Taking BIM to the limits for Structural Engineers & Technicians

Graham Aldwinckle
Arup

Matthew Wash
Arup

Learning Objectives

- Understand how best practice workflows can be applied to any diverse range of your projects;

- Understand how to measure your baseline in BIM adoption in your business, then track progress;

- Adopt lean principles to eliminate waste and maximize value within your organization;

- See just how much improved your models are with well-structured data;

- Reap the rewards from your improved structural efficiency.

Description

Through our embedment in a combined team of 900+ Structural and MEP Engineers and Technicians in our London and Australasian offices, within a world-wide company pool of about ten times that, we have digested the core components of what a structural team needs to know to push the BIM boundaries to the next level.

- From embedding data to linking analysis and design models.
- From quantification to sustainability dashboards.
- From 3D rebar to Advance Steel implementation.
- From Revit templates to data rich Revit content.
- From IFC output to model reviewing and verification.

And with Interoperability at the heart of it all.

Arup is one of the world's premier engineering design consultancies with over 12,000 staff in 90 countries worldwide, and this class will demonstrate our structural workflows across the globe. We will share what we've learned on our BIM journey, and how it is benefitting our daily creative process.

Your AU Experts

Graham Aldwinckle and *Matt Wash* *joined Arup in 1994 and 1996 respectively, in the UK. Both are chartered structural engineers, whilst Matt is also a Technician by background. They bring a broad experience to their projects, across many building types and countries.*

Graham worked in Arup's Seattle office from 2007 to 2010, and now works in the London office, leading the structural BIM development of the Building Engineering teams. Matt moved to Australia in 2007 and now works in Brisbane, following assignments for Arup in Sydney, Melbourne, Adelaide and Singapore.

Table of Contents

Structural BIM

This handout should be read in conjunction with the following:

1. AU2015 presentation: *ES11485* Taking BIM to the limits for Structural Engineers & Technicians
2. Additional Handout Material:
   a. Workflow Analysis report
   b. Prioritisation Matrix for Improving Efficiency in Delivery of our Projects (incl spreadsheet)
   c. Structural Modeling Requirements – quantification (Autodesk White Paper)
   d. Arup's Revit Analytical Model guide

With over 4,000 Civil and Structural Engineers in Arup around the world, we have tried to present what constitutes good practice as embodied in at least two of our regions. This common understanding of BIM, which is both software agnostic and region agnostic, allows us to focus on what matters. We deliberately haven't referred to government mandates or standards. We want to show what makes a structural team want to engage in BIM, and therefore to push the limits.

Workflow

Best practice workflow means different things to many people. Ask 10 project teams to state what workflow works for them and you'll find you get almost 10 different responses. No two projects are identical, unless you happen to like designing shipping containers. Teams change, clients change, locations change. It is because of this that the right workflow has to be based on lean principles as discussed below and in the AU presentation (*ES11485*). The design team is then free(er) to consider what tools work for them (process) and how to connect those tools (interoperability).

The following sections consider various tips that can be given to teams of any ability, as it's about getting them to consider what makes sense for a more efficient process. Get the process right, and even a mediocre team can look good. Combine the right process with the right project team and you will have cracked it. The challenge is making this happen on every project!

Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime.

Top Tips for persuading Engineers to use the model

We have to get the Engineers to have the mindset that Revit is a design tool and not just the documentation tool. At the same time, we need to ensure our Technicians are trained in engineering skills, so that they can input into the analytic aspects of the model. Blurring the lines between the Engineer and Technician is a fundamental change required for successful collaboration.

Getting Engineers into the model also involves them understanding the right way to open Revit models. Here are 15 suggestions, as many find it daunting initially:

DO's and DON'Ts relating to opening models:
1. **DO** open up Revit first (via Start -> Autodesk -> Revit), then click on Open to browse to the Central file. Ensure that the " Create a Local Copy " box is ticked.
2. **DON'T** open a Revit file directly from Windows Explorer, or from a link someone has emailed to you.

