Building Information Modelling - a business process to reduce whole life costs of infrastructure assets

Synopsis:

Building Information Modelling (BIM) originated within the building construction industry. Here, it has already been proven to reduce whole-life costs. Whilst one key aim of BIM is the creation of a 'digital twin', it is not in itself software. Although, of course, software facilitates this. It is a process and, through careful management, the information detailed during the design and build phases of any scheme can be harnessed to ensure the efficient use of resources at all stages, from design, construction and maintenance. The advantages are clear when this is applied to building maintenance, but less obvious for road infrastructure. The paper will shed light on exactly what BIM is, and how it can be used to help you minimise your whole life costs.

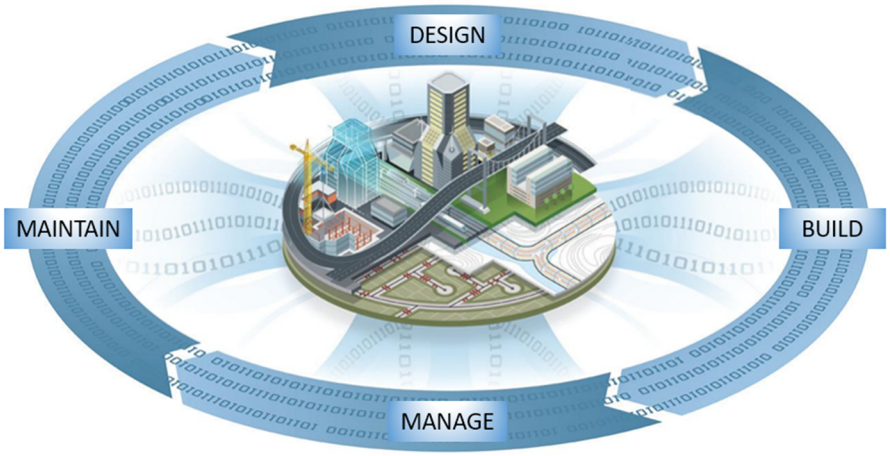
Main Content

I am here as a representative of the Association for Road Traffic Safety and Management, and as chair of the National Highways Sector Scheme 9A for the provision, manufacturer and supply of traffic signs. And my day job is product consultant for Keysoft Solutions. We provide software for the design of road safety and traffic management engineering schemes, and for signalisation and street lighting, and landscape design, supporting industry to deliver BIM projects. My background before my time with Keysoft was implementing road safety and traffic management schemes at Avon County council, including the first safety camera scheme, 'safe routes to schools' schemes and many traffic calming projects.

My talk today is about 'BIM' in infrastructure. First of all, we need to know what BIM is. Building Information Modelling originated within the building construction industry. Here, it has already been proven to reduce whole-life costs.

The word 'building', of course, comes directly from that industry, and originated in the acronym as a noun. But we may use it, in the infrastructure world, as a verb – we will be players in the activity to build a digital model of the infrastructure we are responsible for.

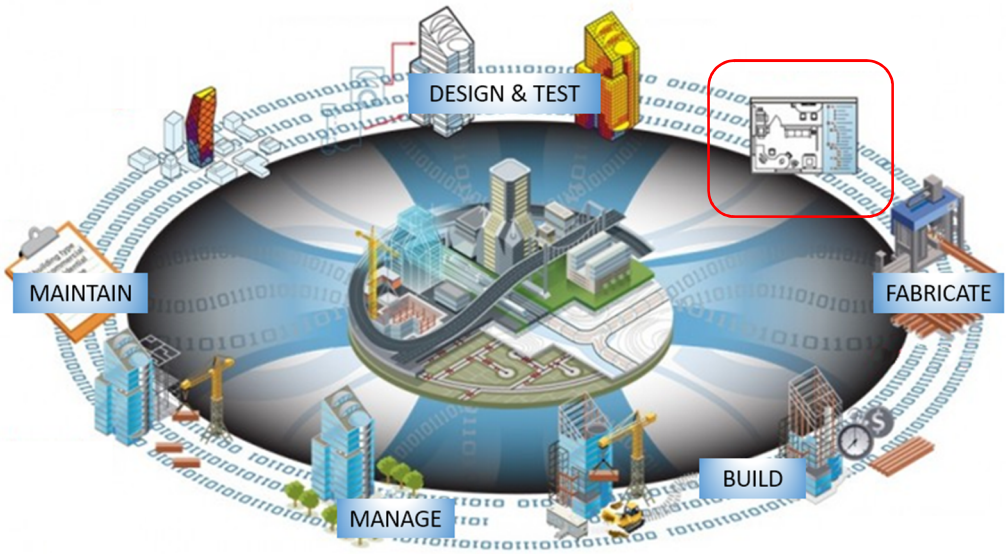
Some of you may be involved in scheme designers, some in construction and some responsible for the operation and maintenance of infrastructure. The good news is that BIM is for you all! It is important to recognise that BIM is a PROCESS, one thing it is not, is software – there is no BIM 'in a box' installer.



