

AS10789

## From CAD Monkey to BIMpanzee: The Evolution of Design Technology at BDP

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### Learning Objectives

- Understand the approach of a multi-disciplinary practice to meet UK BIM 'Level 2' and the efficiencies achieved.
- Organise and manage large project teams through company standards and best practice.
- Use Autodesk products as a tool for commenting and improved communication to enhance design.
- Link modelled objects to external databases and see the opportunities that brings for Design, Construction and Operation.

### Description

Since the UK Government Level 2 BIM mandate, BDP has actively pursued greater BIM adoption centred on Autodesk software and the emerging British Standards. In autumn 2014 BDP became the first UK business to achieve BIM 'Level 2' certification. This class aims to reveal workflows adopted by BDP in a multi-disciplinary approach to address this mandate, enabled using BIM technologies. In a critical analysis of a £330m project, we will divulge the BDP BIM toolbox from inception to construction (with a tested strategy for FM), highlighting how the process has evolved over the past decade, proven efficiencies and further development priorities to deliver a better product for our clients.

### Your AU Experts

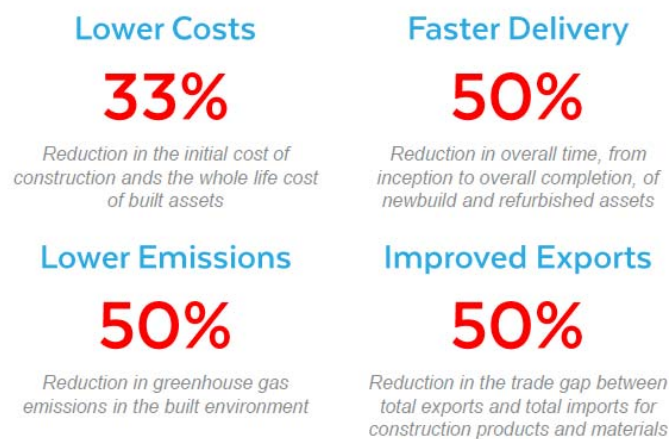
*Elliott Crossley – Associate, BDP (London). The Project Technology Group BDP research, develop and implement new technologies within the multi-disciplinary practice, moving the business forward through innovation and good practice. Instrumental in writing and policing practice standards, the group also supports BDP projects & staff through training, IT & infrastructure needs. They act as BIM managers for their respective offices and manage the application of technology on all projects. Elliott is a Chartered Architectural Technologist, having worked at BDP since 2009.*



## Compounding Efficiency

### UK Government Drivers for BIM

In 2011, the UK Government set out its strategy to develop a more sustainable construction industry, recognizing the inefficiencies in current workflows and processes from inception, through design, construction, operation and demolition. A later document set out specific targets the industry should strive to achieve by 2025 and Building Information Modeling (BIM) plays a key part in our ability to achieve these goals, acting as a vehicle to ensure communication and collaboration is fostered at its most effective.



There has been a suite of documents produced in the UK, collectively forming a good practice guide to delivering a streamlined construction project (likely to become British Standards in due course), and which have been termed the 'foundations of BIM Level 2'. It is recommended that all design professionals read and understand the implications of each:

- **BS1192:2007** – British Standard for the Collaborative Production of Information
- **PAS 1192-2:2013** – Information Management for the Delivery Phase
- **PAS 1192-3:2013** – Information Management for the Operational Phase
- **BS 1192-4:2014** – Information Exchange using COBie
- **PAS 1192-5:2015** – Security Minded Building Information Modelling
- **The BIM Protocol** – Construction Industry Council
- **Government Soft Landings (GSL)** - formerly BSRIA Soft Landings Framework and related documents
- **The NBS BIM Toolkit** – Information Delivery Requirements and Verification Tools

## Collaborative Working Environments

### BDP Drivers for BIM

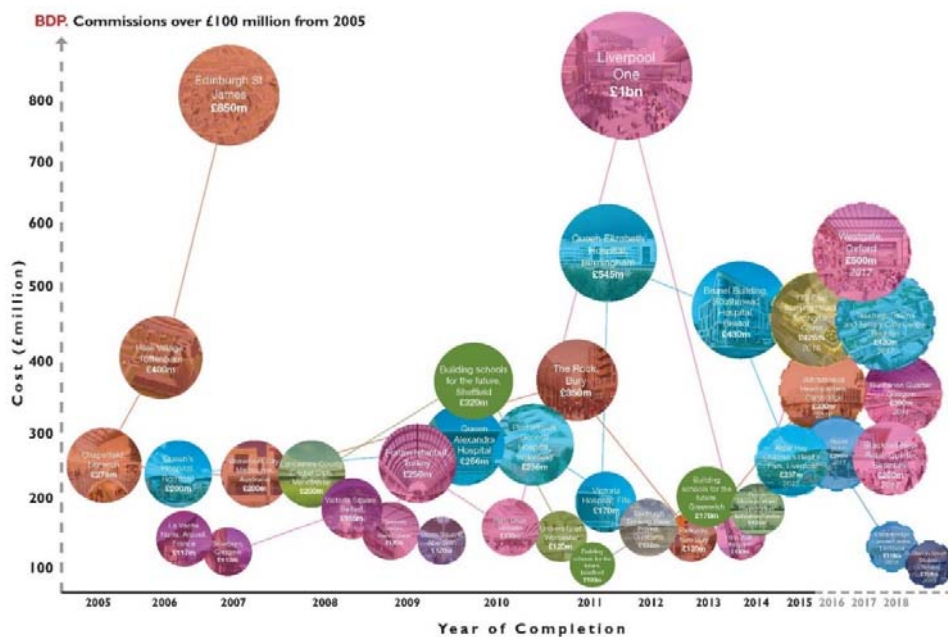
As an inter-disciplinary practice, BDP have worked with a number of professional bodies to develop key documents in an attempt to standardise work stages and processes, namely the RIBA Plan of Work, BSRIA BG6 Framework and, more recently, the NBS BIM Toolkit (also referred to as the Digital Plan of Work). In addition, BDP were the first organization to receive BIM Level 2 compliance, a certification scheme offered by the Building Research Establishment (BRE).

