School of the Built Environment
for
Constructing Excellence
in the built environment

A study into the use of Information Modelling : DCSF Offices, Darlington

Report Number 1(a)

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1. Introduction

Northumbria University have been commissioned by Constructing Excellence, on behalf of the Department for Business, Enterprise and Skills (BIS) to carry out a case study into the use of information modelling in public sector building in the UK. The case study is an office development project for the Department for Children, Schools and Families (DCSF) in Darlington. Construction is planned to be complete by 31st January 2012 with staff migration to have taken place by the end of February 2012. The project has been proposed as a Constructing Excellence Demonstration Project by the principal architect, FaulknerBrowns.

2. The Project

Project name:	DCSF offices, Darlington
Description:	5-storey offices for DCSF: 6,100 M2 GFA
Procurement:	Two stage Design and Build
Cost:	£13 Million construction costs (for shell and core, Cat A and B fit out, excluding furniture, fittings and equipment).

Project Timescales:

Construction start:	12th May 2010
Construction finish:	31st January 2012
Staff migration:	end of February 2012

Project team:

Employer:	DCSF
Employer's agent:	DTZ
Contractor:	McAlpine
Architect:	FaulknerBrowns
Structural Engineer:	AECOM
QS:	Gardiner and Theobald
Sustainability:	Appleyards
Landscape:	Colour

3. Research Aims, Objectives, Method and Timescale

The aim of this longitudinal case study is to observe and analyse the use of a shared Building Information Model (BIM) in the design and construction of a live project, with particular attention to its potential and actual impact on integrated project working and to the barriers to, and drivers for its use.

This can be broken down into the following objectives:

(i) to summarize and review the potential advantages in the use of BIM;
(ii) to explore attitudes to the use of BIM throughout the project team, before, during and after working on the project;
(iii) to examine the impact of BIM upon key activities and phases within the project lifecycle;

(iv) to reflect upon the possible impact of BIM upon procurement and contractual strategies, and *vice-versa*;
(v) using appropriate metrics, to measure the effects of the use of BIM in terms of cost and time efficiency and overall benefits to the client and to its users.

A variety of data collection and analysis methods will be used. Qualitative data will be sought through interview, observation and participatory appraisal focus groups. Quantitative data will employ appropriate metrics, including those based upon standard Key Performance Indicators (KPIs). Research has commenced at RIBA Stage C and is planned to continue to the end of construction. There are three identifiable stages to the project, subject to break clauses[1] in the research contract, these are:

Stage 1: *Initiation and Design*: (RIBA Plan of Work Stages A– D) This stage was planned for completion by the end of October 2009.

Stage 2: *Procurement* (RIBA Plan of Work Stages E-H). This stage is planned to be completed by May 2010.

Stage 3: Construction (RIBA Plan of Work Stages J-L). This stage is planned to be completed by January 2012.

Research reports will be produced approximately to the following timescale:

Interim Report #1
Interim Report 1, which will be largely retrospective, was expected to be produced by the end of December 2009. The late availability of necessary information has delayed production of this report. In view of the delay, the report will be presented in two parts: the first (Report 1a) at the beginning of February 2010 and the second (Report 1b) at the beginning of March 2010.

Interim Report #2:
Interim Report 2 will be produced by the end of July 2010.

Interim Report #3:
Interim Report 3 will be produced around the mid-point of the construction period (i.e. around July 2011).

Final report
The Final Report will be produced within 3 months of the Practical Completion of the construction works (i.e. before the end of April 2012).

All reports will be made available in both hard copy and in electronic format. Where appropriate, academic papers will be published; subject to the scrutiny and approval of the client. The results will also be published on the Constructing Excellence website.

[1] The funder has the option of withdrawing funding before the commencement of each stages listed.

