

Department of Architecture and Civil Engineering
The University of Bath

How will Building Information Modelling impact on a Small to Medium Enterprise Curtain Wall Sub-contractor in the UK?

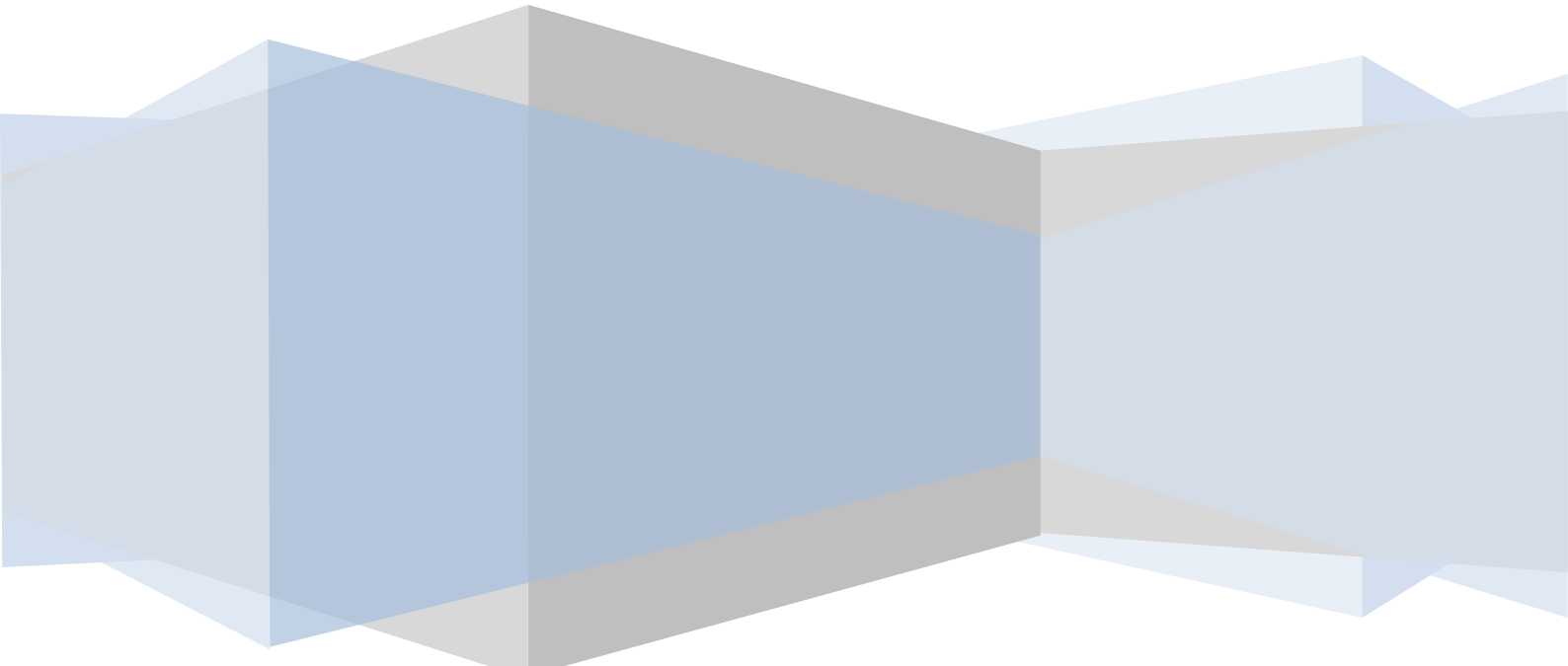
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Declaration

I hereby declare that my dissertation “How will Building Information Modelling impact on a Small to Medium Enterprise Curtain Wall Sub-contractor in the UK?” is comprised of my own personal work and research except where mentioned and referenced within the body of the text. A complete list of the references is included.

Paul Johnson

September 2012

Abstract

Establishing how Building Information Modelling (BIM) will impact on a Small to Medium Enterprise (SME) curtain wall sub-contractor in the United Kingdom, will benefit Clients, Architects and Main Contractors within the construction industry as well as the sub-contractors themselves.