3. **DO** open as "detached from Central" if you're only going in for a look, or to get dimensions etc. Better still, open the Revit Viewer instead to do this, to free up licences.
4. **DON'T** copy'n'paste a Revit file in Windows Explorer, or drag/copy a Revit file to another location, thinking you're creating a copy that you can play with. Revit knows. You will still be syncing to the Central file.
5. **DO** run the "Work Share Monitor" if you're working in the model (not detached), and save regularly, as it allows others to notify you if you have an element booked out to you and are preventing others from editing it.
6. **DON'T** open up your own local file directly at any time – you should always browse in Revit to the Central file first, then overwrite your local file when it asks you. Make sure the option to "Create a local copy" is ticked, and simply overwrite your local copy each time.
7. **DO** get into the habit of closing Revit at lunchtime if you can. Apart from freeing up licences, it clears the memory, meaning fewer crashes or slow PCs. Revit is memory hungry and not that efficient.
8. **DON'T** work directly in the Central file (speak to the Technicians about exceptions). You should always work in the local version, and sync to Central every couple of hours or so. This is assuming that we have worksharing, meaning more than one person can access the Revit model concurrently.
9. **DO** make sure you regularly relinquish all ownership of elements within the model using the Collaborate tab/Relinquish All Mine button. Also, when closing, this is essential.
10. **DON'T** leave a Revit model open overnight. (This is important because of point 7. Also as we have global licences you are stopping some else being able to use Revit. Remember this could be you wanting a licence. Also it causes big issues for the BIM Manager/Coordinator as we can't create the new central file each week (which helps file size and stop errors in the model) or do changes which requires no one else being in the model).
11. **DO** make sure you convey which Revit version (year) your model is saved in, eg when sending a link to others. When there is no file name restriction, name the Revit will with the version on the end eg. XXXXX_2015)
12. **DON'T** open Revit/Navisworks/AutoCAD with a newer version of the software, as this causes problems for all uses, even if the file you are opening is only linked into someone else live. (temporarily up-grade the other files)
13. **DO** ensure that when you are sharing and linking models externally with collaborators that you are all on the same Revit version and build.
14. **DON'T** forget that trying to open an old project in the latest Revit version will lead to the "please wait while your model is upgraded" screen, and is not always successful, depending on how old the project is. Upgrade one Revit year at a time for best results.
15. **DO** save a verified IFC at the end of your project, in addition to the native file. This will enhance your success in the future should you wish to open that model again, eg for a refurbishment of an area of the building.

Lean Principles
Additional material is provided with this handout.

Workflow Analysis report

To consider the optimum workflow for your project and/or company, consider an A3 planning report. The name is derived from the output being distilled down to a single page of A3 size paper – 11.7" x 16.5". It is an analysis of every aspect of the deliverable, at every stage.

The example in the handout was an Arup analysis in one office back in 2013. It has since been considered across many offices around the Arup world, and is an invaluable tool to focus the leadership's mind on lean principles.

Prioritisation Matrix for Improving Efficiency in Delivery of our Projects (incl spreadsheet)

The second aspect of lean principles being shared with this handout is a prioritisation matrix. By considering the three cases of: frequency, importance and ease of implementing a solution, it is possible to focus quickly on the easy wins, and subsequently on the key stages that will really set you apart.

Measuring your BIM Maturity

To progress Arup's understanding of the embedment of BIM within the firm, it was absolutely necessary to measure our baseline on projects. Most BIM Maturity tools focus on the company, or the wider team, and all too often are filled out by those that actually have an understanding of BIM. That, inevitably, means those measures are a little rosy in outlook, for when you delve into many of the projects in that organisation, you find that BIM adoption is patchy at best.

To overcome that, and to measure a real, honest, baseline, Arup has released a free-to-download tool that anyone can use on their projects, irrespective of the country or discipline. It measures the project only – for both information management, and discipline specific BIM maturity. It's a derivative of the Penn State Maturity Assessment tool, and is shared under Creative Commons 3.0.

The tool is currently available from these locations:

- www.arup.com/Services/Building_Modelling.aspx
- http://www.bim4sme.org/resources/bim-maturity-measurement/
- https://www.ice.org.uk/news/bim-maturity-tool

It is hoped that BuildingSmart will adopt the tool soon, such that the wider industry can gain as much from it as we have so far. Feedback is always welcome, and you can contact the originators of it by email to BIM.Maturity@arup.com .