With Architects, Civil & Structural Engineers, Building Services Engineers, Landscape Architects, Acoustics, Lighting, Sustainability, Interior & Graphic Designers, Planners, Urbanists and Project Managers all within the BDP team, in studios spread across the world, the entire ethos is centered around collaboration and, by working with standard processes across all professions, BDP are able to deliver projects with much more consistency.

In the early part of the Millennium innovation progressed, as it naturally does, in pockets across the business with limited structure or standards. The Glasgow Science Museum, shown below, won a Bentley Award for BIM in 2003, being one of BDP's early projects to use computation to generate form in a 3D environment.



Through the next 5 years, the construction industry in the UK was prolific, the chart below demonstrating 38 projects above £100m delivered by BDP since 2005. Large healthcare schemes were carried out using Bentley Microstation linked to external databases to manage fixed furniture and equipment (FF&E), while other projects tested Revit as a production tool. Ultimately, in 2011, BDP took the decision to use Revit as the standard platform for project delivery.



### Information Management Systems

Being able to connect 800+ staff became priority in creating best practice documents, and BDP implemented a number of tools to facilitate this, over and above the existing IT support.

In addition to local intranet, internal forums and 'Bytesize' training material, BDP deployed Newforma as its standard information management system, giving staff the ability to search companywide for information, precedents & QA procedures (<http://www.newforma.co.uk/>). Newforma has since emerged as an essential tool to allow BDP to deliver Level 2 BIM.

From the knowledge shared in these ways across the business, BDP were able to publish Standards for Revit, BIM Execution Plan and a Guide for Content Creation. Continually reviewed and updated, these form part of the 'BDP Design Process' for project guidance & governance.

## Recruitment & Basic Training

A considered training strategy is also important when rolling out new software or processes. BDP worked with Global eTraining (<http://www.globaletraining.ca/>) to provide basic training for its core software platforms. KnowledgeSmart (<https://www.knowledgesmart.net/>) was also introduced for both recruitment and ongoing skills assessment for all staff. This allows targeted training for individuals, and training records to ensure consistent improvement.



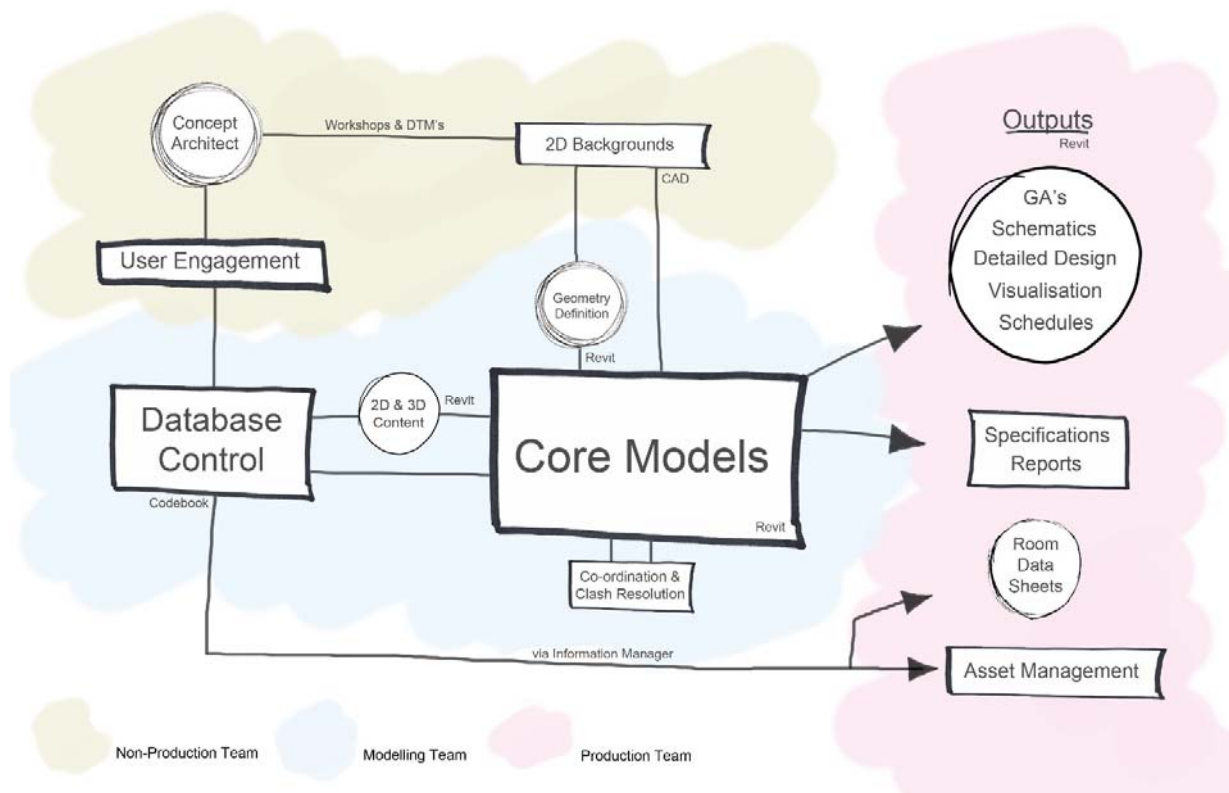
## Practical Application of BIM - Stage 1: Preparation

### More Collaborative Working Environments

Employers Information Requirements (EIR) - At project inception, it's important to meet with both the author of the EIR document, but also the Facilities Management team, Project Management, Design Consultants and all other key stakeholders involved to make sure the drivers for BIM on the project are clearly defined.

BIM Execution Plan (BEP) – Developing the deliverables from the EIR into a BIM Execution Plan can take time, and should be revisited at the end of each project stage. This document should continually evolve until handover.

Preparation & Planning – Mapping out how the design team will interact is also an important task during the preparation Stage to communicate expectation with the wider team. At this point, ideas around file splits, file formats and software versions should all be agreed. The map below shows how one project envisaged working with an external concept architect, with 2D backgrounds forming the basis to develop a Revit model, and how the user engagement process would allow the capture of project data to an external database, linked to the Revit models.