This dissertation outlines the philosophy of BIM, the drivers behind it, and assesses the need for implementation by a curtain wall sub-contractor. It concentrates on the new demands on SMEs from the industry relating to design and facilities management information, as this is the area set to undergo significant change from current working methods. It addresses the individual issues that await a particular SME sub-contractor; and others within the glazing sector considering BIM adoption, and after reviewing these issues has designed a strategy suitable for implementation.

The intention announced by the Government for collaborative 3D BIM on all its projects by 2016, has sent out a clear message to the construction supply chain and as a result, BIM has fast become a topic that can no longer be ignored within the UK construction industry. David Philip (Head of BIM implementation at the Cabinet Office) is encouraging companies to 'start now' by understanding their role within BIM and the contribution they will be required to make.

It was found that BIM is predominantly Client driven with good awareness and adoption levels amongst Architects and Main Contractors at the beginning of the design process; however these adoption levels diminish further down the supply chain. As the subject matter is relatively new to the vast majority of the industry, and curtain wall SMEs are yet to implement BIM, there is limited data available to substantiate the anticipated benefits of its methodology. However, from the research undertaken, there is plenty of historic data to highlight the inefficiencies within the construction industry and the requirement for a collaborative way of working such as BIM.

This dissertation has established that a particular curtain wall SME must look towards BIM adoption in order to sustain their successful business model and to enhance their business development. This statement will be true for many companies within the curtain wall sector, as it appears inevitable that all members of the construction supply chain will need to contribute to a project BIM by 2016 if they are to advance their business.

Acknowledgements

Firstly I would like to thank Bennett Architectural Aluminium Solutions Limited for sponsoring me on the MSc in Façade Engineering, and for giving me the opportunity to fulfil a long-held ambition of gaining a university education.

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Abbreviations and Nomenclature

BAASL	Bennett Architectural Aluminium Solutions Limited
BIM	Building Information Modelling
BMS	Building Management System
BOM	Bill of Materials
BSF	Building Schools for the Future
CAD	Computer Aided Design
CNC	Computer Numerical Control
COBie	Construction Operations Building Information Exchange
CPIC	Construction Project Information Committee
DfE	Department for Education
H&S	Health and Safety
IFC	Industry Foundation Classes
ISO	International Organisation for Standardisation
IT	Information Technology
KPI	Key Performance Indicator
M&E	Mechanical and Electrical
MD	Managing Director
NA	North America
NBS	National Building Specification
NIBS	National Institute of Building Sciences
O&M	Operation and Maintenance
OTIF	On Time in Full
PFI	Private Finance Initiative
PfS	Partnerships for Schools
PSBP	Priority Schools Building Programme
Q&A	Question and Answer
QSUM	Quotation Summary Sheet
RIBA	Royal Institute of British Architects
RICS	Royal Institute of Chartered Surveyors

ROI	Return on Investment
SME	Small to Medium Enterprise
TBA	To Be Advised
USP	Unique Selling Point
WMCCE	West Midlands Centre for Constructing Excellence

1.0 INTRODUCTION

1.1 Introduction

The aim of this dissertation is to consider how BIM will impact on a SME curtain wall sub-contractor within the UK construction industry. It sets out to give clarity to a specific SME company in terms of their role within BIM, and to develop an implementation strategy that will enable cost-benefit analysis. Bennett Architectural Aluminium Solutions Limited (BAASL) are typical of many curtain wall manufacturers within the industry who are currently unsure of the impact BIM may have on their business, what action they may need to take, and what the associated costs may be.

BIM is not a single piece of software; it is a way of working. The philosophy being that the BIM partners communicate and collaborate by exchanging information throughout the total life of the building; from the early concept design stage, through to the final dismantling of the building as illustrated in Figure 1.1.1.

