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BIM for the terrified
a guide for manufacturers

nbs

construction products association

contents

BIM for the terrified

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1. Introduction

What is BIM?

Building Information Modelling (BIM) is a process for managing the information produced during a construction project, in a common format, from the earliest feasibility stage through design, construction, operation and finally demolition, in order to make the best and most efficient use of that information.

BIM has three key elements:

- The consistent, conventional labelling or naming of documents and data – this helps in tracking and finding data throughout the life of the asset and ensures all those working on the project follow the same procedures. A suitable process is described in BS 1192, which is already used for numbering drawings on many projects and can form the basis of a system for use with BIM
- A method for storing and manipulating information. On many projects this involves the use of a three-dimensional representation of the buildings in software. Essentially, a BIM is a shared representation and spatial database that records the location and attributes of every component
- A method for exchanging or issuing information about the building, including its construction, operation, performance and maintenance. Traditionally, this has involved exchanging drawings, schedules and manuals, in paper or electronic format and this may continue. The difference is that when BIM is used, the information will be generated from the BIM, rather than by preparing the documents separately

The use of BIM can increase efficiency and reduce errors. Virtual designs are built in three dimensions before work proceeds on site; the attributes of all the elements of the building can be found in the model; and spatial 'clashes' can be identified and resolved in the model instead of on site.

Fig. 1.1 Casino: Completed in 2001, Connecticut's Mohegan Sun Casino is an early example of a full virtual modelling project (today known as BIM)

Who is this guide for?

This guide is aimed at the general reader who does not have a detailed understanding of BIM, but wishes to gain sufficient understanding to assess the possible impacts of BIM on their construction product manufacturing or distribution business.

The guide explains the basic vocabulary of BIM so that readers will be better able to understand the wider debates about it. It looks at how BIM has evolved from the earliest drawing and specification systems, how the various types of BIM differ and what benefits they offer. The reasons for the government's drive to adopt BIM are explained and the requirements that will fall on to the supply chain are set out. Case studies are included, showing how manufacturers are taking up the challenge of BIM. Finally there are references to sources of more detailed information.

The reason for publishing this guide now is that the government has set a requirement that all central government building procurement contracts must use BIM from 2016. The Cabinet Office has set up the BIM Task Group to work with industry to bring the construction industry up to speed. The Construction Products Association is working with the BIM Task Group and others on a range of initiatives to support this work.

To be prepared for BIM, manufacturers and distributors will need to invest time and resources. It is hoped they will be better informed and more confident about BIM after reading this guide and will be able to ask the right questions as they make investment decisions.

Fig. 1.2 Construction site: BIM enables errors and clashes to be resolved early in the model, rather than later on-site

Why should I invest in BIM?

The Construction Products Association has worked with NBS to encourage sector trade associations to develop BIMs at a generic level for products, e.g. a brick, a WC, or an insulation board, so that designers have access to a range of products in BIM format. It is then up to individual companies to decide whether to take the next step and give the designer the opportunity to specify their particular products using BIM information.

That decision revolves around an assessment of when making company level BIM-compliant data available will become commercially essential. Certainly if the company's products are used in central government contracts there will be a requirement to meet the government's BIM standards from 2016.

Some argue that being an early adopter will give market advantage. However, if everyone invests in getting their product data 'BIM ready' it is unlikely that any one company will benefit or sell extra product. Essentially being BIM ready becomes part of day to day business.

Investing in BIM has other advantages. These include better internal management of technical data, integration of multiple data sources into one place and for some industries, the possibilities of linking designers directly to manufacturers, thus reducing the risk of contractors, quantity surveyors and others undermining the designer's intent and the manufacturer's skills by 'value engineering'.

Ultimately the decision is not whether to invest in BIM, but when to invest in BIM. Investing in a planned way is almost always better than being forced to invest at short notice. It is a strategic management decision, not just a technical one.

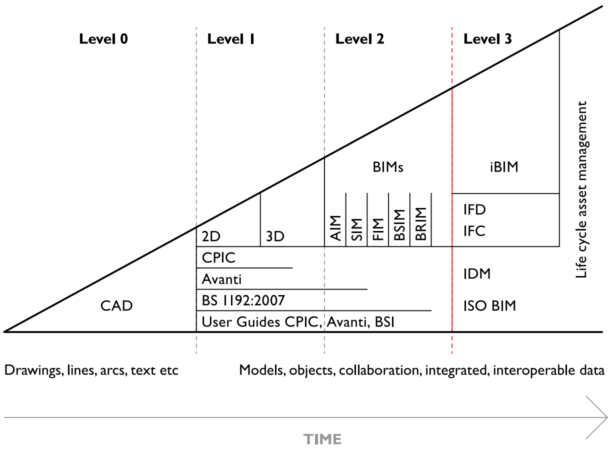


Fig. 1.3 BIM Maturity Model

2. The Background to BIM

Existing information systems

From the very earliest buildings, designers and builders have needed to communicate with each other to agree what was required and what was satisfactory and although the earliest drawings are hard to date, there are examples from China in the fifth century and from the Romans in Europe. Certainly by the 15th century, drawings were widespread for major buildings and some type of Building Regulations were introduced around this time. Following the Great Fire of London in 1666 Building Regulations were used to improve the standard of buildings and to avert a similar catastrophe occurring again.

Drawing boards with pens and paper remained in use for several hundred years, but once computers became affordable in the 1970s they quickly started being used for computer aided design and drawing (CADD or CAD).

Information that accompanies drawings has also developed over time and various systems have been developed for classifying the parts of buildings. Such systems are vital because all parties need to use a common language and understand the meaning of terms such as 'door', which could mean the complete door assembly including the frame, just the moving leaf with or without the hardware, or even just the piece of wood that fills the doorway.

Manufacturers have developed their information for customers to reflect the development of different ways of communicating. Thirty years ago most product information was printed in catalogues. Then came the first online systems and CD-ROM based catalogues. Otherwise, the basic system of drawings, specifications and bills of quantities has changed little since the mid nineteenth century.

Moreover, each party has held their own information in their own way. Manufacturers pass details to designers who rework or redraw the information which is then passed to contractors who in turn reassemble the model in their own format. Apart from the waste of resources, this process almost always leads to mistakes which have to be rectified later, at not insignificant cost.

The development of shared data

In the last few years there have been attempts to get all of the information for a project into one place that is accessible by all parties. BIM requires collaborative exchange of information across the supply chain, using three dimensional models of the buildings, in machine-readable electronic format, consistent with open, non-proprietary standards. The key features of BIM are:

1 Collaboration across the industry.

2 Engagement through the entire life-cycle of the building.

3 Collation and exchange of information in common format.

4 Shared three-dimensional models.

5 Intelligent, structured databases.

The first point is key and for much of the industry it will be difficult because it involves changing a deeply ingrained culture. Collaboration is defined as working with others, not working for others. Some argue that procurement and payment practices will also have to become collaborative before BIM can work properly.

It is widely recognised that much of the cost of buildings is incurred during their operating life, from energy and maintenance costs. BIM enables better information to be delivered to the building operators and this is where significant value is added. For manufacturers, supplying building operators with information about their products (e.g. durability, maintenance requirements and operating instructions) will be a key part of their BIM offering.