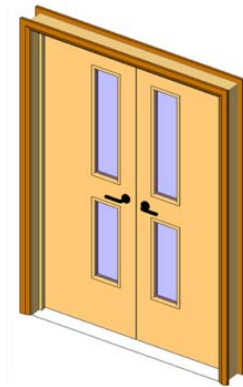


## Level of Detail

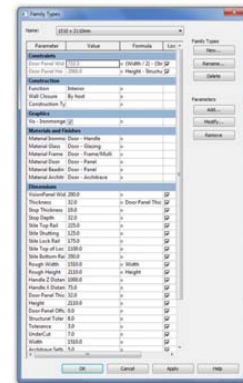
Level of detail (LOD) is another important discussion that should be had at Preparation Stage, to clarify project deliverables and responsibility. As a minimum, it is necessary to complete the typical LOD matrix at the back of the CIC BIM protocol, although I would urge a more detailed breakdown by built element to be included as part of the BIM Execution Plan, or Project Implementation Plan (PIP).

In order to do so, BDP recently helped deliver the NBS BIM Toolkit, or Digital Plan of Work (<https://toolkit.thenbs.com/>). This is a free to use tool to help define, manage & validate responsibility for information development and delivery at each project stage, and provides a mechanism to meet UK Level 2 BIM requirements.

### LOD Graphical / Geometric Definition



### LOI Information associated with objects

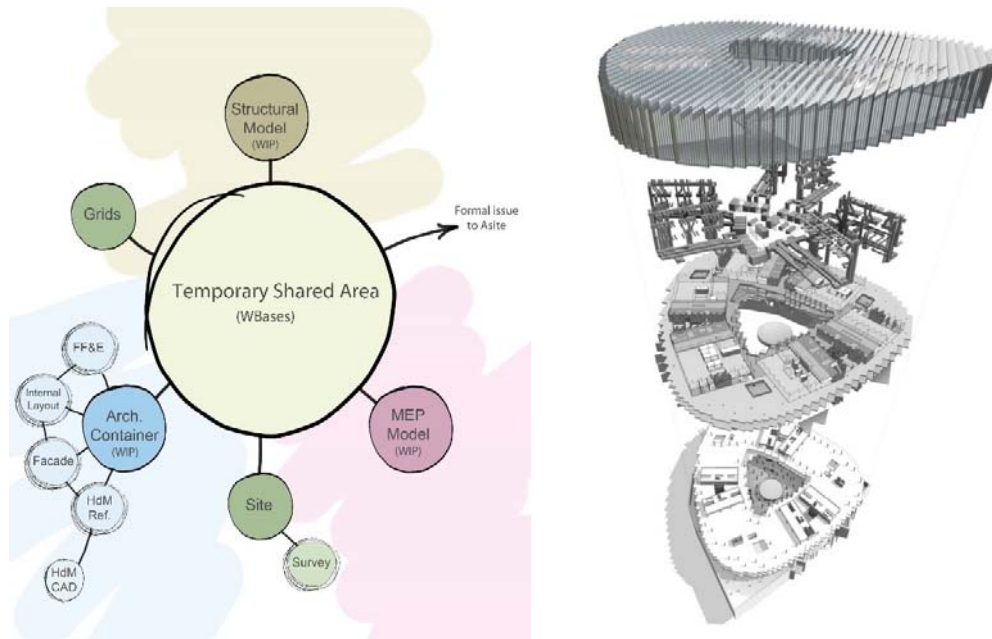




## Practical Application of BIM - Stage 2: Concept Design

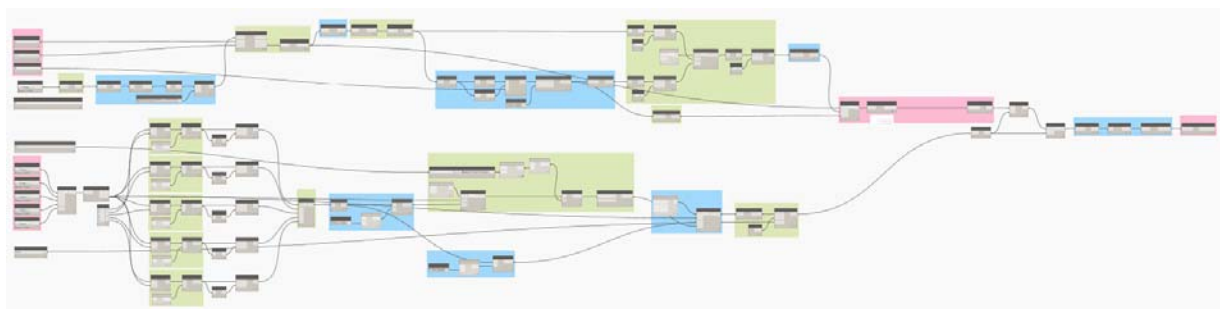
### Re-Plan & Test

At concept stage, it's important to re-validate the processes agreed in Stage 1, in particular, testing that file formats work as intended, and that all models are to correct origin and orientation.



### Computational Design

The concept design stage is inherently inefficient, as a variety of schemes are tested against a project brief, but data driven design is increasingly common place today and software such as Dynamo for Revit, Grasshopper for Rhino, or Generative Components for Microstation provide a flexibility that previously didn't exist. BDP also use similar tools at later Workstage in order to extract, edit and transfer data between different platforms.





## Revit for Communication

Working on a project with an external Concept Architect, a solution was developed within Revit to comment on models. Commenting on information is traditionally done in either the 2D or 3D environment – i.e. hand/electronic mark-up of 2D drawings, or 3D commenting using a tool like Navisworks. Whilst in some ways rudimentary, it's possible to use a 3D family (and model text) with added data to carry out a similar task within the Revit environment. The family, outlined below, can be placed in a standalone 'Revit Comments' file and provides a schedule of the comments, a quick reference to the 3D model (via the 'Highlight in Model' tool) and a 2D drawing output for archive purposes. A simple solution, but a good way to integrate staff to Revit.

VISIBILITY: LEFT REVISION

Revision Discipline    Revision Date

Revision ID ..... 00001 MEP    XYZ 140514

Revision Status ..... PENDING FEEDBACK XYZ

Revision Comment ..... CLASH X WITH Y

VISIBILITY: RIGHT REVISION

00001 MEP    XYZ 140514

PENDING FEEDBACK XYZ

CLASH X WITH Y

Parameter Values input in Family Properties.