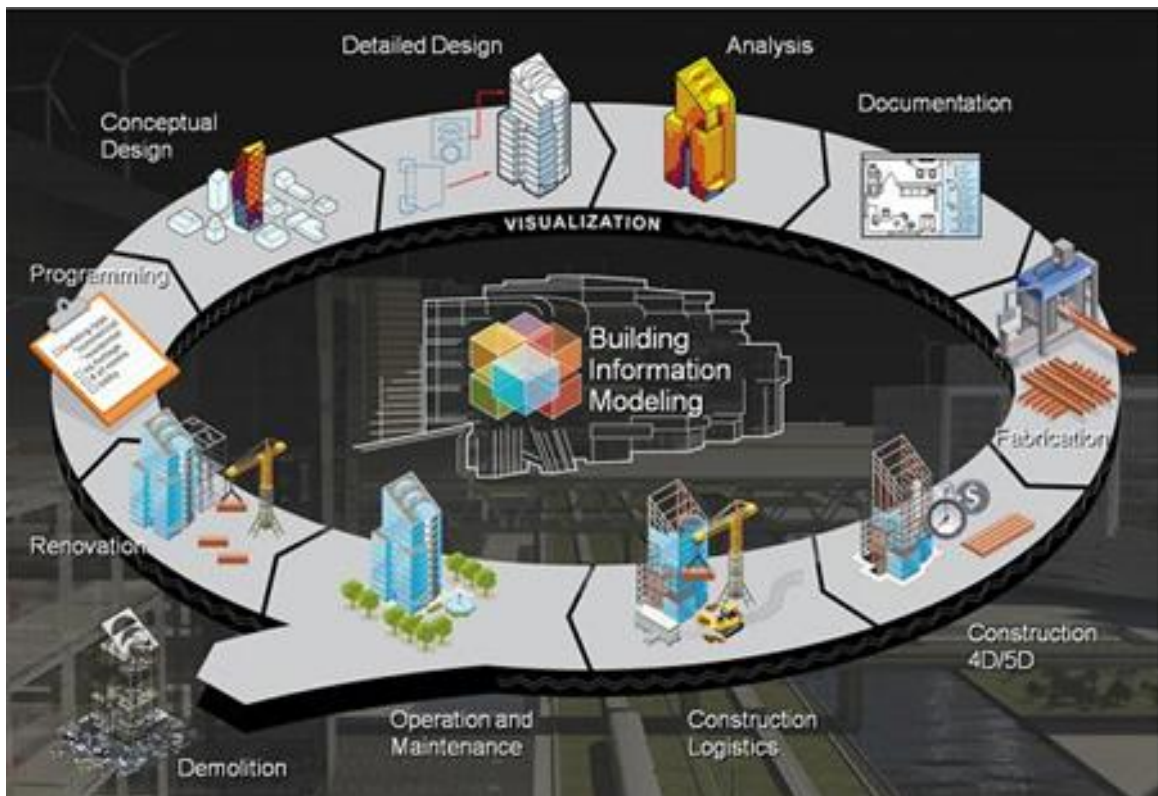


Figure 1.1.1: BIM Diagram (Austin, J, 2011)

The Cabinet Office announced the Government's new Construction Strategy 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, (Poletayeva, E, 2011). The criteria were that all publicly funded Government projects worth £5m and above, are to use BIM at Maturity Level 2 by 2016.

This intention announced by the government has sent out a clear message to the whole UK construction supply chain, and as a result BIM has fast become a topic that can no longer be ignored within the UK construction industry.

1.2 SME Focus

This dissertation will focus on Bennett Architectural Aluminium Solutions Limited (BAASL) who are an established Midlands-based company specialising in providing aluminium and bolted glass glazing solutions for a variety of projects nationwide. The company was founded in 1960 and with a current annual turnover in the region of £10 million, has established itself as a reputable specialist sub-contractor and leading Kawneer dealer who offer a fully integrated service from the initial design stage through to installation of architectural aluminium projects.

BAASL are positioned within the top 10 of the 70 Kawneer dealers across the UK and need to assess how BIM will affect their business plan over the next 4 years. They operate in both the Public and Private industry sectors where their largest curtain wall project to date has been £3.5 million. Other companies wishing to adopt the BAASL approach should consider the industry sector they work in, the type of contractor they work for and the value of the projects they undertake and tailor their implementation strategy accordingly.