4. Strategic and project benefits in the use of BIM: from the Literature

A number of key benefits (strategic and project-related) have already been identified, in both the literature on BIM and several early reports on its use. These will be added to in future reports as they are identified. Currently, these include:

- At Concept Design Stage
  - Improved communication between commissioning client/employer and lead designer;
  - Improved communication between designers;
  - Possible early involvement of key supply chain members;
  - Visualisation of design proposals for external revues and appraisal;
- At Detailed Design Stage
  - Efficiencies through the use of a single project model;
  - Improved co-ordination within the design team;
  - Integrated energy performance modelling and sustainability assessment;
  - Integrated n-d modelling capabilities (including time, capital & whole-life costs, carbon costs, and further simulations and decision making tools);
- At Contractor Procurement Stage
  - Improved communication of Employer's Requirements for tendering and pricing;
  - Possibility for earlier integration of contractor input;
  - Supporting the case for integrated Project entities such as *Project Co's, Project Bank Accounts, Project-based Insurance*;
- At Construction Stage
  - Better integration of BIM-literate supply-chain parties (including the incorporation of their design elements);
  - Supporting the case for Modern Manufacturing Methods, Lean Construction, and other process improvements;
  - Improvements in Risk and Change Management effectiveness.
- Building Operation Stage
  - Better integration of construction information into the support of building operation/ planned and reactive maintenance and performance monitoring of cost-in-use, energy, space utilisation, and modifications.

5. Summary of research activity to-date: PA focus group

A Participatory Appraisal focus group was held at FaulknerBrown Architects' offices on 11th December 2009. Participatory Appraisal (PA) is an approach that places participants and their knowledge at the heart of the process, treating them in the role of potential 'expert'. It is suited to all types of investigation and as it does not presuppose any knowledge on the part of the facilitator it can be considered very objective.

The PA was conducted with members of the Principal Architect's organisation. Not all participants were connected with the DCSF Project.

Two PA tools were used at the beginning of the focus group, namely:

- brainstorming around what the participants felt about Building Information Modelling (BIM) and
- an examination of the potential advantages and disadvantages of BIM.

This discussion revealed a number of concerns, convictions and constraints around the introduction of BIM. A full transcript is available on request. There were nine active participants. Six of these had declared themselves as 'in favour of BIM', though only one had extensive experience (6 years). The participants represented the disciplines of; design architect, technical manager, IT director, business director, and company director.

Concerns

Key words; complexity, uncertainty, drivers, unknowns, frustrations.

Complexity

Participants expressed the view that BIM is hard to use and complicated, making it a time-consuming investment. The perception of BIM as a complicated package to learn and use was the most often quoted difficulty.

Uncertainty

Throughout the session lots of questions were raised about using BIM, indicating a lack of general knowledge in this area.

Drivers

The question arose of who was driving the move to wider use of BIM? A "pressure from industry" to use BIM was perceived and this made some feel that the eventual wide scale adoption of BIM was "inevitable". There was a tension with this view as for others the feeling that "Business didn't sit down and think this is the perfect job for BIM it is being driven by interested staff".

Some clients are insisting on the use Revit. There was a concern about being left behind – "do we lose out to our competitors?"

Unknowns

For the majority of the participants BIM represented an "unknown quantity" and they wondered "will it be easy to learn?" That it was new and needed to be learned represented a difficulty for some participants.

Frustrations

The introduction of a new way of working was frustrating for some participants; for example, one observed "just at a stage where we had 2D CAD nailed and along comes Revit and it's all up in the air again." It is sometimes viewed as a "challenging technology" and "frustrating", though this is not the case for all as will be discussed under *Convictions*.

Convictions
Key words; efficiency, excitement.

Efficiency
Contrary to one participant's view that BIM is "hard to use", another participant found it "easy to use". The advantages expressed were about the tool itself whereas the bad points often related to the difficulty in learning to use it. BIM is regarded as fast, "accurate", "streamlined", and "integrated", "streamlining all the things we naturally do". It is perceived by its supporters to be good for "coordination" and ease of "clash detection" due to having "one package rather than different ones for different jobs" on a "single platform". For instance, moving an element in a 2d environment may result in not knowing "that you've 'clashed' until you are on site". BIM "makes revisions easier" as it is "fast to draw and update information" as it provides "one model that you can produce everything from". The "shared environment" gives it the capability of "producing everything" from it, as it offers "compatibility, exchange [and] schedule". It was noted that "Assuming you have buy -in from the design team you can make changes at any stage: QS can cost, get our model to M&E and they can give us the thermal implications. They usually only want to build their model once."

Excitement
The introduction of BIM was viewed by some as exciting and interesting although some had worries about it. These are explored more fully in *Constraints*. A participant asked, "Will it allow us to spend more time being creative and less drawing and communicating?" The experienced user answered, "No, it takes more time to get the model right at the start of the project. The benefit is at the end of the project when you change with a small tweak and everything regenerates. You programme your work differently."