For the manufacturer and supplier, the work will be in collating information from a multitude of existing documents and drawings and putting it into one place. It is not about buying expensive hardware, software or training for a variety of proprietary systems from software providers or contractors. The use of open, non-proprietary standards will allow information to be exchanged easily.

Three-dimensional models are the most evident feature of BIM, partly because they are easy to show off, whereas a data structure or exchange format is not. However data sharing is just as important as the model. Structured data is perhaps the single most important feature of BIM. Much work has been done by committees to define data structures for all the components of construction and how they relate to each other. This system is known as the Industry Foundation Classes.

For manufacturers the main requirement is the provision of product data in a standard electronic format known as COBie. This stands for 'Construction Operations Buildings information exchange', which is an open (non-proprietary) standard. For the UK government there is a specific version known as COBie UK 2012.

COBie files are often in the form of tabular electronic worksheets but other formats are possible, e.g. HTML or Industry Foundation Class. COBie is a way of presenting information, not a request for new information.

The Government's Requirements

According to the government's BIM Task Group:
'BIM is essentially value-creating collaboration through the entire life cycle of an asset, underpinned by the creation, collation and exchange of shared 3D models and intelligent, structured data attached to them.

'The Government Construction Strategy was published by the Cabinet office on 31 May 2011. The report announced the government's intention to require collaborative 3D BIM (with all project and asset information, documentation and data being electronic) on its projects by 2016.
'Essentially the UK government has embarked with industry on a four year programme for sector modernisation with the key objective of reducing capital cost and the carbon burden from the construction and operation of the built environment by 20%. Central to these ambitions is the adoption of information rich Building Information Modelling (BIM) technologies, process[es] and collaborative behaviours that will unlock new, more efficient ways of working at all stages of the project life cycle.'

In summary, government is asking the construction industry to reduce the costs of building by 20% in both capital monetary and whole-life carbon terms through, amongst other means, the use of BIM.

Data Drop 1

The data available at Drop 1 are broadly consistent with those expected at RIBA Stage 1. The rationale for the data drop is to approve the business case for the project. Checks are made to ensure that the emergent design and specifications are consistent with the brief in terms of function, cost and performance. The model will be made up as a massing model indicating space allocation and overall site location. The massing model can be defined as a conceptual model to establish the general building shape, orientation and spaces.

The model contains all client requirements and constraints information. It can be used to communicate other requirements back to the client. Feasibility analysis can also be carried out. Room data sheets that record and confirm client requirements for all spaces can be generated from the model.

Data Drop 2

The data available at Drop 2 are broadly consistent with those expected at RIBA Stage 3. The rationale for the data drop is to select the main contractor. Checks are made to ensure that the design and specifications are consistent with the brief in terms of function, cost and performance and that potential suppliers can demonstrate capability and integrity through the competitive process and be selected to deliver the asset. The process will include costs and performance analyses at a level defined in the Employers Information Requirements (EIR). This Data Drop may be split into two, 2a and 2b, to distinguish the model delivered by the client-side technical team (2a) and the model returned by the contracting supply chain (2b). The tender comparison data will be in Data Drop 2b. The differences between Data Drops 2a and 2b will identify either areas of non-compliance or alternative approaches.

The model now represents a technical solution that can be built. All input from the contractor has been incorporated. The CIC Working Group indicates that the accuracy of information incorporated at this stage is likely to be 75%-80% with a tolerance of ±20%-25%.

Data Drop 3

The data available at Drop 3 are broadly consistent with those expected at RIBA Stage 4. The rationale for the data drop is to approve the agreed maximum price. The checks are to ensure that the developed design and specifications are consistent with the brief in terms of function, cost and performance. The model is a fully coordinated technical solution developed from the one in Data Drop 2.

The model now represents a technical solution that can be built. All input from the contractor is incorporated into the model. The CIC Working Group indicates that the accuracy of information incorporated at this stage is likely to be 85 - 90%.

3. What Manufacturers Should Do

Developing a BIM strategy

What do manufacturers and product suppliers need to do to allow BIM to work for the rest of the supply chain? Each manufacturer should consider the supply chain's requirements with respect to BIM and develop a clear BIM strategy with defined outcomes. A BIM strategy should take into account the following:

- The perceived short and long-term costs and benefits of BIM
- Staff training needs
- Software requirements
- Integration of BIM with existing workflows (suitably adapted)
- Restructuring product data to make it BIM compatible

The requirements of the supply chain

Once a BIM strategy is in place the manufacturer should consider deliverables associated with a BIM-enabled project. These deliverables are known as COBie Data Drops. The BIM Task Group website defines Data Drops as follows:

'COBie data is delivered along with existing contract deliverables depending on your specific contract. COBie does not change the content of existing contract deliverables. COBie does, however, change the format of the information that is delivered.

'The number of COBie UK 2012 worksheets to complete depends on the project stage. Project team members only enter data for which they are responsible. Designers provide spaces and equipment locations. Contractors provide manufacturer information and installed product data. Commissioning agents provide warranties and maintenance information.'

A key aspect to consider is that BIM aims to minimise or eliminate information loss through the process of design, construction and operation of a building. At each stage structured information should be added to the BIM. This information will allow the design team to make informed decisions at the correct time, de-risking the project and ensuring that a better building is delivered.

The designers of a building (e.g. the architect, structural engineer and services engineer) will require product information, which will be entered into the BIM. Others (e.g. the client, planners, regulators, assessors, contractors) will need information about the project, from the BIM. Packages of output information are described as 'Data Drops', which correspond to the various stages of the new BIM-compatible RIBA Plan of Work:

- Data Drop 1 is related to the client's requirements and spatial analysis. At this stage the model will be used for feasibility studies and will be generic in content and structure
- Data Drop 2 is a technical solution that can be built. Information from the model can be used for costing. The information within the model is still generic and not product specific
- Data Drop 3 is also a technical solution that can be built. The information is far richer than in Data Drop 2 because it is fully coordinated and can be used for procurement of materials and products. At this stage product specific information should be included in the model to allow extraction of data about components, systems, locations, connections, documents and attributes

Manufacturers' structured product information

To enable the BIM to be updated with relevant information manufacturers must present product information in a structured manner. This structured product information may be in a number of formats ranging from standard manufacturer's technical literature through to multi format BIM objects. Multi format BIM objects are preferred because they can be used by designers within their own software. The benefit of manufacturers providing multi format BIM objects to designers is that the information contained in the BIM objects will be consistent and accurate.

A manufacturer may consider that it already provides structured data about its products, however there are many examples where the format and content of one manufacturer's information differs from another's.

Consider the example of three insulation manufacturers (A, B and C) providing what should be the same information, but which has been compiled inconsistently. Figs 3.1 to 3.3 show the information provided by each manufacturer. We have three inconsistent and differently formatted sets of information.

All of this information can be captured in a BIM project. However, the use of this information during the design, construction and operation of a building will be inhibited by the inconsistent terminology and formatting. The information as presented could restrict specifiers' ability to make a selection based upon product comparison, because there are inconsistencies in the level of detail provided.