BAASL are an Investors in People accredited company who keep comprehensive training records of all employees, and encourage personal development through their appraisal system. This can be evidenced by the fact that apart from the two company directors, four of the remaining five Senior Management Team members all started with the company in lesser roles.

Following the launch of the BSF initiative in 2003, which announced and the Government's intention to rebuild or refurbish all England's 3,500 secondary schools, BAASL shaped both their business plan and model to target work in this area. New hospitals being built under the PFI scheme were also targeted by the company and the success of this focus is reflected in their order intake over the last three years.

Figure 1.2.2, shows the project split for BAASL in terms of their order intake by sector for 2009, with Figure 1.2.4 and 1.2.6 showing a comparison for 2010 and 2011 respectively. Sitting alongside these charts are Figures 1.2.1, 1.2.3 and 1.2.5 which show the market split for the construction industry over the same periods. This demonstrates that BAASL's top two areas, of Health and Education, have followed the same trend as that of the construction industry as a whole.

2009 Construction Industry Market Split

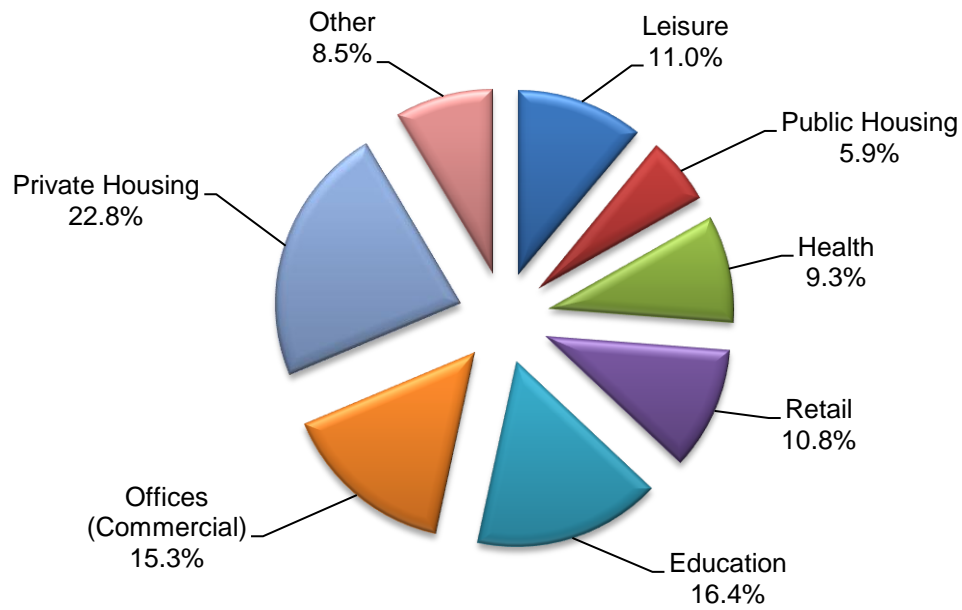


Figure 1.2.1: 2009 Construction Industry Market Split