Category	Parameter	Value
Constraints	Level	BASEMENT 1
	Host	Level: BASEMENT 1
	Offset	1500.00
	Moves With Nearby Elements	<input type="checkbox"/>
Graphics	3D-ANNO-TEXT-POS-RIGHT	<input checked="" type="checkbox"/>
	3D-ANNO-TEXT-POS-LEFT	<input type="checkbox"/>
	3D-ANNO-DGT_SIZE	150.00
Text	3D-ANNO-SOLVED_BY	JBR
	3D-ANNO-RECEIVED	HGM
	3D-ANNO-PRIORITY	HGM
	3D-ANNO-NOTE	140514 solved
	3D-ANNO-INITIALS	JBR
	3D-ANNO-ID	00153
	3D-ANNO-DISCIPLINE	STR
	3D-ANNO-CREATION DATE	140603
	3D-ANNO-COMMENT	ADD COLUMN acc. to BH
	3D-ANNO-STATUS	SOLVED
Dimensions	NOTE-SPHERE-SIZE	150.00
	Volume	0.024 m³
Identity/Data	Comments	
	Mark	
	Workset	8_ANNOTATION
	Edited by	
Phasing	Phase Created	New Construction

Some Samples:

00123 STR    AXV 140528

TASK ASSIGNED

MOVE COLUMN acc. to BH

00125 STR    AXV 140528

SOLVED

ADD COLUMN acc. to BH

00018 MEP    FRB 140518

CLASH TO REVIEW

CLASH ELEC. - COURTYARD

Schedule: SCH\_REQUEST-CLASH\_ANNO\_ALL

A	B	C	D	E	F
LEVEL	ID	3D-ANNO	3D-ANNO-COMMENT	DATE	AUTHOR
BASEMENT 1	00030	STR	NOT ALIGN WITH ARC	140520	JBR
BASEMENT 1	00031	STR	NOT ALIGN WITH ARC	140520	JBR
BASEMENT 1	00032	STR	NOT ALIGN WITH ARC	140520	JBR
BASEMENT 1	00033	STR	NOT ALIGN WITH ARC	140520	JBR
BASEMENT 1	01105	MEP	REVIEW ICT	140520	JBR
BASEMENT 1	01106	MEP	REVIEW ICT	140523	JBR
BASEMENT 1	01107	MEP	REVIEW ICT	140520	JBR
BASEMENT 1	00228	STR	NOT ALIGN WITH ARC	140610	JBR
BASEMENT 1	00024	STR	NOT ALIGN WITH ARC	140520	JBR
BASEMENT 1	00025	STR	NOT ALIGN WITH ARC	140520	JBR
BASEMENT 1	00027	STR	NOT ALIGN WITH ARC	140520	JBR
BASEMENT 1	00026	STR	ADD STR WALL acc. to BH	140520	JBR
BASEMENT 1	00028	STR	REMOVE STR WALL	140520	JBR
BASEMENT 1	00063	STR	REMOVE STR COLUMN	140521	JBR
BASEMENT 1	00064	STR	NOT ALIGN WITH ARC	140521	JBR
BASEMENT 1	00065	STR	MOVE COLUMN acc. to BH	140521	JBR
BASEMENT 1	00066	STR	ADD STR WALL WIDTH acc. to BH	140521	JBR
BASEMENT 1	00068	STR	NEW STR WALL acc. to BH	140521	JBR
BASEMENT 1	00069	STR	NEW STR WALL acc. to BH	140521	JBR
BASEMENT 1	00070	STR	NOT ALIGN WITH ARC	140521	JBR
BASEMENT 1	00071	STR	MOVE COLUMN acc. to BH	140521	JBR
BASEMENT 1	00072	STR	MOVE COLUMN acc. to BH	140521	JBR

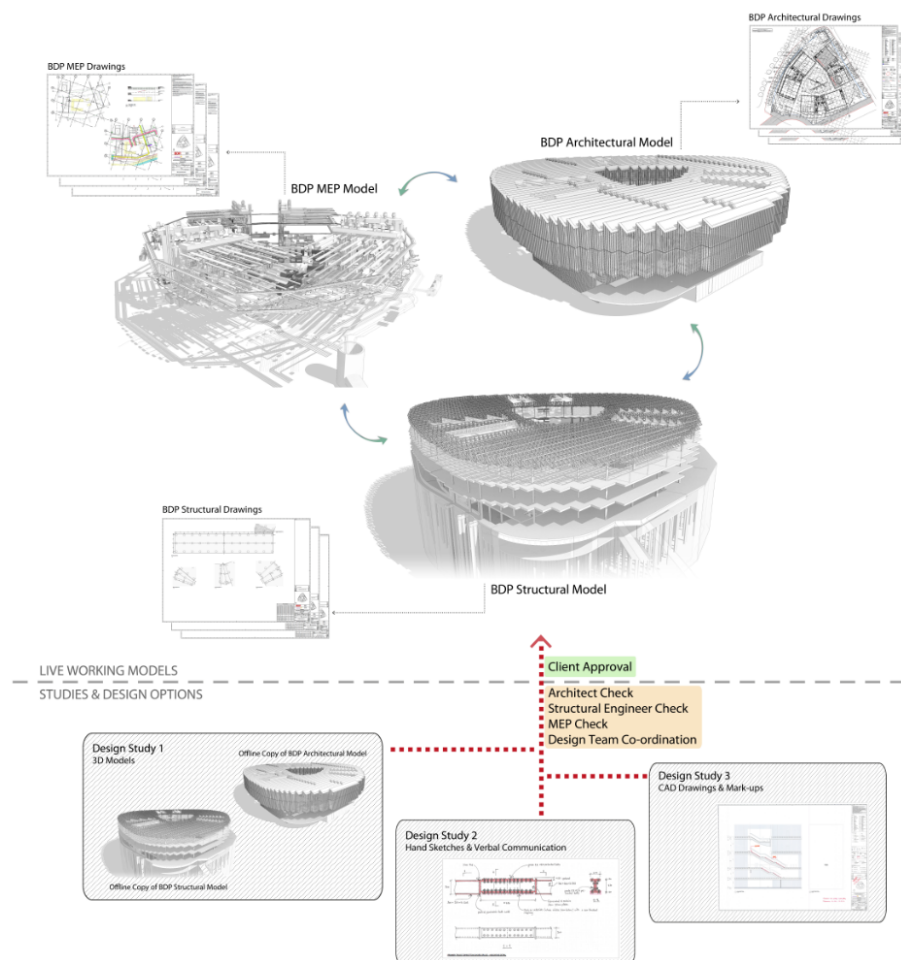
3D View (3D - s.j.menez)

## Practical Application of BIM - Stage 3: Developed Design

### Study Models

In the spirit of having a single building model, there is a temptation to carry out 'options' within that same model, which can prove problematic. All design studies should be carried out in an 'offline' environment until the implications of that change (be it for aesthetic reasons, to reduce cost, or solve co-ordination issues) have been fully explored, and signed off by the instructing authority.