For BIM, manufacturers must provide consistent, structured product information for use by the supply chain. This information should preferably be in a BIM format so that the designer can incorporate it into the building model.

Sets of product information in BIM format are known as BIM objects. Manufacturers may produce BIM objects themselves, but there are drawbacks to this including:

- The expense of purchasing software for a range of BIM platforms
- Training staff to use the software to create BIM objects

Another option is to appoint a consultant to produce BIM objects from existing technical data. This option also has drawbacks because there are varying levels of quality of consultants. Manufacturers should seek specialists that have a good understanding of BIM, product information and specification.

Data Drop 4

The data available at Drop 4 are broadly consistent with those expected at RIBA Stage 6. The rationale for the Data Drop is for the operator to take possession of the operation and management information.

The data delivered is the operational and detailed functional information supplied by the product manufacturers. Particular attention needs to be paid to the first year of operation because many 'as installed' processes may invalidate warranties if incorrectly applied during that period.

The model now represents the building as it has been built. It also contains all information about the systems and equipment actually installed. Information to support Facilities Management can be extracted from the model. The accuracy of information incorporated at this stage is 100%.

Product Code	Thickness (mm)	R-value (m^2K/W)	Weight (kg/m^2)
GA4050	50	2.25	1.55
GA4055	55	2.50	1.74
GA4060	60	2.70	1.90
GA4065	65	2.95	2.05
GA4070	70	3.15	2.19
GA4075	75	3.40	2.34
GA4080	80	3.60	2.48
GA4085	85	3.85	2.62
GA4090	90	4.05	2.76
GA4095	95	4.30	2.90
GA4100	100	4.50	3.27

Fig. 3.1 Manufacturer A's product information

STOCK NO	DESCRIPTION	UNIT	AREA
8106	6mm Insulation Board 1.3x0.6	10	0.78
8110	10mm Insulation Board 1.3x0.6	10	0.78
8120	20mm Insulation Board 1.3x0.6	ea	0.78
8130	30mm Insulation Board 1.3x0.6	ea	0.78
8140	40mm Insulation Board 1.3x0.6	ea	0.78

Fig. 3.2 Manufacturer B's product information

	Mineral insulation board
Approval	European Technical Approval ETA -05/***
Areas of application	External thermal insulation composite system from system partners
Density	Approx. 115 kg/m^3
Thermal conductivity	λ=0.045 W/mK
Water vapour diffusion resistance coefficient	μ=3/5 open for vapour diffusion
Fire classification	Non-combustible – fire classification A1
Compressive strength	Average $\geq$ 300kPa
Bending strength	$\geq$ 80kPa

Fig. 3.3 Manufacturer C's product information

4. Open Standards

The Need for Open Standards

For BIM to be effective, information must flow through the design, construction and operation process from briefing to facilities management (FM) via various construction professionals. The idea of the industry moving away from working in silos towards collaboration and coordinated information is an over-arching ethos of BIM. To achieve this we need to work in an environment of open standards and interoperability.

Interoperability is required throughout the life of a project. There are various levels of interoperability including that between software from the same vendor and that between software from different vendors. Within a project team, several consultants may be working on separate three dimensional models, using the same CAD software and these models can eventually be integrated into a combined model. In reality it is more common that several different CAD packages are used. This requires interoperability between the packages, in accordance with agreed communication rules.

To achieve interoperability and to transfer data along the project time line, we require open data standards. These are commonplace in computing - we take for granted that an email sent from an Apple iPhone can be read by recipients using Microsoft Outlook, Google Gmail or Yahoo Mail (Hamil 2012). Historically, the construction industry has operated without commonly used, open standards for sharing data. Those standards that are used tend to be tied to proprietary formats that are particular to a BIM software vendor. Proprietary data formats may be a quick and efficient way for software companies to adapt to a changing market, but in the long term they are expensive to maintain and support and do not promote a shared approach.

Early adoption

Open exchange standards started to emerge in the late 1970s following an agreement between leading CAD vendors and users to develop an open exchange mechanism (Laakso & Kiviniemi 2012). This was initially considered a threat by the CAD vendors, who were fearful of losing competitive advantages. However, support for open standards began to grow when vendors started to view them as something attractive from a marketing standpoint as well was a way of increasing the chances of obtaining government contracts. (Kemmerer 1999).

In the mid-1980s a subcommittee of the International Standards Organisation (ISO) considered that none of the existing formats could support the needs of an open computer modelling standard for multiple industrial and manufacturing industries (Bloor & Owen 1995). This led to the development of the Standard for Exchange of Product (STEP) data model. STEP was attractive in that its intention was to cover a diverse range of industries, enabling collaboration. Motivation to develop a separate standard for the architecture, engineering and construction (AEC) and facilities management (FM) industries started to grow when it was realised that STEP was too slow and unresponsive to meet future market need in construction (Tolman 1999).

Without open standards in place individual software packages require the use of direct translators to convert information back and forth in order to communicate with other software packages. An open standard becomes a 'middle man' whereby information only needs to be translated back and forth from a single format in order to be compatible with all other applications supporting the same standard.

Within construction, there are two well established open standards for the transfer of data: Green Building XML (gbXML) and Industry Foundation Classes (IFC).

Green Building XML

Green Building XML is an open schema developed to facilitate the transfer of information in the BIM to engineering analysis tools. From its development in 1999 and first publication in 2000, gbXML has been supported by a number of leading BIM software vendors.

Industry Foundation Classes (IFC)

Industry Foundation Classes is an industry-wide open and neutral data format that is becoming the de-facto standard for rich data exchange. Its specification started from the vision that the STEP based integrated product model would cover all vital information about the building in its life cycle (Pazlar & Turk 2008). It was first developed by an industry consortium known as the Industry Alliance for Interoperability, formed by Autodesk in 1994. The consortium advised Autodesk on the development of routines that could support integrated application development. To assist the development of a non-proprietary standard it was renamed the International Alliance for Interoperability in 1997. The Alliance promotes IFC as a neutral product model supporting the building life cycle and membership is open to all interested parties. Following a further name change to buildingSMART International in 2005 it is now the Alliance's mission to continuously develop and maintain IFC through a standing group, the Modelling Support Group (MSG).

gbXML

buildingSMART International Alliance for Interoperability

Fig. 4.1 The gbXML and IFC logos

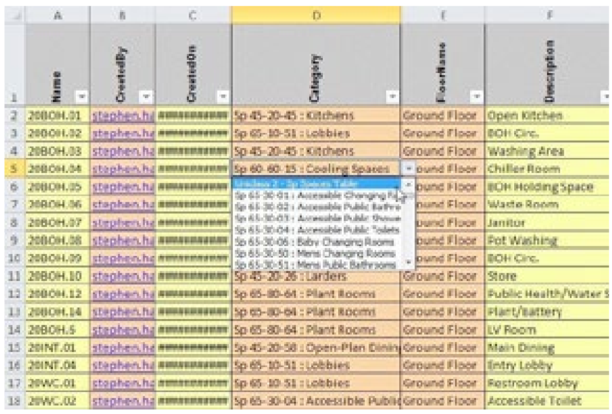
IFC is registered with ISO as a Publicly Available Specification, PAS 16739 and is not controlled or owned by any single software vendor or group. It is different from proprietary formats in that it is object focused and open; its schema is freely available on the web and can be used across various applications. IFC provides guidelines to determine what information is exchanged. It is an object-oriented data schema based on class definitions representing the objects (such as building elements, spaces, properties and shapes). IFC not only represents tangible building components such as walls and doors but also enables alphanumeric information (properties, quantities, classification, etc.) to be linked to building objects.