But let's take a step back for a moment and examine it in the wider context.

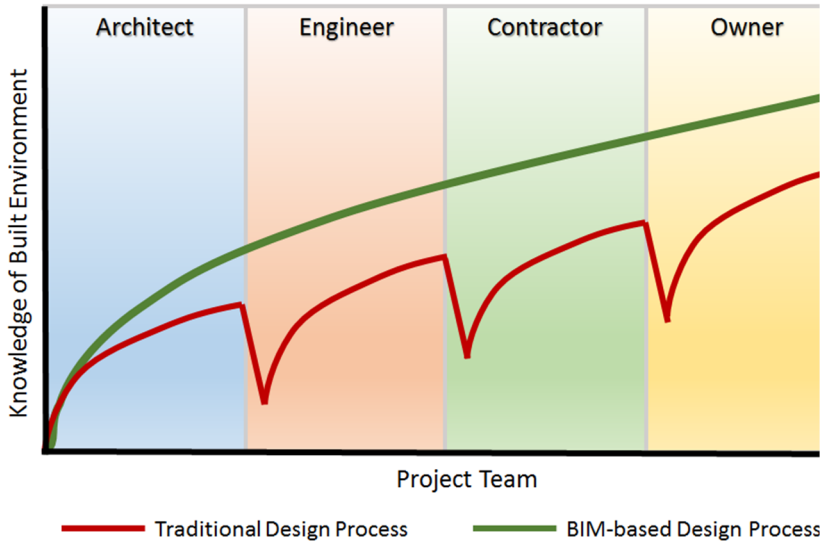
BIM can enable you to realise cost savings as we go through the Design → Build → Manage → Maintain stages, exactly how, I will illustrate shortly. For us particularly, working in roads infrastructure, the process is a cyclical one as traffic conditions change over time, because of the continuous need to re-plan, adapt and modify the network. So cost savings can be found by connecting the end of construction phase to the beginning of the next cycle. This cycle is illustrated on the previous page.

Taking a look at this next, more granular info-graphic below, the same circular process is represented, and this picture highlights that there is, between stages, an information handover (here shown circled in red) between the design & test and fabrication stages, for example as printed documentation. Now increasingly site operatives may carry around tablets and directly access a digital model of the design. Construction sequencing, or '4D' information, can be hugely beneficial on-site and is not possible from paper copies of the model.



One thing this image represents is the flow of information between people involved at each point. Information can be design drawings, or operational manuals. What you can typically find in projects is

represented in the next figure. We call it the 'sawtooth' graph. As information is passed between players there is often a loss of detail, a loss of information. This may simply be because the CAD drawings are printed, or saved as PDF, and the meta data, such as part numbers, voltage drop calculations or other information that is not likely to be annotated, is lost. The receiver therefore needs to learn and build their own understanding of the design from a lower position or state.