Interoperabilty

The notes in the additional material are based on our internal Arup guidance, written to help Engineers and Technicians gain the most from the Revit analytical model. Guidance is given on analytical model manipulation, adjustment and checking. It should be remembered that there are no set rules here, and

the reader is advised to test the methods, to ensure the outcomes are as expected in the particular software being used by the team.

Furthermore, the reader should note that there are competing demands on modelling for a certain outcome. The team should consider if this hierarchy of Revit modelling priorities is right for their circumstances:

❖ Develop your Model to…
   ➢ Build it quickly and easily (all technicians strive for this one!)
   ➢ Make drawings look good (still required for many projects!!)
   ➢ Link to analysis and design programmes – especially if you can link bi-directionally
   ➢ To extract material / quantity metrics, or to export material quantity information to others
   ➢ To enable timeline displays via eg navisworks
   ➢ To export a good quality ifc model or other open standard deliverable

Unfortunately, it appears to be currently not possible to easily satisfy all these at once, though that would be nice, wouldn't it Autodesk. By adding in element classification, such as Omniclass, Uniclass or NRM etc, it should be possible to extract correct material quantities quite readily, but how you model those elements is then fundamental.

Consider a classic example: a step in a slap that doesn't occur on a column line. Depending on relative levels, you could model the step locally as:

- a slab edge/drop on the upper slab;
- a separate thickened slab between the two;
- a downstand beam;
- a short wall.
- an upstand on the lower slab

Even then, do you model the two adjacent slabs to the edge of a beam/wall, or through to the far side? Do you then cut the beam/wall element down in depth, or simply join the elements together in Revit? Will any of this get properly modelled in the analysis software?
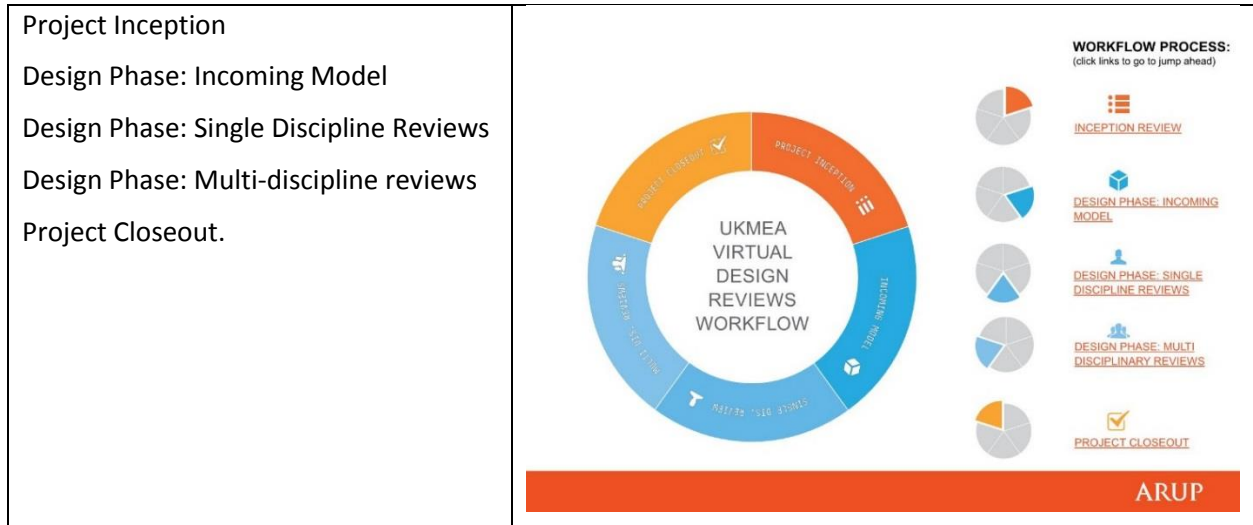
In this example, the option you chose would be based on what you consider is most important for your chosen priority for subsequent (or downstream) use. Given no guidance, the modeler is likely to do what he's done before for speed. Ask five engineers how they want it, and probably 3 will give you a different answer, and the other 2 will say they will leave it to the modeler.