Constraints
Key words; limitations, competing packages, fear

Limitations
The limitations fall broadly into three categories: process, user, and technical.

The *process* of using BIM raises some issues, although some of these may be perceptual rather than factual. There is a perception that using BIM is "restrictive" and "aids design more than technical information". It is seen as a bad point that there is a high "level of detail demanded".

Many of the perceived limitations were based around either *user experience* or perception. It was remarked that the "danger is we focus on Revit too much, use it just as another method of drawing". There were "suspicions of impact on design freedom" and it was noted that "BIM can run away with design if you don't control it, training will control this", which leads to another issue, that of the time it can take to train in a new software programme. With training, "time is an issue and expensive and not all training is good quality."

For some of the participants the "learning curve is an obstacle" and some were only keen to learn a new piece of software if they could be sure it was the right

one to learn. The effective use of BIM is “limited by knowledge” and the “library information currently limited”. The paucity of experienced users means that you “can’t get maximum benefit unless whole design team is using” BIM.

There are a number of *technical difficulties* perceived in the use of BIM:

- “High hardware requirements”
- “Difficulty in sharing”
- “Large file size”
- “Sometimes these things don’t work quite as well as they should/could”
- “cost so much”
- “Generally a nightmare to export properly.”

Competing packages

There are a number of competing packages currently in use though Revit is seen as a “safe industry standard” BIM package. Throughout the discussion the terms Revit and BIM were used interchangeably but some participants were eager to point out that “BIM isn’t Revit”, although it was also said that when BIM is talked about we “mostly think of Revit” and”it’s not the best but is becoming the *de facto* standard”. Thinking about the way they currently work and “already use Autodesk products” it was noted that different software components [are] not compatible”. There is a “need to be compatible with other team members – no good if not”. It is most likely that no one will never just use one package.

Fear

The participants were willing to consider the use of BIM but found that it was “daunting”, left them “confused”, and some were a “bit scared about change particularly in the time scale”. The ‘learning curve’ is seen as the biggest barrier. Good metrics are considered to be available regarding time spent on each phase of each job: the danger is “what do we do with the extra time”; “Will we get squeezed more and more, or should time be used to produce better designs?”

6. Tentative conclusions

In general the move to using BIM was seen as something that is already happening and something that would need to be learned at some stage. There were mixed perceptions of what it can do and what it can be used for and mixed feelings about its introduction. The use of BIM was felt to require a “different mindset” and operated in a “clinical not tactile” way, the implication being that currently designers operate in a tactile way. An examination of the tools that participants currently use at each stage of a project shows that most people use a mix of computers (clinical) and hand (tactile) to produce their designs, although there are some that use exclusively one or the other. Interestingly one participant had stated that they use “traditional CAD” in the detailed design stage yet for others this would be far from traditional.

During the discussion it became clear that BIM would have impacts in collaborative working, libraries, workflows, and there was also a general discussion around what BIM really does. The main aim of using a *whole-system-BIM* would be to improve integration and collaboration. There is a concern,

however, that this may result in “changing culture to *expect* (rather than hope for) collaboration”. Other concerns with the use of BIM in collaborative working were the “ownership of model”, “liability for its content”, and “document control”. It was conjectured that the ‘live’ document will not be shared, only a ‘locked’ version.

Positive aspects (for the firm and the project) of using BIM in collaborative projects were perceived to include:

- the improvement of co-ordination, especially with structure and services, with the caveat “if everyone buys into it”;
- more efficiency as there will be “less duplication of information across the design team”;
- production of an inter-office component library.

A constraint in practice exists as “currently the design team use it only”, “The QSs don’t use it”. There is a “perception that Revit M& E [is] not as good as other parts of the Revit suite”. A participant noted that the “maximum benefit [can] only achieved when whole design team [is] using” it. From this it appears that the main constraint on BIM’s effectiveness in collaborative working is its patchy uptake, as not all professions use it.

It was felt to be fortunate that Revit is becoming the *de facto* BIM package. There was a concern that using a library “restricts innovation” although another participant pointed out that libraries aren’t actually *for* design. Whether the libraries would be matched to manufacturers’ components was another concern and it was noted that industry is starting to provide these libraries. The time it takes to produce libraries is a big issue and can constrain the use of BIM in the first instance and to keep them up to date.