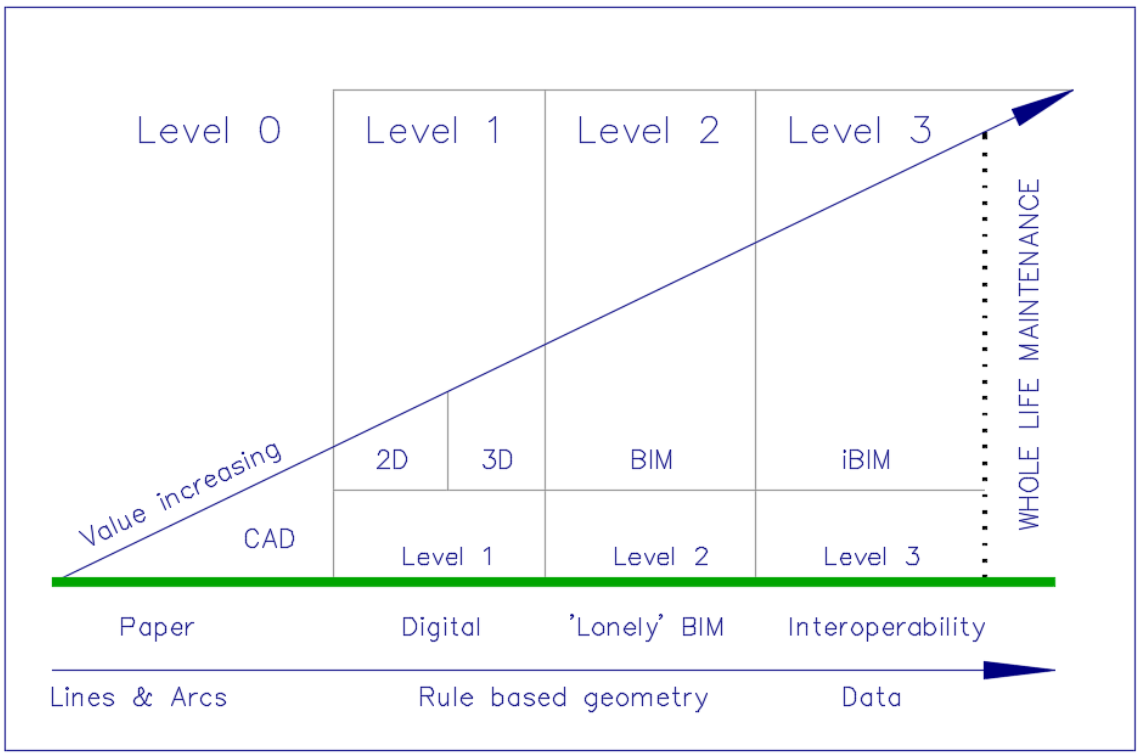


The ideal is to make sure no information is lost at any stage, saving time and reducing error. The information should also become richer as time progresses. This increases the level of understanding between interested parties. In the design and construct phases good data management can reduce the frequency and cost of expensive last minute design changes.

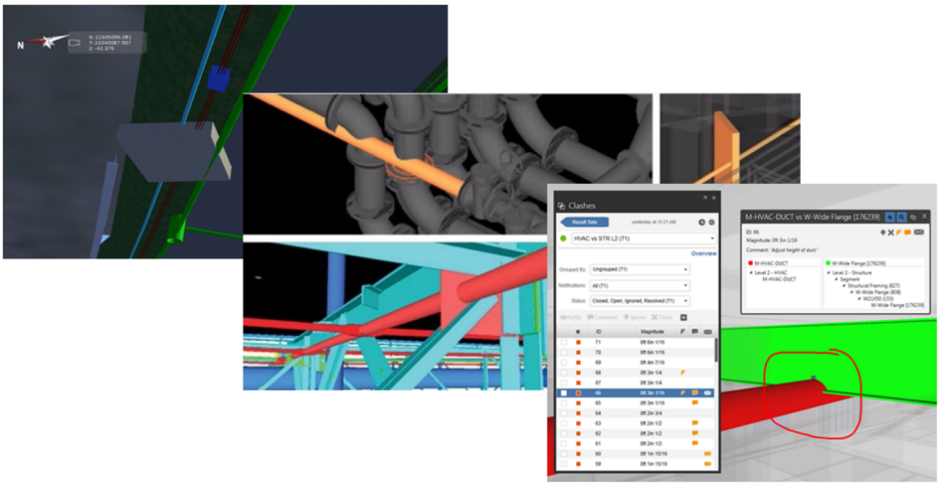
This reduces or eliminates the sawtooth effect.

The UK BIM Alliance defined a successful outcome from adopting the processes in BIM would have the following features:

- **Clear definitions for the information needed** by the project client or asset owner, and for the methods, processes, deadlines and protocols that will govern its production and checking;
- The quantity and quality of **information produced being just sufficient** to satisfy the defined information needs, whilst not compromising health and safety or security. Too much information represents wasted effort by the supply chain and too little means clients/owners take uninformed decisions about their projects/assets;
- Efficient and **effective transfers of information** between those involved in each part of the life cycle – particularly within projects and between project delivery and asset operation.



As we move the design process from one done on paper, to 2D CAD and so on, the opportunities for the model to add business values become clear. Ramping up the level at which we work, we move through 'lonely' BIM, with little or no interoperability, through to integrated BIM (iBIM), with a high level of interoperability, integration and business value. Few, if any schemes have been operating at Level 3.