Extracting material information needs to be based on discussions with the person using the information. It might depend on the specific software being used, and on what classification system is adopted. It certainly depends on how elements are modeled, and what assumptions are made. Make it clear what those assumptions are, especially if you are providing this information via a Revit schedule to someone else. This is covered further in the additional handout material guide, "Structural Modeling Requirements - quantification". It really is a case of testing for your project and liaising with the wider project team.
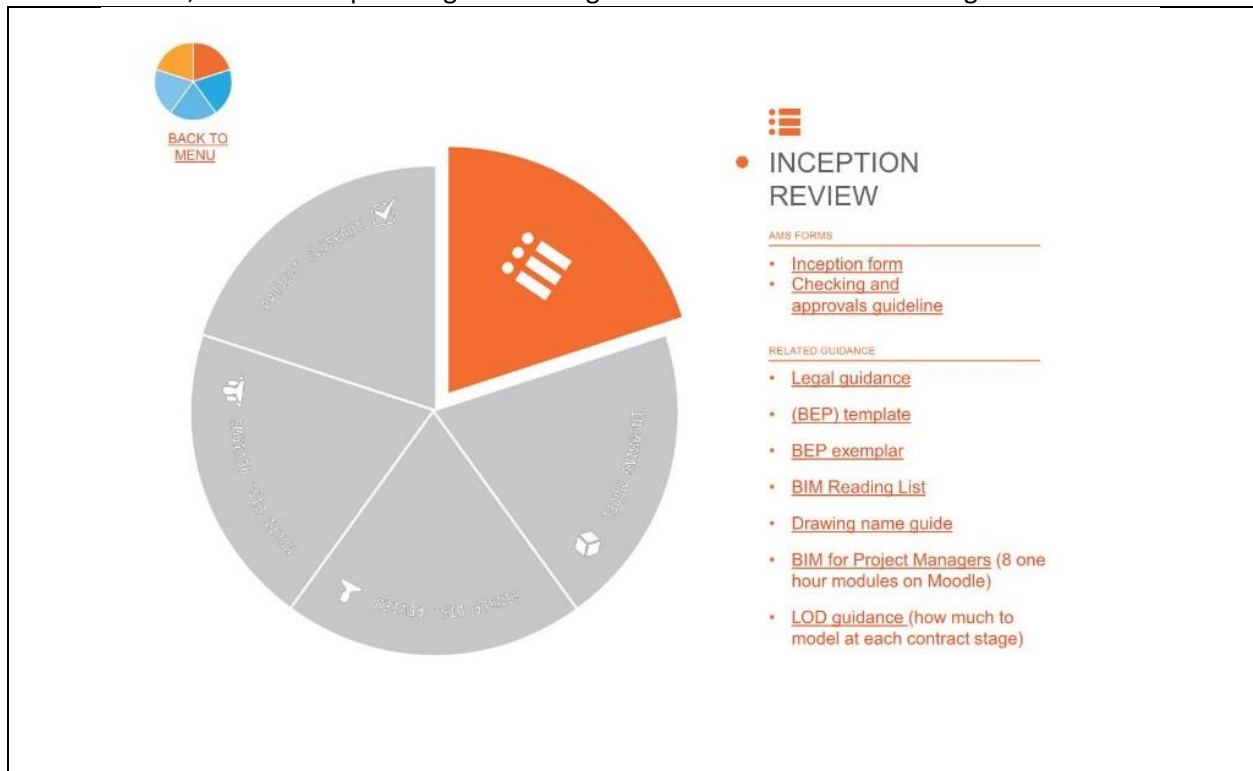
Virtual Design Review Guidance

The images below are the internal guidance notes Arup uses to feed into the Virtual Design Reviews (VDR) at various stages. The VDR is to be considered at both inception and closeout, and the guidance below also address three distinct design stage reviews:

Project Inception Design Phase: Incoming Model Design Phase: Single Discipline Reviews Design Phase: Multi-discipline reviews Project Closeout.	