Fig. 4.2 Lakeside Restaurant Model Image

It is worth noting that as a schema IFC cannot provide interoperability by itself - it relies on how software packages interfacing with it. Most modern BIM authoring platforms support import and/or export of IFC model data and buildingSMART International certifies applications that comply with the standard. This flow of information is critical for collaboration and interoperability because it connects different downstream applications, for example facilities management, structural modelling and performance analysis applications.

Construction Operations Building Information Exchange

The UK government has stated that interoperability through open standards is at the core of its Construction Strategy, published in May 2011. As a client, the government is mandating data drops at key stages throughout a construction project, for which the Construction Operations Building Information Exchange (COBie) UK 2012 schema will be the required format. COBie is the formal schema for organising information about new and existing facilities, holding and transmitting it beyond handover to support ownership and operation. COBie is a simplified, non-geometric subset of IFC, which in its simplest form can be presented in an electronic worksheet. While the government promotes this standard, it deliberately does not specify the technologies that the industry should use to comply.



	A	B	C	D	E	F
1	Name	CreatedBy	CreatedOn	Category	FloorName	Description
2	20BOH.01	stephen.ha	###########	Sp 45-20-45 : Kitchens	Ground Floor	Open Kitchen
3	20BOH.02	stephen.ha	###########	Sp 65-10-51 : Lobbies	Ground Floor	BOH Circ.
4	20BOH.03	stephen.ha	###########	Sp 45-20-45 : Kitchens	Ground Floor	Washing Area
5	20BOH.04	stephen.ha	###########	Sp 60-60-15 : Cooling Spaces	ound Floor	Chiller Room
6	20BOH.05	stephen.ha	###########		ound Floor	BOH Holding Space
7	20BOH.06	stephen.ha	###########		ound Floor	Waste Room
8	20BOH.07	stephen.ha	###########		ound Floor	Janitor
9	20BOH.08	stephen.ha	###########		ound Floor	Pot Washing
10	20BOH.09	stephen.ha	###########		ound Floor	BOH Circ.
11	20BOH.10	stephen.ha	###########	Sp 45-20-26 : Larders	Ground Floor	Store
12	20BOH.12	stephen.ha	###########	Sp 65-80-64 : Plant Rooms	Ground Floor	Public Health/Water S
13	20BOH.14	stephen.ha	###########	Sp 65-80-64 : Plant Rooms	Ground Floor	Plant/Battery
14	20BOH.5	stephen.ha	###########	Sp 65-80-64 : Plant Rooms	Ground Floor	LV Room
15	20INT.01	stephen.ha	###########	Sp 45-20-58 : Open-Plan Dinin	Ground Floor	Main Dining
16	20INT.04	stephen.ha	###########	Sp 65-10-51 : Lobbies	Ground Floor	Entry Lobby
17	20WC.01	stephen.ha	###########	Sp 65-10-51 : Lobbies	Ground Floor	Restroom Lobby
18	20WC.02	stephen.ha	###########	Sp 65-30-04 : Accessible Public	Ground Floor	Accessible Toilet

Fig. 4.3 Sample COBie output

In summary, many people believe that the problems of non-collaborative 'silo working' and badly coordinated documentation will be greatly reduced through the adoption of BIM. Structured information will flow through the construction process from brief to facility management, with interoperability and open standards playing a central role.

Example of COBie Template

- **Product classification**
- **Product definition**
- **Property sets**
  - NBS National BIM Library Properties for Plasterboard Panel Partition for UK.
  - Definition from IAI: Properties common to the definition of all occurrences of IFC Wall and IFC Wall Standard Case.
  - Properties for Manufacturer Type Information.
  - Properties for UK Specification.
  - Properties for Economic Impact Values for Production.
  - Service Life.
  - Base Quantities.
  - Revit type.

Ownership (of the Template)

Fig 4.4 List of sections in COBie template for non loadbearing wall

To help start the process of data collection and structuring, the BIM Task Group has prepared more than 700 templates for a range of products and elements. These can be found at http://www.bimtaskgroup.org/cobie/

Each template is presented in five ways including Industry Foundation Class, as a spreadsheet and as web pages (HTML and XHTML). For the uninitiated the latter is the easiest from which to gain an understanding of the basics including the range of data that is needed. If a COBie template in HTML or XHTML is opened via a web browser the key features can be seen.

The full set of sections for a non loadbearing plasterboard partition is shown (Fig 4.4). Note that COBie is a non-geometric set of data, in other words there are no drawings or diagrams. Other than basic dimensions and description of shape, there is nothing about geometry or size of the object in COBie.

In the BIM National Library section there is a list of all the components of the wall and in the IFC section there is a comprehensive list of wall properties such as fire resistance, acoustic and thermal performance along with simple TRUE/FALSE data on load bearing, if it is an exterior element or extends to the ceiling of the space it is in. The manufacturer's data is short and focuses on the manufacturer's details and the product name and model number. More product data including size, shape, grade and sustainability is included in the UK Specification. Embodied impacts and Life Cycle Analysis is covered in the Economic Impact Values section along with the cost of replacement. Service life covers expected replacement periods. Base Quantities sets out the dimensional units to be defined i.e. length, height, width, areas and volumes.

Following the original set of COBie templates, additional information lists about building materials can now be found in the 'labs area' of the BIM Task Group website at http://www.bimtaskgroup.org/task-group-labs-portal/ These set out what information is needed at what stage of a project for twenty typical constructions such as lighting, walls, a bath and wood windows. The definitions comply with Uniclass2, which is the latest version of the Uniclass system developed by the Construction Project Information Committee www.cpic.org.uk

5. BIM and Facilities Management

Record BIM

By the end of the construction phase of a project, the Building Information Model will have evolved from project inception, through design, costing, performance analysis, regulatory approval and documentation and then through construction, culminating in a 'Record BIM' that is probably best prepared by the construction team. This Record BIM will describe what has actually been built, with geometries and specifications branded (where this is appropriate and practical) and assembly drawings showing actual dimensions and details rather than those in the contractual Construction BIM. Such a comprehensive description is not usually prepared at present, for either pre-BIM projects or BIM projects, though a requirement for the construction team to prepare record (or as-built) drawings is common.

Something similar could also be prepared for existing buildings, based on pre-BIM documentation, if any, and on survey work (as was done for the Sydney Opera House – CRC 2007 http://construction-innovation.info/index3ca5.html?id=53

Operational BIM

Typically, the construction team will also be required (in the Contract BIM, for example) to prepare a number of other largely text-based documents for handover from the construction phase to the occupancy phase. These include the health and safety (H&S) file (in the UK) and the operation and maintenance (O&M) manual. At present these are separate documents, not integrated with each other or with the contract documents. However, in BIM projects it is possible for these to be integrated together, which is obviously desirable because the health and safety file is mostly about H&S aspects of operation and maintenance. We might call this the 'Operational BIM'.