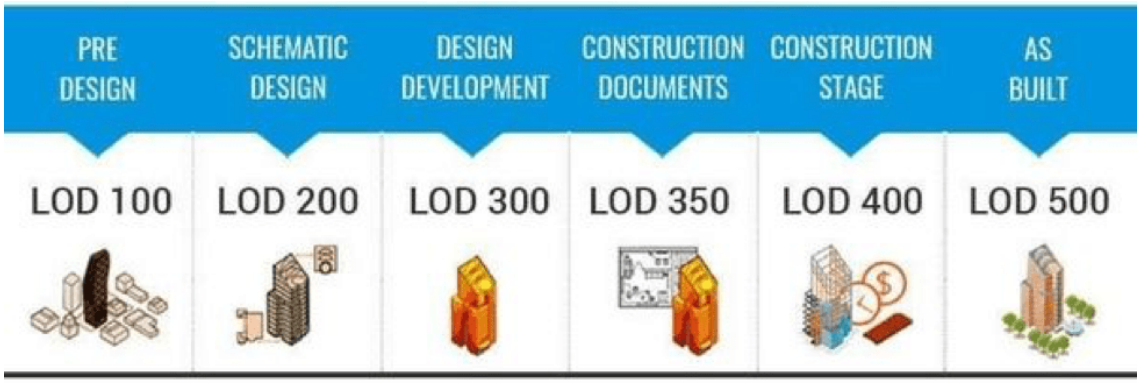
Ensuring that the digital model reflects accurately what is already in the built environment before a design iteration begins, and during the phases of design which may involve multiple disciplines, the potential for savings can be realised through design collaboration, better model coordination, and of course clash detection.

Let's consider for a moment the idea that information increases in value – quantity and quality – during the design phase. There is of course, even before any detailed design is done, a stage of planning and conceptual design. As a scheme progresses greater and greater clarity around specifications and suppliers is arrived at.

BIM defines the idea of 'Level of Information' or of Detail - LOD. The 'Publicly Available Specification' PAS 1192-2:2013, sponsored by the Construction Industry Council (CIC) and published by The British Standards Institution, gives 'broad guidance' as to an appropriate framework for LOD. These are as follows:

- Brief
- Concept
- Definition
- Design
- Build and commission
- Handover and close-out (as built)
- Operation and in-use

At the conceptual design stage, many elements may only be represented by a simple bounding box. But what is interesting here is that a low level of detail doesn't necessarily mean an inaccurate model – a give way triangle will likely be drawn with full accuracy, even at the conceptual stage even if its exact position may change at the detailed design stage. It would make little sense for linear elements such as proposed road markings along a stretch of motorway to be illustrated by a bounding box, and even at the conceptual stage it is likely that the precise Traffic Signs Regulations and General Directions diagram number (defining the marking length and gap), for example for a lane line, would be known.



The American Institute of Architects has a framework that uses numbers (see above). Whichever framework is employed, it is clear that these stages are useful as descriptions of design elements during a single Design, Build and Commission iteration. The as-built model can then add enormous value at the start of any future iteration, so it is incredibly important to get this right before it is passed on to the owner/operator.

On the existing road network, we deal with many existing built assets, some of them can be decades old. So it is not easy to imagine when the effort of building or maintaining a digital model is worthwhile at all. It may have key information, for example services, comms or drainage assets simply missing, or at best wildly inaccurate. One question to ask is whether no information is better than incomplete information. So in time the gains will increasingly be realised. We have to start somewhere.

Key to delivering projects in a BIM way is to have an agreed Execution Plan – a BEP. This will be agreed in advance by all interested parties. You must understand what it is you want out of the efforts involved, what are the deliverables at each stage, and at the end of any scheme implementation.

The key to that is to ensure there is just a single source of the truth.