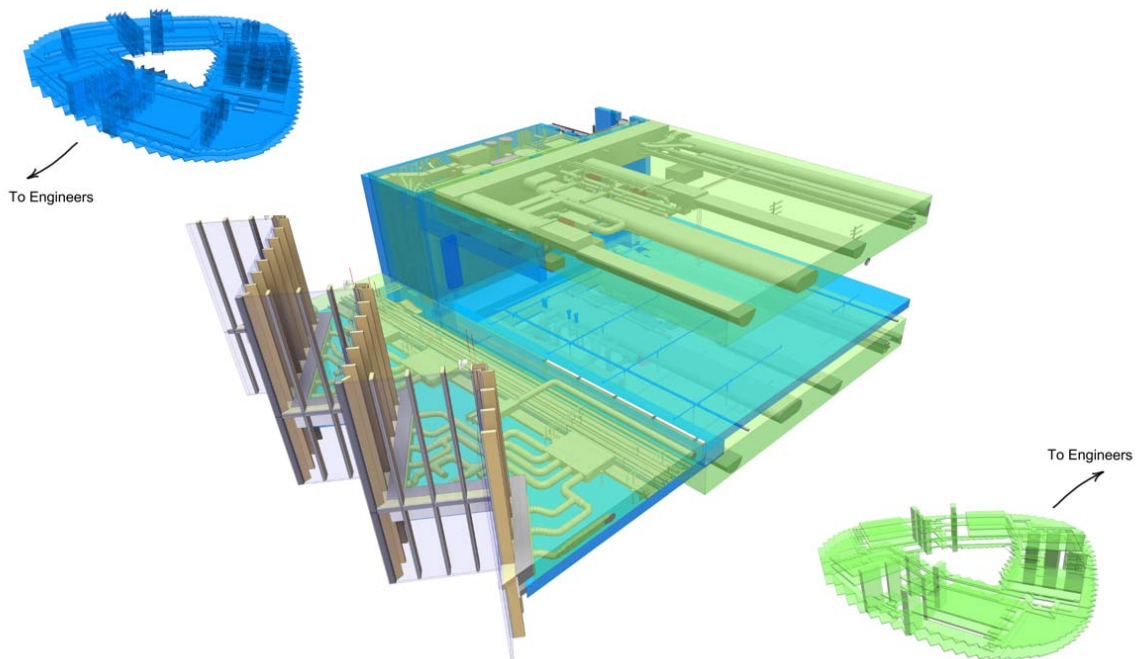
The diagram below shows how such studies may be explored, by taking offline copies of 3D models, working in 2D CAD, or sketching ideas by hand. Either way, the result should be communicated with the wider project team & passed through the approval gateway *before* finding its ways into the 'live' environment.



## Zoning Models

Where major change occurs in a project, it may mean full re-design of large parts of the scheme, and not normally limited to one profession. The concept of 'zoning models' is to create a model to outline a space within which another profession should be contained. For example, the Architects may decide to develop a Structural Zoning Model (Blue in image below) and a separate MEP Zoning Model (Green).

This allows architects to progress with their studies, allocating space for other professions, without necessarily having to wait for other consultants to progress their design in parallel. Of course this workflow should not detract emphasis from close collaboration and information exchange between professions and, conversely, provides a quick method to validate that structure/services fall within the zone provided.



## Revit Issues

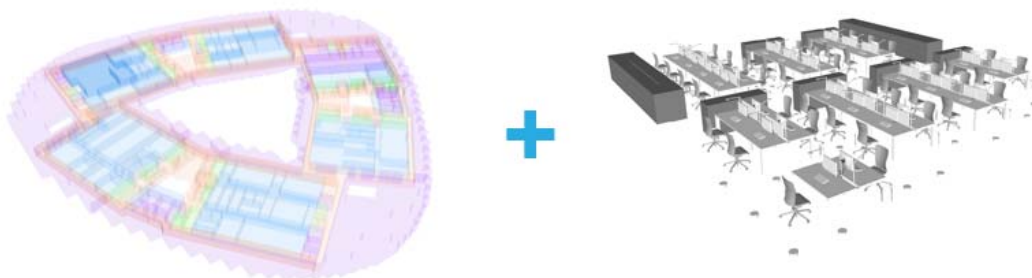
### The Problem with...Linked Files

On projects with a large number of Revit project files, it is not uncommon to split internal walls from fixed furniture & equipment (FF&E). This may result in the 'room' objects being held in a separate file from FF&E. This being the case, Revit is currently unable to schedule the FF&E *by room*. Working in the FF&E project file, we are able to schedule the equipment, and separately schedule the rooms ('include linked files'), but not join the two together.

Without the ability to select an object in the 3D environment and see the room to which it belongs as a parameter stamped onto that object, the geometric 3D model has little use to many facilities managers.

Whilst certainly not ideal, current workarounds for this include:

- 1) Copy/paste 'Room' objects into all other Revit project files in order for Revit to schedule elements 'by room'.
- 2) Use an external application to Schedule elements, and push the 'In Room' property back to the Revit elements as a new parameter.