Integration

The Operational BIM can be integrated with the Record BIM. This makes sense because the Record BIM tells the owner what it is that needs to be operated (in a broad sense) and the Operational BIM tells the owner how it is supposed to be operated. Both need to be delivered to the organisations responsible for operating and maintaining the built project, i.e. owner-occupiers and/or tenants, so that they in turn can benefit from having access to a building information model tailored to their needs.

For both the Record and Operational BIMs, a lot of the information would currently be held outside the BIM, particularly about branded products (including warranties and guarantees). But this must be in BIM format if it is to be interrogated properly by those querying the model and it must be maintained during the occupancy phase, e.g. if an original product manufacturer is bought out by another or goes out of business, if a product line is discontinued, or if a product that was used is subject to a court case. With both these points in mind, it might make more sense if all this information was imported into the Project BIM and if someone was given the task of maintaining it for the duration of the operational phase on behalf of the owner or occupier.

We should bear in mind that at this stage the Project BIM is a large creation, so much so that it will probably exist as a collection of linked BIMs, rather than as a single model. It potentially incorporates all decisions made since the very beginning of the project. Though not all of this information is needed for the operation phase of the project, some information from early stages will need to be re-activated, particularly from the briefing phase. Construction BIM information and even Design BIM, information, may also still be needed, e.g. if there are defects and disputes about materials, products or systems. It is probably safe to say that we should not throw anything away. Instead, we need a range of filters geared to different uses, and generating different Project BIM subsets (Data Drops), including the Record and Operational BIMs.

The BIM chain should remain unbroken from project inception to the eventual demolition of the project, otherwise data will be lost, data will have to be remade and the benefits of having the complete project history in a single (or federated) BIM will not be realised.

Using the Record and Operational BIMs

The integrated Record and Operational BIM should be invaluable to building owners and occupiers – eliminating the need for surveys and supporting asset management, repairs and maintenance, alterations, extensions, changes of use and eventually demolition. It should deliver the BOOM of BIM-BAM-BOOM, which is the main reason that the UK government is so interested in BIM. The expected benefits of using BIM during the long occupancy phase are irresistible.

The UK BIM Task Group 'About the templates', published in 2012, has identified what it calls product replacement as a particular role for the operational BIM:

"Both the design and supply side of the AEC sector can benefit from the use of a common set of construction objects, classifications and property names. In particular, the UK government BIM strategy includes as a key purpose for handover information, the information needed to support the process of product replacement, specifically 'specification and selection'. Replacement includes both direct re-ordering and substitution. The critical objects, classifications and properties are those that inform this process."

This would be needed for repair work, alterations, additions and so on. Products would only be substituted where they have failed, or where they are no longer available. Products would be re-ordered where they have succeeded and are still available.

Further information about the use of BIM in Facilities Management can be found at www.thenbs.com/BIM-FM

Kingspan Insulation

Following the 2012 NBS National BIM survey, NBS predicted that the adoption of BIM would rise from 13% in 2010 to more than 50% in 2012. 78% of those who responded to the survey thought that BIM was the 'future of product information'. However, 80% of respondents felt that the construction industry is still not clear what BIM is.

With this in mind, Kingspan Insulation decided to research BIM extensively before committing to any BIM library or software format. Although it was unclear whether there was likely to be a single leading software package, what was clear was government's commitment to BIM. Government requires the use of fully collaborative three-dimensional BIM by 2016, on all projects greater than £5 million in value. The Ministry of Justice requires the use of BIM by 2013. In order to maintain Kingspan Insulation's position as a market leader it was crucial to respond and to take steps to ensure that BIM objects became widely available within the industry.

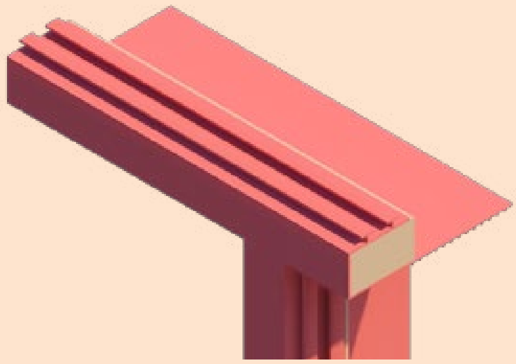


Fig. C1 Kingspan Kooltherm® Cavity Closer Plus (Close up)

Having considered the options for providing BIM objects, it was decided that the NBS National BIM Library would be the most suitable one. Kingspan Insulation has a history of working with NBS - the product range already features in the NBS Plus Specification Library, therefore BIM objects could easily be linked to the existing NBS specifications. NBS also has links with BIM groups such as buildingSMART International and the OPENBIM Network.

Kingspan Insulation's initial BIM objects were launched in four formats:

- Bentley AECOsim
- Graphisoft ArchiCAD
- Nemetschek Vectorworks
- Revit Architecture

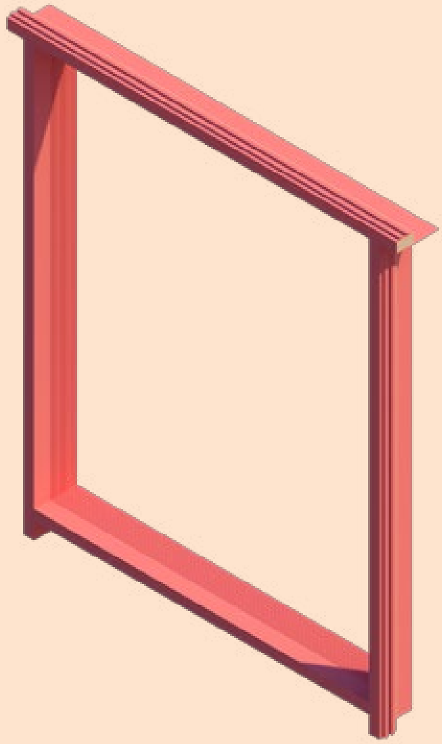


Fig. C2 Kingspan Kooltherm® Cavity Closer Plus BIM Object

The BIM objects were also made available in Industry Foundation Classes (IFC) format, in order to provide interoperability. This was key to ensuring that the objects are useable by as many organisations as possible.

Initially, Kingspan Insulation chose to provide five BIM objects:

- Kingspan Kooltherm® K3 Floorboard
- Kingspan Kooltherm® K8 Cavity Board
- Kingspan Kooltherm® K10 FM Soffit Board
- Kingspan Kooltherm® K15 Rainscreen Board
- Kingspan Thermaroof® TR27 LPC/FM

Each of these objects consists of many items of data that describe the attributes of the product (for example thermal performance). Decisions about what data to include were taken jointly with NBS, taking into account standards such as COBie.

Once the BIM objects had been created, it was important that they were tested before launch. Kingspan Insulation selected several architectural practices and main contractors who agreed to test the objects and provide feedback. The testers commented on several issues, including format, content, level of detail and file sizes.

In November 2012 Kingspan Insulation became the first manufacturer to launch BIM objects via the NBS National BIM Library. Having manufacturers' BIM objects allows not only more accurate specification, costs and quantities, but also better facilities management information for the life of the building.

