that are not translated or understood correctly.

The UK industry is reactive and does not consider the wider potential of consistent geospatial data and coordinate reference systems, and the ability to transfer between different systems. The capability of geospatially-enabled devices has evolved faster than the capability of the majority of their users. The issue for Survey4BIM is that data consumers are not fully aware of technical capabilities of existing technology or the pitfalls of using different location definitions. Identifying and addressing these restrictions and commonalities should lead to consistent interoperability.

How do we get there?

First and foremost, the industry needs to be more aware of the issues surrounding interoperability and the exchange of geospatial data. We believe that to get to the required level of maturity, the following steps should be considered:

- The processes for data exchange need to be standardised for common usage.
- Data consumers need to be more aware of the consequences of inconsistent data exchange.
- Taking into account international research carried out to date, a baseline method to test the application of geospatial data within the BIM model is critical. Theory and practice must be verified.

First steps

Two actions have been prioritised as having the greatest impact in the immediate future:

- Survey4BIM will challenge geospatial software houses to provide a common workflow so that their products pass data through their systems that can be transferred into standard file formats for additional work in other software environments.
- Survey4BIM will produce a best practice case study to be disseminated across the geospatial industry.

What we are considering

Survey4BIM believes the following further action is needed:

- Collation of current data exchange formats and assessment for commonality and suitability between data systems and environments (i.e. CAD, GIS, database).
- Specific tests to verify current file formats and tasks to see how data loss or degradation can be avoided, mitigated and understood.
- Guidance on why different coordinate reference systems used in a project need to be translated correctly and how this can be achieved — nationally and internationally.
- Educational material related to positional data covering the subject ranging from the value of postcode locations, to latitude/longitude, to local site grids that are accurate to the nearest millimetre.

Level of Detail

Geometric level of detail and graphical representation is critical to the underpinning of space allocation in BIM, both for proposed and existing features, and for client decision making. For the purpose of this paper, we have looked at the geometric level of detail, which will include the level of graphical representation and partial reference to level of information. The two key issues are (i) the variance in the definitions of the acronym 'LoD' (for example, if it refers to level of detail or level of definition); and (ii) graphical representation of as-built data is not always the same as the design.

How do we get there?

Level of detail in a geospatial context is generally related to the amount and maturity of geometric detail shown for an object and how it is graphically represented. The definitions below give a hint of the variety of interpretations currently being used. These need to be clarified and considered.

Level of detail is currently defined by UK PAS 1192-2-2013 as: "Level of Definition. A collective term used for and including 'level of model detail' and the 'level of information detail'. The 'level of model detail' is the description of graphical content of models at each of the stages defined, for example, in the CIC [Construction Industry Council] scope of services. The 'level of model information' is the description of non-graphical content of models at each of the stages defined, for example, in the CIC scope of services."

There is further articulation from the American Institute of Architects as: "Level of detail — how much detail is included in the model element; level of development — the degree to which the element's geometry and attached information have been thought through and which can be relied upon."

First steps

Two actions have been prioritised as having the greatest impact in the immediate future:

- Survey4BIM will identify current standards and industry groups and forums leading this development.
- Survey4BIM will set up a working group within the survey community to address geospatial concerns impacted by level of definition variances and lack of as-built standards.

What we are considering

Survey4BIM believes the following further action is needed:

- Collation of standards relating to level of detail.
- Guidance on what level of detail in a geospatial context actually means.

Meta-data

Meta-data is the information which defines other data and is essential when understanding the accuracy, provenance and critical information associated with a piece of data. Though meta-data standards are generally well developed, there are two common issues in the geospatial industry that need to be addressed (i) lack of awareness, knowledge, understanding and use of meta-data standards; and (ii) current meta-data standards, such as Gemini v2.2, require further review to assess their suitability for use.

How do we get there?

- There needs to be a significant education programme within the survey industry to ensure surveyors understand the current concept of meta-data and differences to taxonomy, exchange schema and attributes.
- Clients need to be aware of their own meta-data requirements and what gaps they have in existing datasets which inhibit their own decision making or asset lifecycle management.
- Software houses' approaches to meta-data storage and attribution need to be assessed for commonality and usefulness for applying industry standards.
- Research needs to be undertaken on available meta-data standards and groups actively developing them to see where surveyors can contribute to or adopt their outcomes.

- Overlaps in the use of the terms ‘meta-data’, ‘attributes’, ‘exchange schema’ and ‘taxonomy’ need to be defined and where possible distinguished where each is appropriate.
- Overlaps between meta-data standards and other technical challenges for BIM such as accuracy attribution, interoperability, level of detail and generalisation need to be mapped.

First steps
Two actions have been prioritised as having the greatest impact in the immediate future:

- Survey4BIM will assess the details, feasibility and suitability of Gemini as a common standard, looking at what may be missing and what needs to be included. This assessment will include Gemini’s capability applied to CAD, GIS and BIM applications, including survey data capture.
- Survey4BIM will become involved with the AGI IST36 BSI Standards Committee to understand how surveyors can input into v2.3 or later versions of Gemini.

What we are considering
Survey4BIM believes the following further action is needed:

- Research and collation of meta-data standards, their current usage and likely application to BIM.
- Collation of the differing elements of information exchange, such as taxonomy, schema, attributes and parameters, and distinguish where each one sits in the data management process and what the master is through the timeline.

Generalisation

Generalisation is the selection and simplified representation of detail appropriate to the scale and/or purpose of its end use without reducing the accuracy of the captured data or distorting the context. The two key issues are (i) the representation of 2D/3D data while maintaining geometric integrity and recognisable context; and (ii) the capability of the user to interpret generalised data and utilise it accordingly.

Through the process of generalisation, features relevant to the end use are identified whilst less significant details are removed simultaneously, creating simplified outputs that can be used multiple times at multiple scales, albeit through a single data capture process. In a BIM context, single-capture multiple-use is essential for cost control, project delivery and confidence in a single version of the truth.

How do we get there?
- The geospatial industry needs to think outside of the construction context and learn from other 3D industries to adapt existing technology and solutions.
- This is a fast changing area of technology and surveyors need to keep track of the maturity of cartographic and GIS capabilities within new developments and products.

First steps
Two actions have been prioritised as having the greatest impact in the immediate future:

- Survey4BIM will ask software vendors how they currently support generalisation.
- Survey4BIM will identify and engage with 3D specialists outside of the construction community who specialise in generalising data for visualisation and gaming for use in mobile and ‘lighter’ user environments.

What we are considering
Survey4BIM believes the following further action is needed:

- Identification of the maturity needed in GIS and cartography, and the rules and procedures governing it.
- Clarification of the different types of generalisation, for example on-the-fly for display/contextual purposes; user interface for data transfer and sharing; and source generalisation to simplify databases.
- Definition of the rules and guidance using GIS and cartography as a starting point due to the more advanced level of maturity.

Survey4BIM

Survey4BIM is a cross-industry group open to all organisations involved in the survey, collection, management, processing and delivery of geospatial information within the context of building information modelling (BIM).

The group involves clients, contractors, consultants, suppliers, subcontractors, institutions, academia and other bodies — reflecting the composition of the construction sector in which it operates.

Survey4BIM's mission is to provide a forum for survey organisations and industry professionals to collaborate and share their journeys putting BIM into practice, and to provide best practice guidance documents on survey matters relating to BIM.

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