Qty	Code	Description	--	Group
17	CHT102	CHAIR; task; adjustable arms		84
2	DSK122	DESK; double; 6 Person; 4800mm (width) x 1600mm (depth) x 730mm (height)		84
1	DSK110	DESK; Single Bench; 1 Person; 1600x800mm		84
1	DSK119	DESK; single side; 4 Person; 6400mm (width) x 800mm (depth) x 730mm (height)		84
17	ACO122	LIGHT; task; desk clamp		84
17	ACO110	MONITOR ARM; clamp; single		84
17	ACO125	MONITOR; with keyboard; desktop		84
17	WST104	WASTE BIN; office desk		84
7	SLO130	STORAGE; 1 unit (3 linear metres); 3 draws		85
1	SCO130	STORAGE; coat		85
17	STP100	STORAGE; pedestal		85

## The Problem with...Revit Families

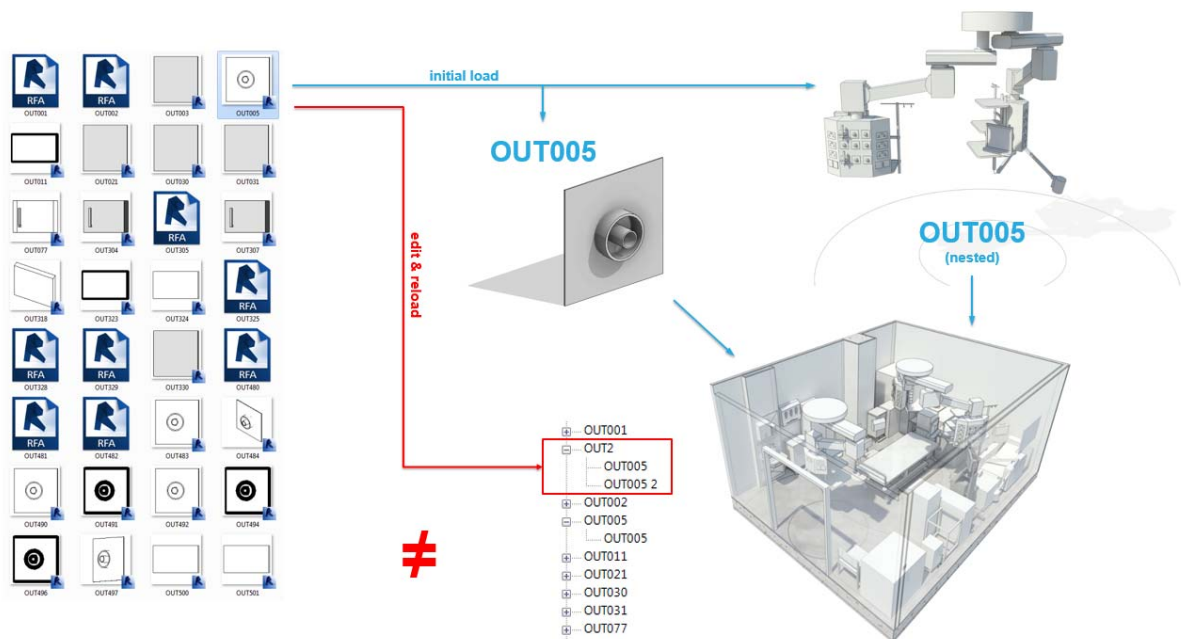
This one is a little peculiar and needs to be fixed – first experienced in 2010, and is yet to be resolved in 2015. Unlike other building design software, Revit does not reference back to an external component library. Once a family is loaded into the project, it then exists as its own entity.

The diagram below shows that an item named 'OUT005' in the BDP library is loaded directly to a Revit project, and also nested into another family (referred to as a 'union'), which is loaded into the same project (the blue arrows).

Now, if we were to edit the original library element, we need to load the family back into the project to update it. Revit obviously cannot overwrite the version that is nested in the 'union', so usually will throw an error to say so. But sometimes, Revit continues to load the family, and simply *renames* it to get around the problem, without informing the user.

In the image, Revit has changed the name of the family from 'OUT005' to 'OUT2' when loaded into the project and, as the image shows, can also do the same with the family types.

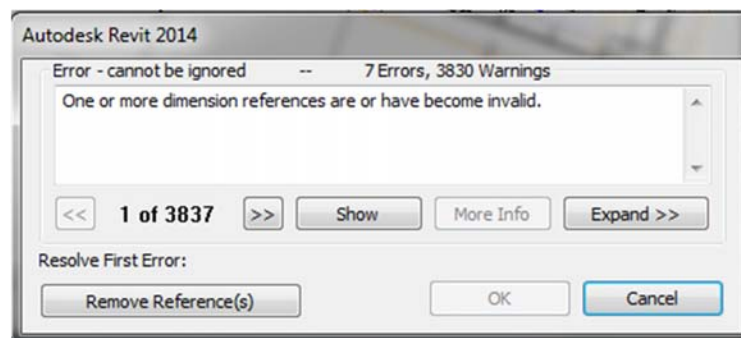
This 'OUT2' is now an element that does not exist in the external library and, when working with an external database to manage asset information, causes big problems when trying to report quantities & locations of assets; this 'OUT2' is simply ignored.



### The Problem with...Container Files

When working with large datasets, the use of 'container files' is common place. That is, a Revit project file which contains only draw sheets, no 3D elements. It gives the ability to better manage drawings, issue (or not) all project documentation, and adds a clear line of purpose between core geometry and production (see Stage 1: Preparation diagram).

As with everything, however, it comes with a drawback for each benefit. When annotating a drawing with tags & dimensions in a Container file, the element that hosts those annotations is actually in a linked file. On a project with 15+ Revit users in and around the same files, it is not uncommon to receive error message such as the one below when opening or synchronizing a file, where Revit is trying to remove 3837 annotation from a file, with no option but remove!



There is no robust fix for this problem but, having investigated, there are two potential causes to look out for:

- 1) The order in which people work, sync, open & reload linked files. You can image a scenario where somebody is working on a drawing sheet while someone else is editing the linked file. If a third person now opens the Container File, Revit will try to update the annotations to match their newly updated 'host' objects, and things quickly become complicated. One solution offered is to Reload linked files *before* synchronizing. Admittedly, this can be hugely time consuming on large projects, but there is little more advice available in the Revit community.
- 2) Something that can be policed more easily is to check the path that linked files have to your network. Revit can see files differently if linked by a mapped drive (i.e. the path starts with a letter, such as L:\...) or a full UNC path (e.g. \\LN-sfs6\...). This can also be an issue for Keynote file paths.
- 3) I'm open to advice on this one! Get in touch if you have a solution, or have similar experiences.