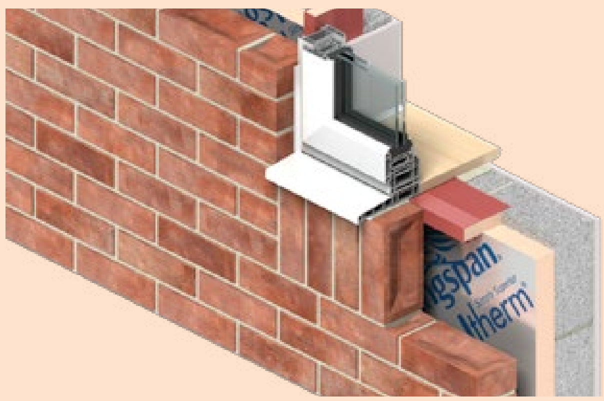


Fig. C3 Kingspan Kooltherm®K5 External Wall Board

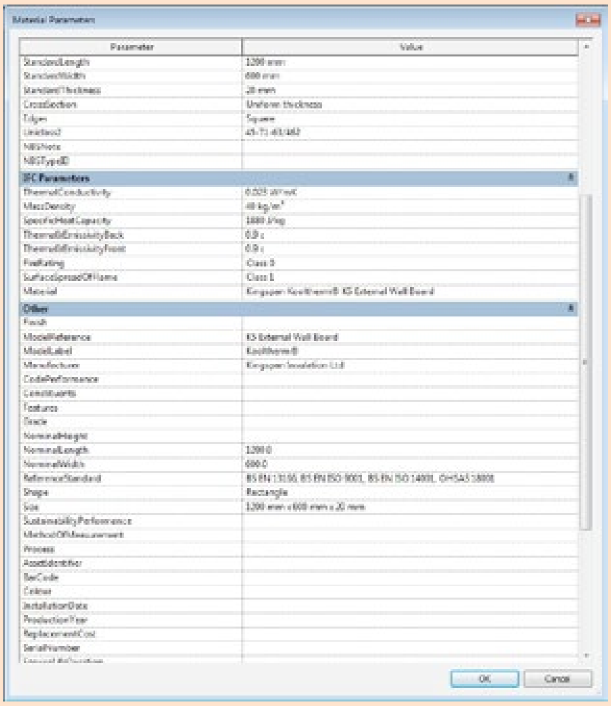


Fig. C4 Embedded Parameters

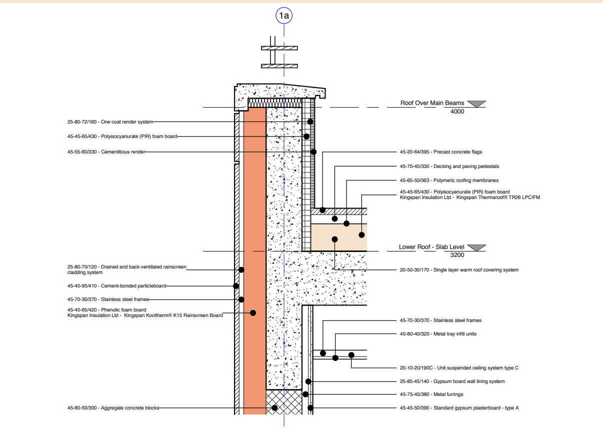


Fig. C5 Typical Roof Edge detail

With an extensive product range, Kingspan Insulation has begun its BIM journey and work is already underway to provide the whole product range as BIM objects. Kingspan Insulation is now exploring how to best use BIM with the systems that it offers, for example the Kingspan TEK® Building System and Kingspan Thermataper® LPC/FM Systems. This presents more of a challenge than creating BIM objects for individual insulation boards, however it offers much more in return, as Kingspan Insulation looks for ways to integrate BIM into manufacturing. Kingspan Insulation is also developing a BIM solution that works not just in the UK, but also in other regions, including North America, the Middle East and other countries where different software formats are favoured.

More information can be found at: www.kingspaninsulation.co.uk/BIM and www.nationalBIMlibrary.com/Kingspan-Insulation

Case Study

Glazing Vision

Glazing Vision is a UK privately owned company based in Norfolk that manufactures aluminium and glass rooflights for high end residential and commercial projects, including educational establishments, museums and art galleries. The rooflights are primarily for flat roof installations and can be fixed or opening, hinged or sliding, for natural ventilation, smoke venting or roof access. The main focus for sales is the specifier market.

Glazing Vision decided to investigate the adoption of BIM approximately 12 months ago, due to requests being received from some customers and the appearance of third party BIM of Glazing Vision products. There was concern regarding the accuracy of these models and any background data that might be included with the potential to misrepresent the product modelled. A further incentive was to receive an invitation to tender for a project where one of the conditions of tendering was that the company had to confirm that it was able to provide BIM for its products or be excluded from tendering.

We approached our CAD provider, Adris Limited, an Autodesk Partner, who was very supportive and prepared to spend time explaining BIM, how it related to manufacturers, the level of detail we should be planning to include and good reasons to make the investment now. They were looking to make a sale, but all our subsequent knowledge gained, backed up what we were told. Because Adris Limited supplies a number of different types of business in the construction supply chain they were able to present a balanced perspective.

All product development and project specific design was already being done in 3D using Autodesk Inventor to generate models and produce manufacturing drawings, so making the transition to BIM was not such a big leap as it might be for someone still designing in 2D. As an existing user of Autodesk products it was a logical step to install Revit to produce and support BIM product families. This was installed on an existing workstation alongside the Inventor software and the operator received one day's introductory training from which they were able to start producing models. This was based on an operator that was already fully versed in designing in a 3D environment. The first models generated were sent to the Revit provider for test and advise on how they might be improved, the Autodesk partner has proved very supportive during this process.

There is a great temptation to provide a fully detailed CAD model and it took a new mindset to remember that for BIM the visual CAD image has to be just a representative of the product, but it is the accuracy of the data built into the model that is all important. A complex, detailed CAD image of an individual product, as might be produced for manufacture, will soon make a building model falter, due to the final model file size once all the products have been added. The key is to keep the model simple. Glazing Vision is now in the process of gradually building their model library to cover the whole range. The first model produced was the simplest product; the fixed Flushglaze Rooflight. This model includes the upstand and hole in the centre, so that when the designer places the model in the building it automatically cuts the hole in the roof and places the correct upstand required. The model is parametric so the designer can type in the size of rooflight required and it adjusts accordingly. The product limits are built into the model so that the designer cannot place a rooflight that cannot be supplied or a size can be selected from a list of standard stock sizes available. Once a size is set the U-value and product weight is provided in the properties. There are also hyperlinks to web pages for the product data sheets, installation, operation and maintenance manuals, 2D installation drawings and an enquiry page to request a quotation.