BIM will accurately model more complex shapes. The hardware requires very powerful machines making sharing across project extranets very challenging. Currently different methods are being tried out; file transfer sites, DVDs, issuing in 2D, revisions are notified as snapshots of the building over time, model issued only to structural engineer. Contractors are still at the stage where they ask “what’s that?” when BIM is mentioned. Currently it presents three Quality Assurance issues to deal with; 2D, 3D and BIM.

For anyone thinking of introducing BIM to the workforce it was considered useful to keep the following in mind:

- There is more than one package on the market though currently a lot of companies (in the UK) are favouring Revit;
- BIM software is a complex system to learn and time consuming to become proficient in;
- The frustration of learning more new ways of working when the perception is that they have just learned one new way can be unsettling;
- Users need to feel in control of the process of change and new ways of working. It wouldn’t be everyone’s choice to make the change but they would if they had to, though this would be with differing levels of conviction. Not everyone wants to learn a new way of working

- Education and training are key to making BIM more acceptable and less threatening. A mixture of online courses, practice sessions, on the job training is desirable;
- There is a perceived tension between *clinical versus tactile* approaches to design, though many designers already use a mix of new technology (clinical) and traditional methods (tactile).

The results of the PA have highlighted a number of important concerns, constraints and convictions around the adoption of BIM in an Architectural practice. Particularly salient were the concerns over ownership, liability and control of project data. The introduction of BIM into a practice inevitably results in the need to evolve existing working processes and quality assurance procedures to harness the capabilities of the BIM technologies. The need for training is paramount. However, the potential benefits were also acknowledged, and there was a conviction that adoption of BIM could facilitate "more creative" designs by altering the shape of a project allowing potential savings in one phase to be utilised in another. Unfortunately the full potential of the BIM technologies was felt to be currently constrained by the lack of interoperability of existing software and uptake of BIM technologies by other design and construction team members.

Finally, it should be noted that feelings were often very polarised, e.g.

Excitement	Fear
complexity	Efficiency
Ease of use	Difficulty
Restriction	Freedom
Minute detail	Basic idea
Good to be all in the same package	Worry of being 'held to ransom'

6. Next steps

The findings presented above are based on one focus group and to ensure a wide representation of views and disciplines within the full range of the built environment further investigation will be necessary. For instance there was no representation from the legal, contractual, and administrative participants. Also there was only one BIM expert present and a distinct lack of anti-BIM users. The range of people made for a good basis for the start of the investigation but to make this a rounded process it will be necessary to carry out further investigations with representatives from the missing groups. This investigation can be either more focus groups, interviews, questionnaires, or a mixture of all three. A further PA workshop will be held with other project participants (including the contractor and wider design team) before the end of February 2010.

The research team will also attend monthly project meetings which should make information exchange a little smoother, and provide a mechanism for engaging with other team members.

In discussions with FaulknerBrowns (initially) and subsequently with other project participants an agreed set of practicable KPIs will be adopted to measure the

impacts of the use of BIM on performance and client value-added. This will include mechanisms for measuring (in line with Constructing Excellence KPIs)

- the predictability of design and construction cost and time
- Client satisfaction with:
    - Product
    - Service
    - Value for money
- Contractor Satisfaction with:
    - Provision of Information
    - Approvals and Payment

Future reports will also incorporate:

- An incremental synopsis of the key strategic benefits that the full use of BIM offers;
- An ongoing appraisal on how far these benefits have been captured in the case project;
- A set of paper-based and electronic information sources, which, in the Final Report, will appear as an Annotated Bibliography;
- A purpose-developed BIM 'Maturity Model' together with the operationalisation of its elements with metrics and the location of DCFS project participants within the model.

Appendix 1: The Research Team

Project Manager, Dr. Jane Matthews:

Jane is a Senior Lecturer in the School of the Built Environment. Her particular areas of interest are in Built Environment information flow.

Academic expert, Professor Steve Lockley

Steve is Professor of Information Modelling in the School of the Built Environment.

Academic expert, Professor Dave Greenwood

Dave is head of research and Professor of Construction Management in the School of the Built Environment.

Senior researcher, Lyn Dodds:

Lyn is a Research Associate at the Sustainable Cities Research Institute. She is a social scientist with particular skills in qualitative data collection.

Appendix 2: Bibliography

Future reports will contain a developing set of paper-based and electronic information sources, which, in the Final Report, will appear as an Annotated Bibliography.