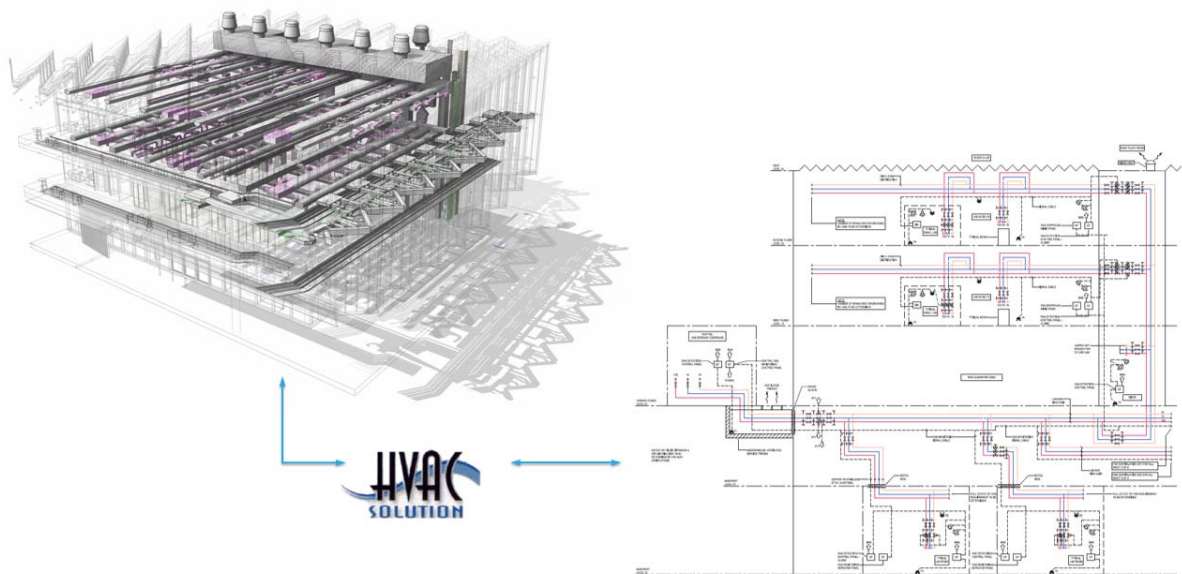


**Schematics**

A quick-win for Engineers; out of the box, Revit does not have a facility to link 2D schematics with the modelled 3D geometry, which has been a cause for concern for a long time. Luckily there is a piece of software called HVAC Solution (<http://www.hvacsolution.com/>) which promises to fill the gap.

HVAC solution presented at Autodesk University 2013, class information here:

<http://au.autodesk.com/au-online/classes-on-demand/class-catalog/2013/revit-for-mep-engineers/mp1378#chapter=0>





## Practical Application of BIM - Stage 4: Technical Design

### Drawing Management

The ability to manage drawing issues on a large project can be difficult, especially as the number of drawings rapid increases through Stage 4. Luckily RTV Tools (<http://www.rtvtools.com/>) lend a hand through their numerous productivity offerings. Revit TV Drawing Manager is an external database that links to Revit and can act as a full project drawing register. This software can be configured to not only export pdfs, dwg, dwfx & ifc files at the same time, but also manage revision notes on drawings – you can simultaneously update the revision, date & note on any number of documents.



### Data Management

The ability to manage project information outside of the drawing production tool is becoming increasingly important, and BDP have used Codebook (<http://www.codebookinternational.com/>) for a number of years. With the ability to link to Revit, Codebook is able to import brief information, store room data and control a project component library. It also gives numerous reporting benefits, such as Room Data Sheets (RDS) and FF&E specification sheets.



In terms of Asset Management, Codebook gives the ability to track & report components that are *not* modelled in Revit. BDP have developed the term 'Architecturally Significant' to determine whether or not the component should be represented by 3D geometry. If an item is decidedly not Architecturally Significant, then it is not placed in the Revit model, but *is* still captured & reported from the project database.

The workflow diagram overleaf explains how the database is built from briefed information, which then informs the 1:50 room loading process. From here, user engagement can take place, utilizing 2D drawings, the 3D model & data exported from the project database.