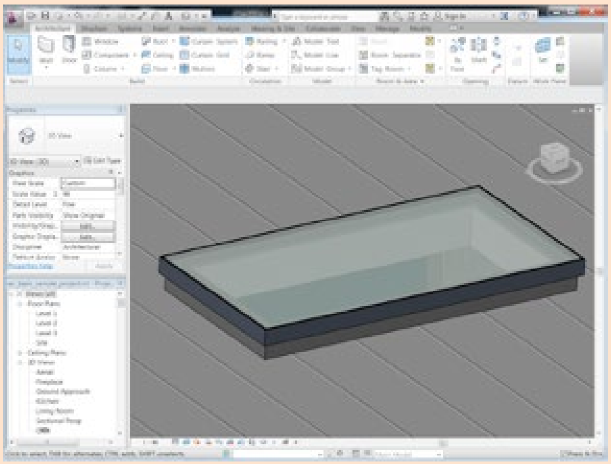


Fig. C6 Flushglaze main image

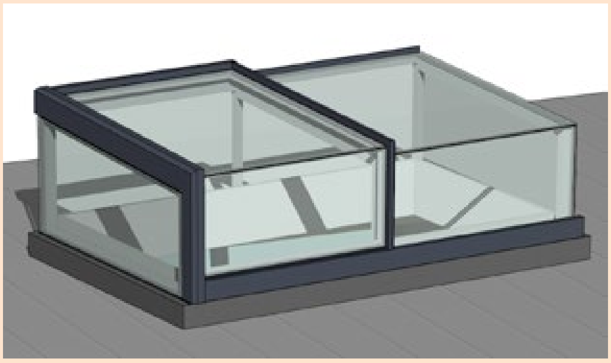


Fig. C7 Box Rooflight Revit

Fig. C8 Box Rooflight Installed

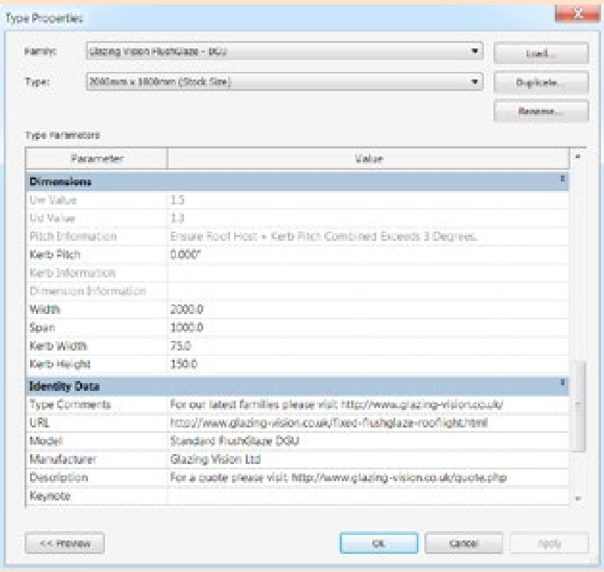


Fig. C9 Properties box standalone

The BIM are available for downloading from the Glazing Vision product pages of their website and also the Building Centre's specifinder.com website. One of the staff members in the product support department has been earmarked to be the BIM expert and is gradually extending the range of products for which BIM are available. The current intention is also to provide bespoke models on a request basis for individual projects, but this will be monitored to see if this is sustainable, depending on how demand develops.

Glazing Vision has focused on the Revit platform on the basis that it fits with the Autodesk products already in use and that advice seems to be that this is the most widely used platform. However, providing BIM suitable for other platforms and to suit BIM use in the rest of Europe and North America, is still an issue that needs to be addressed, but these priorities are likely to be guided by future demand.

Demand for BIM is slowly taking off and there have been one or two key projects where it seems to have been essential. The adoption of BIM will be a gradual process, as many smaller architects practices are showing no interest as yet, but Glazing Vision expects this to escalate and to see BIM as an investment for the future and to maintain its position as a market leader.

Kalzip

Kalzip manufactures metal standing-seam roof and wall cladding systems for buildings. Kalzip systems can accommodate complex geometries and have been used in iconic projects such as the Lord Sefton and Earl of Derby stands at Aintree racecourse, (Fig. C10) home of The Grand National, Snowdon Summit visitor centre and many airport terminals, railway stations, sports stadia and retail centres, worldwide.

Fig. C10 Aintree Racecourse

Kalzip works closely with major construction contractors who perceive BIM as the key to delivering design certainty, quality assurance, improved coordination and sequencing, reduced risk and better understanding of project complexities. The two main drivers of Kalzip's commitment to BIM have been:

- Increasing the organisation's capability for involvement with design activity for major projects
- Providing another marketing platform for the organisation's products and systems by providing information in a range of formats hosted by third-parties such as the NBS National BIM Library

Kalzip sees the three-dimensional modelling that is an integral part of BIM as critical to its ability to support innovative architectural designs incorporating complex geometries and advanced off-site construction methods.

Fig. C11 Concept image of Newport Station

Kalzip has approached BIM in four stages:

1 An initial BIM trial, for familiarisation

2 Provision of BIM objects via the Kalzip website http://www.kalzip.com/kalzip/uk/technical/technical_bim.html and the NBS National BIM library sites http://www.nationalbimlibrary.com/kalzip These models are free to download and contain basic information on various systems, as well as links to other literature, product approvals and certification

3 Provision of design advice supported by project-specific modification of standard Kalzip BIMs

4 Full BIM-based collaborative design and delivery, involving Kalzip's design department as an integral part of the project team

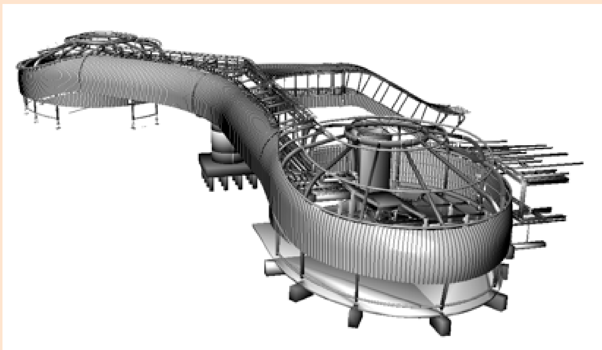


Fig. C12 3D model showing Kalzip seams

Kalzip has been using BIM techniques, especially shared three-dimensional modelling, for several years (Figs. C11/12/15) and now include detailed information in its standard models. At stage 1 the organisation identified 'families' of specifications that are most likely to be required in a format compatible with BIM. (Fig. C13) shows a typical Kalzip roof construction with it's corresponding BIM family shown in (Fig. C14).