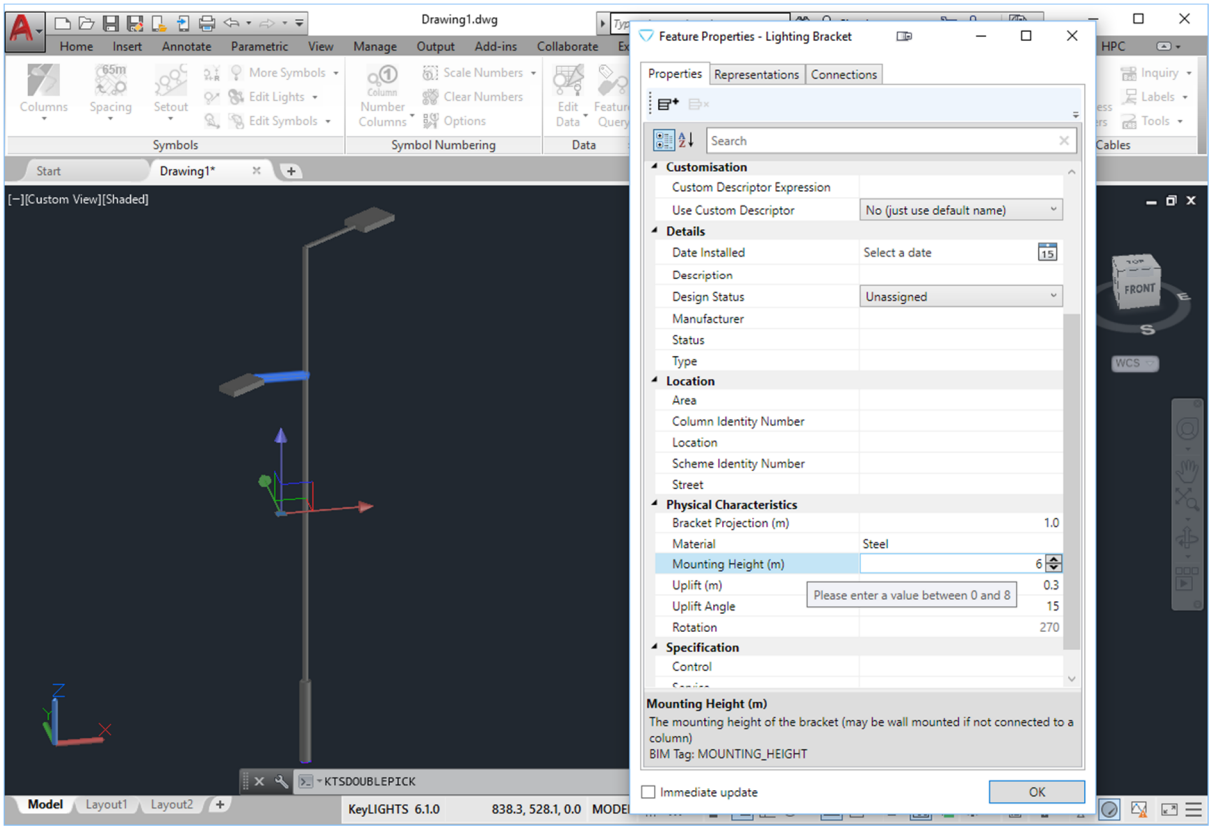
THE CAD MANAGER EXPERIENCED A CLASSIC 'SPARTACUS' MOMENT

Clients, construction companies and owners are already grappling with this question, and contractual and legal issues need to be bottomed out. Versioning during the design and construction phase is a potential minefield. How can design changes, identified on-site, be passed back to the client and the

change authorised? Design changes are somewhat inevitable – is the whole model versioned, or does versioning happen for every single element of design? And how exactly do changes to the design get passed up and down the chain?

In reality, most are at best at Level 2. To move to Level 3 – Integrated BIM (iBIM), we need to be connecting our systems, processes and information. We talk a lot about information exchange with terms like COBIE and IFC or XML being bandied about. But these are just conversion formats, and in some respects not unlike a conversion from CAD to PDF or to printed copies. Perhaps technology may be able to come to our rescue here after all, with cloud-based models providing the answer. All fine if we have digital connectivity and centimetre accurate global positioning during construction, and the capture of as-built information.

There are, as yet, no easy answers, what is needed is clarity in the requirements, what should be delivered at the end of construction, and how this information will be stored and used. So we have to concentrate on the BIM Execution Plans to ensure we get the most from an integrated way of working and understand how we manage and maintain the digital model.



A final thought, we often hear that there is a desire for 3D, that BIM is in some way synonymous with 3D. In fact, 3D may simply be that the digital model contains 3D information. For example, the height of a lighting bracket, or the height, depth and width of a foundation. This dimension data can be used to generate 3D when it is needed, and only then. This may not be required during the construction phase, and only at times during the design phase, for example to ensure sight lines will be maintained. There will always be a place for symbolic representations, even of as-built assets that are in operation,

for example in GIS systems where the information about an asset needs to be rendered in quite a different way to what is needed during the construction phase.

In summary then, three take home points:

1. Design your BIM Execution Plan to minimise the loss of any design and construction information and be clear about the deliverables.

2. Ensure your BIM processes maximise the opportunity for connecting the chain – design, construction and maintenance should not be silos.

3. Despite the lack of real world digital data about much of the built environment, we need to show leadership, collectively as an industry and take this forward.

Thank you