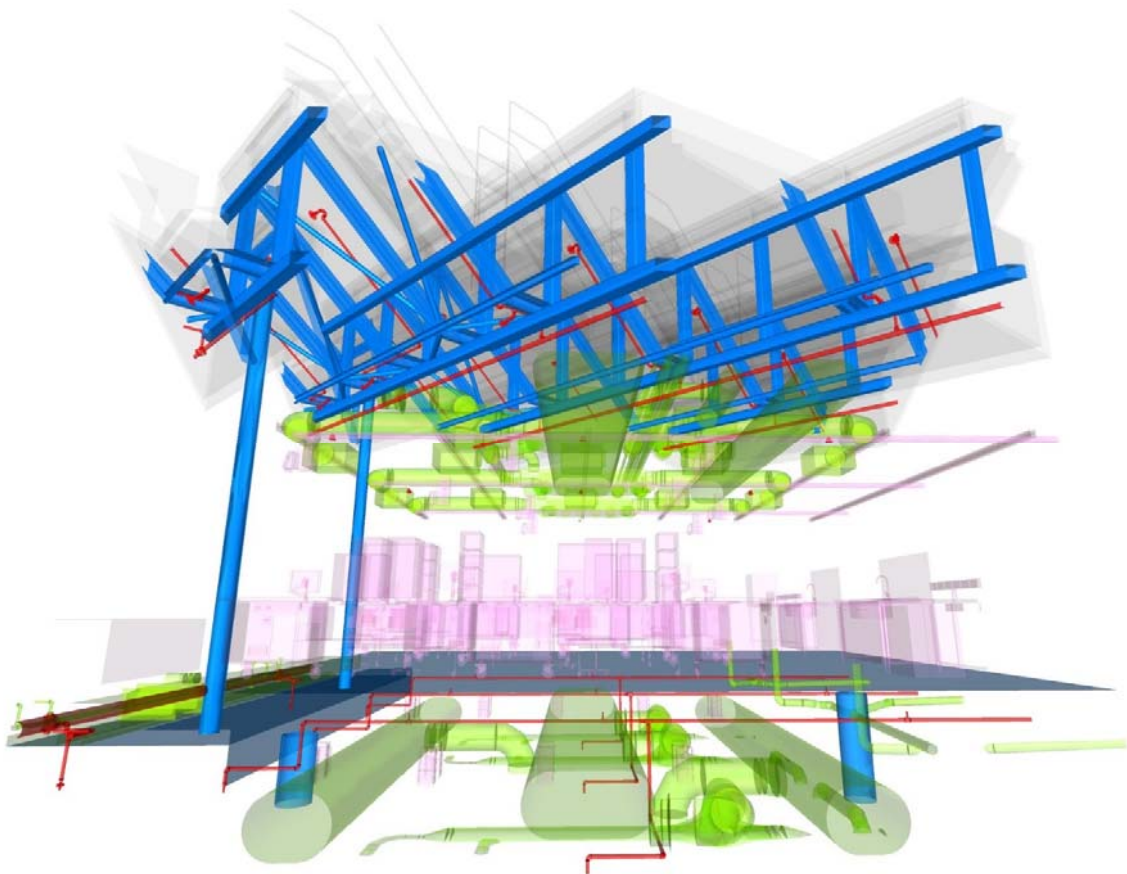


## Practical Application of BIM - Stage 5: Construction

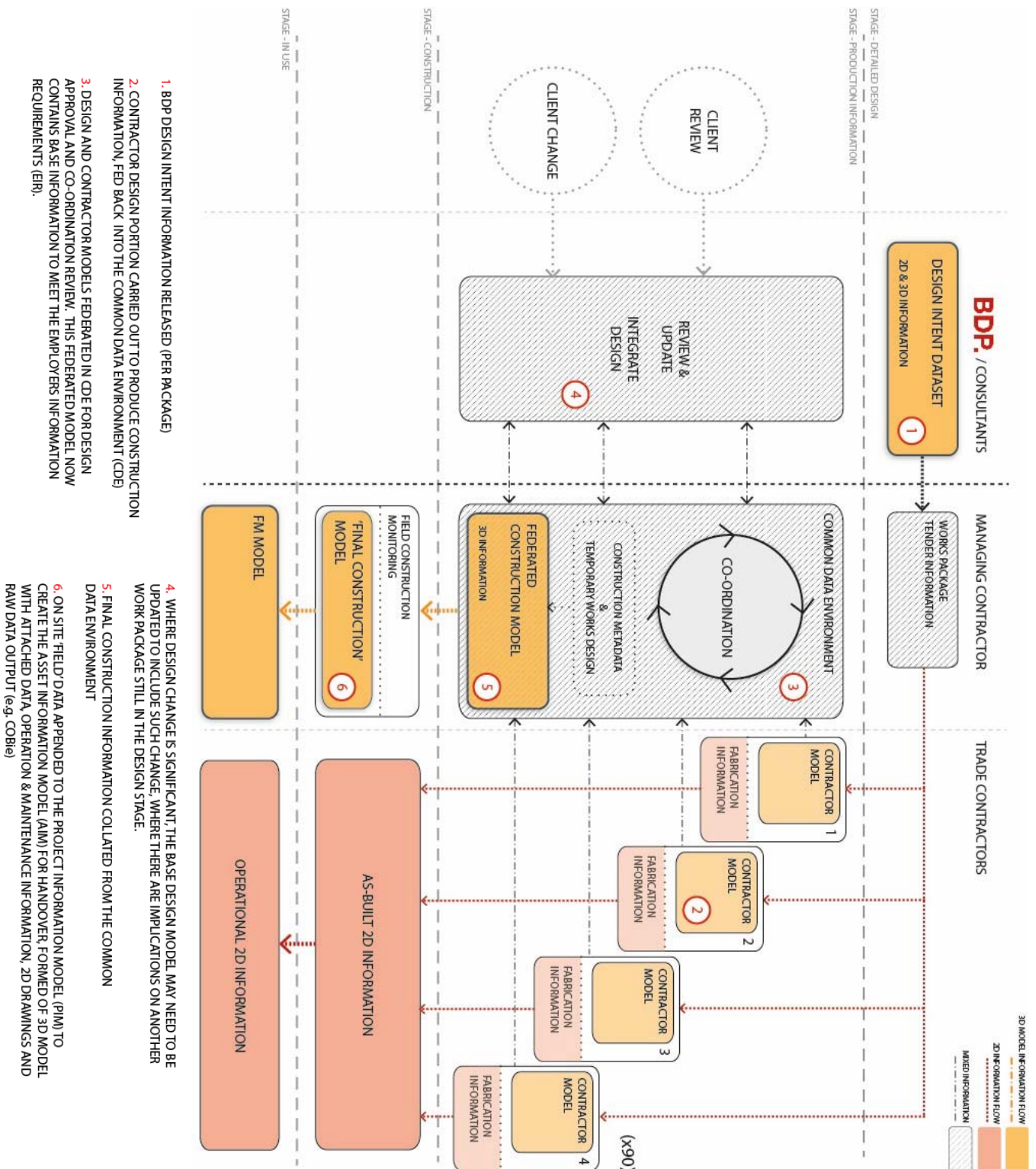
### Co-ordination Strategy & the Common Data Environment

The workflow diagram on the following page describes the process of delivering design information to trade contractors and the role of the Common Data Environment (CDE) in design co-ordination. BDP have had recent success using Autodesk's BIM 360 Glue software (<http://www.autodesk.co.uk/products/bim-360-glue/overview>) as the collaboration software to host 3D model files; acting as a high-level view & review tool, but also giving the ability to append models into navisworks for added functionality in technical reviews.

The image below shows BDP design models for structure, MEP and FF&E federated with Trade Contractor models for both Roof Steelwork and Sprinklers.







**Construction Data**

Part of Autodesk's BIM 360 platform, construction management software comes in the form of BIM 360 Field (<http://www.autodesk.co.uk/products/bim-360-field/overview>) which allows construction data to be input on site and pushed back to the modelled elements in BIM 360 Glue.

The image below shows data input to structural foundations; Dates for excavation, caging and pouring were added to BIM 360 Field, and pushed back to BIM 360 Glue, where the design team are able to track site progress.