Kalzip has converted these families of specifications into a series of volumetric models in formats including Revit and IFC. The Revit versions can be downloaded from www.kalzip.com, with other formats available on the NBS BIM National Library. A range of product information is embedded into these models, including:

- Two-dimensional system build-up
- Hygrothermal performance
- Acoustic performance
- Structural performance
- Fire performance
- COSHH documentation
- BBA documentation
- Product literature
- NBS format specification

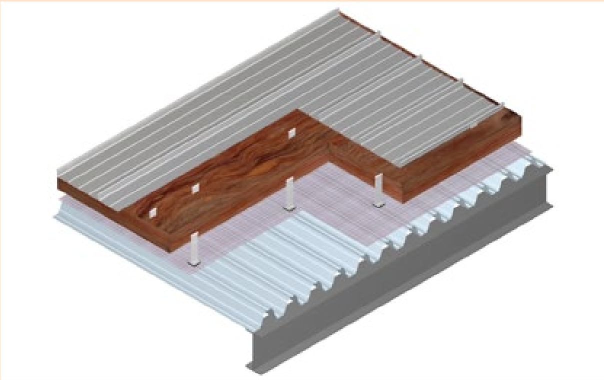


Fig. C13 Kalzip Deck Roof System - Isometric

Construction	
Structure	Edit...
Default Thickness	385.0
Graphics	
Coarse Scale Fill Pattern	
Coarse Scale Fill Color	Black
Materials and Finishes	
Kalzip Profile	0.9 mm Aluminium Kalzip 65/400
Kalzip Clip	E 180 Clips + S10 Spacer
Kalzip Insulation	200 mm Kalzip Insulation Plus - 40 Compressed to 190 mm
Kalzip VCL	Kalzip VCL Foil
Kalzip Top-hat	30 mm deep x 2 mm Aluminium Top-hat Profile Sub-Purlin
Kalzip Acoustic Slab	30 mm Kalzip Acoustic Slab TF
Kalzip Internal Profile	1.0 mm Web Perforated Steel Kalzip Structural Deck KSD [illegible]
Identity Data	
Keynote	H31
Model	KAL-HH-U-20
Manufacturer	Kalzip Ltd.
Type Comments	Kalzip Acoustic Deck Roof System
URL	www.kalzip.com
Description	Kalzip 0.20 High Humidity Deck Roof System
Assembly Description	
Assembly Code	
Type Mark	
Cost	
Kalzip UK Website	www.kalzip.com/kalzip/uk/home
Kalzip UK Systems Brochure	www.kalzip.com/PDF/uk/Kalzip-Systems.pdf
NBS Format Specification	www.kalzip.com/files/CAD/uk/bim/H%20Kalzip%20Acoustic%20Deck%20R
Kalzip BIM User Guide	www.kalzip.com/PDF/uk/bim/kalzip%20-%20system%20family%20user%
Data	
U-value (W/m2K) - 1.000 m Clip Centres	0.19
U-value (W/m2K) - 2.000 m Clip Centres	0.18
Building Humidity Class	Upto 5 (very high)
Acoustics - Sound Reduction Index, Rw value (dB)	39
Acoustics - Sound Absorbtion Class	D
Maximum Wind Suction Load (kN/m2) - 1.000 m Clip Centres	[illegible]
Maximum Wind Suction Load (kN/m2) - 2.000 m Clip Centres	[illegible]
Maximum Snow Load (kN/m2) - 1.000 m Clip Centres	4.81
Maximum Snow Load (kN/m2) - 2.000 m Clip Centres	2.39
Fire - External Surface Spread of Flame	AA/BROOF (t4)
Fire - Internal Surface Spread of Flame	Class [illegible]

Fig. C14 Kalzip Deck Roof System - BIM family

The volumetric models indicate construction depth and can be inserted into master models, but they do not offer a great deal of detail. They are suitable for standard projects, but more complex geometries require more specific input. The models do not currently include information on programme, photographs or guarantees. They can be used for clash detection, but cannot yet confirm whether the supporting structure is suitable for the roof. Parametric modelling, detailing and project specific data output from the standard models are also being developed.

Kalzip's design team can also provide fully detailed roof element BIM objects, in Revit, to be included in a project BIM. In time this will be extended to other formats. The project BIM can then be used for clash detection, lighting studies and walk-throughs, to provide greater design certainty and improved cost analysis.

Kalzip's BIM offer for off-site construction projects includes development of a bespoke project model, once a project's technical requirements have been established. Once the model is complete, the following can be obtained automatically:

- Architectural drawings, including plans, details and sections
- Manufacturing assembly drawings including plans, details and sections
- Bill of materials for procurement
- Component fabrication drawings

The model also allows updates at architectural drawing level to cascade automatically through other drawing sets. Two-dimensional drawings can be produced from the solid model and because they are taken from the same central set of information and only one set of drawings is created, contractors' tender costs should be reduced.

Installation methodology can be included, and in time Kalzip hopes to work with the supply chain to add a programme that models and specifies the installation sequence. This may be added to the project BIM after the design stage, when a contractor has been appointed.

Fig. C15 Newport Station

Glossary

Building Information Modelling
(BIM) A process for managing the information produced during a construction project, in common format, from the earliest feasibility stages through design, construction, operation and finally demolition.

Building Information Model
A representation of a building project in BIM format, usually consisting of a three-dimensional model integrated with a database about materials, products, components, systems and their properties and performance.

BIM object
An element of a building modelled in BIM format.

BIM platform
A software system that supports BIM.

BIM Task Group
A working group set up by the UK government to implement BIM in construction, with cross-industry representation.

buildingSMART International
The organisation that develops, maintains and promotes Industry Foundation Classes (IFC) as a neutral common data standard for BIM.

CAD
Computer aided design.

CADD
Computer aided design and drafting.

Construction BIM
The BIM of a project that contains the information required for construction.

Contract BIM
The BIM of a project that forms part of the building contract documentation (usually very similar to the Construction BIM).

Construction Operations Building information exchange (COBie)
A standard format for organising, holding and transmitting information about new and existing buildings through the handover process, to support their operation; COBie is a non-geometric subset of IFC.

Construction Products Association
The trade association representing manufacturers and suppliers of construction products in the UK and joint author of this publication.

COBie UK 2012
The UK government's required format for BIM data drops, from 2016.

Data Drop
Transmission of a package of building data from a BIM to a developer, contractor, regulator or user.

Design BIM
The BIM of a project that supports the development of the design.

Green Building XML (gbXML)
An open scheme developed to facilitate the transfer of information about a building from a BIM to engineering analysis tools.

Industry Alliance for Interoperability
An industry consortium formed in 1994 by Autodesk to advise on software development for BIM; subsequently renamed the International Alliance for Operability and then buildingSMART International.

Industry Foundation Classes (IFC)
An industry-wide open and neutral data format that is becoming the de-facto standard for exchange of BIM data.

Interoperability
The ability of BIM software to transmit and receive data from other BIM software, through the use of commonly agreed data standards such as gbXML and IFC.

Modelling Support Group (MSG)
A standing working group of buildingSMART International that is tasked with development and maintenance of Industry Foundation Classes.

Multi-format BIM object
A BIM object that embraces more than one data format, e.g. three-dimensional geometrical information about a product combined with its technical properties.

NBS
The organisation that has developed and maintains the National Building Specification in the UK, and the NBS National BIM Library.

Operational BIM
The BIM of a building that supports its operation and maintenance, after it has been handed over to the occupant.

Project BIM
A collective term for the series of linked BIMs (Design, Construction, Record, Operation, etc.) that may be associated with a project.

Publicly Available Specification (PAS)
A published specification for common use, usually developed with industry support by the International Standards Organisation (ISO) or a national standards body such as BSI.

Record BIM
The BIM that records a building as it was built.

Standard for Exchange of Products (STEP)
An open computer modelling standard for the industrial and manufacturing industries, developed by the International Standards organisation during the 1980s.

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Open Green Building XML Schema: a Building Information Solution for Our Green World http://www.gbxml.org/

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