The sections below suggest topics that should be considered at each stage. In Arup, this guide is an interactive PDF, with each topic being a link to a guidance note or further training.
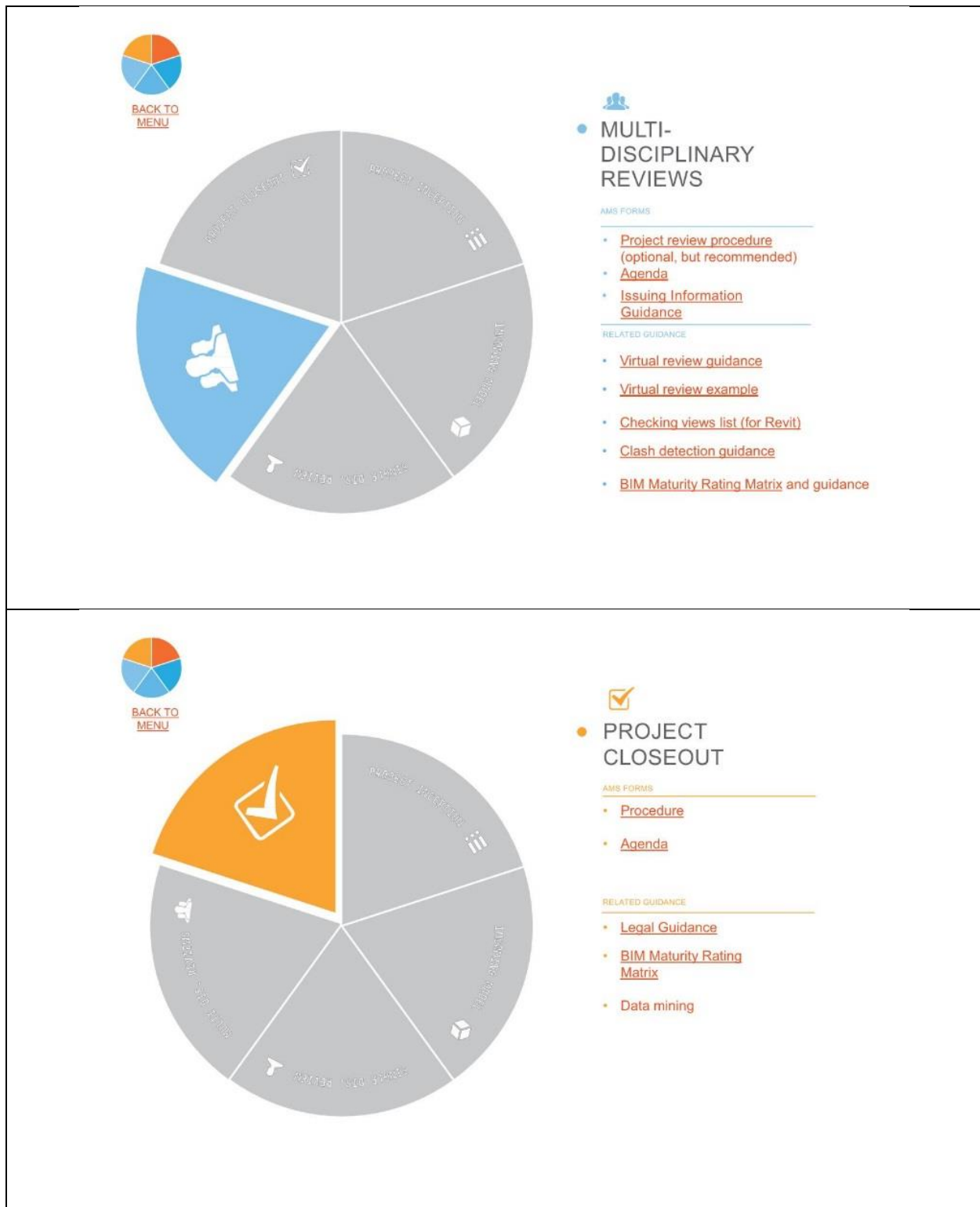
FIGURE 1: VIRTUAL DESIGN REVIEW PROCEDURES