2009 BAASL Projects by Sector

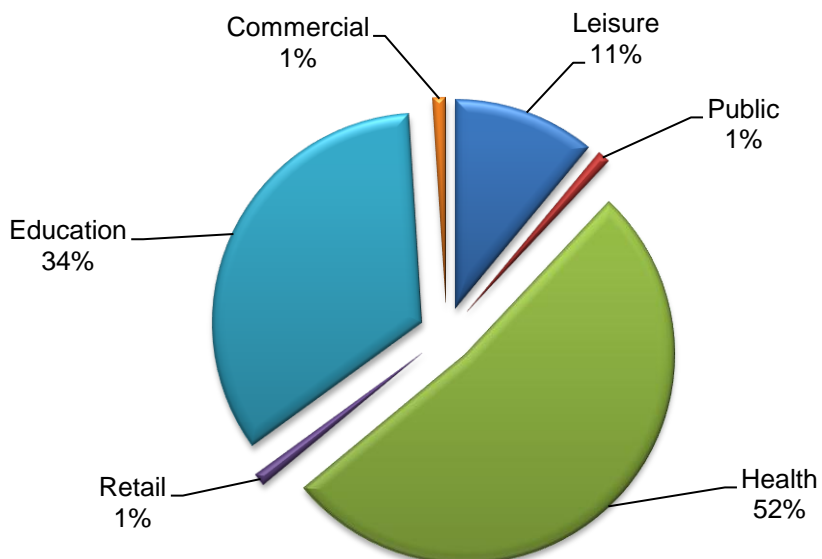


Figure 1.2.2: 2009 BAASL Projects by Sector

2010 Construction Industry Market Split

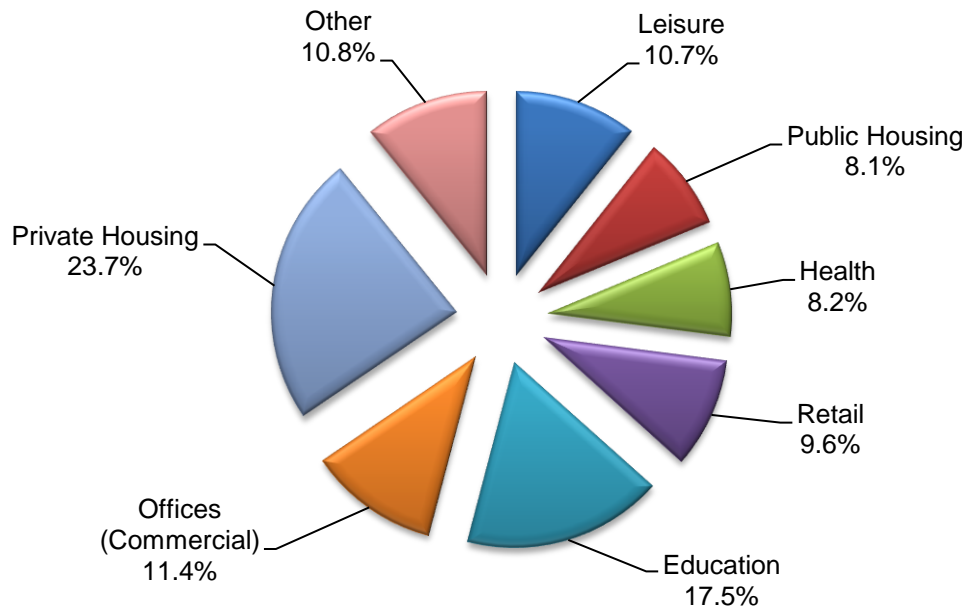


Figure 1.2.3: 2010 Construction Industry Market Split

2010 BAASL Projects by Sector

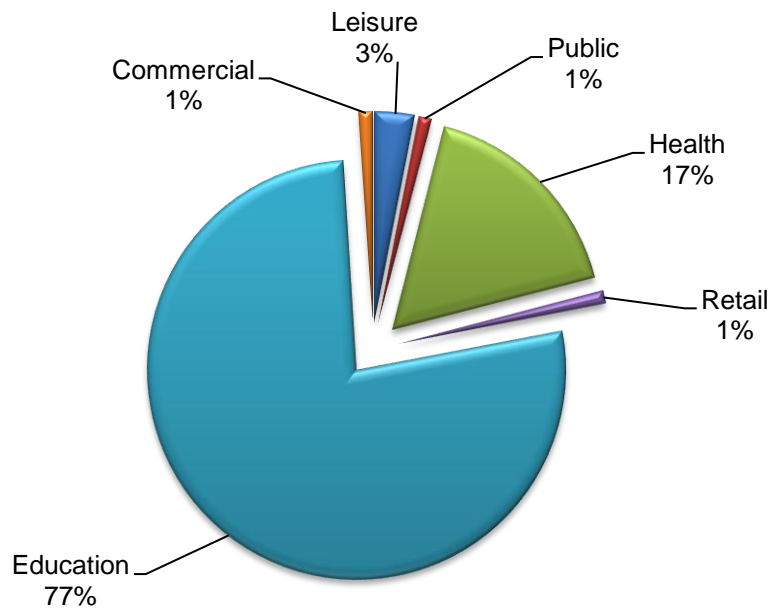


Figure 1.2.4: 2010 BAASL Projects by Sector

2011 Construction Industry Market Split

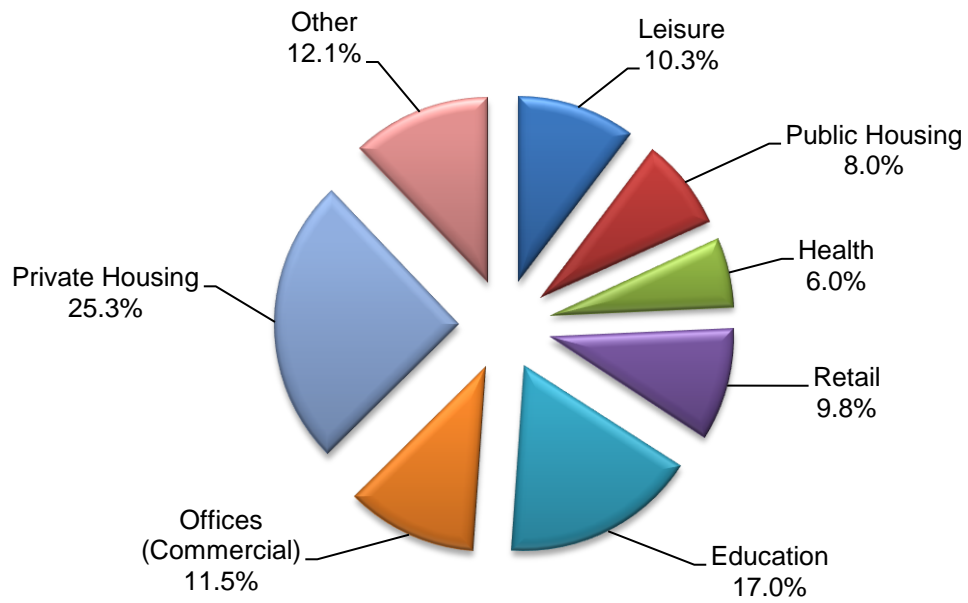


Figure 1.2.5: 2011 Construction Industry Market Split

2011 BAASL Projects by Sector

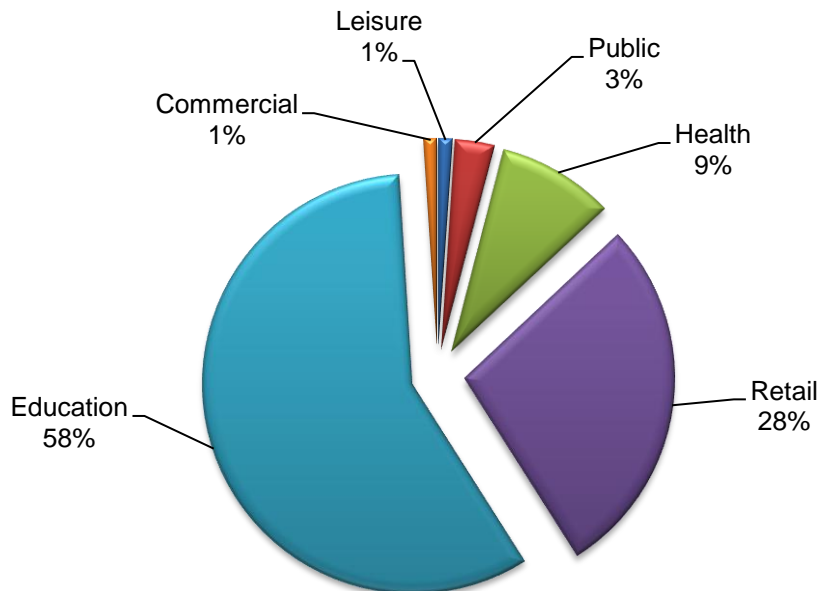


Figure 1.2.6: 2011 BAASL Projects by Sector

Estimated Market Split 2012 - 2014 Compared to 2011

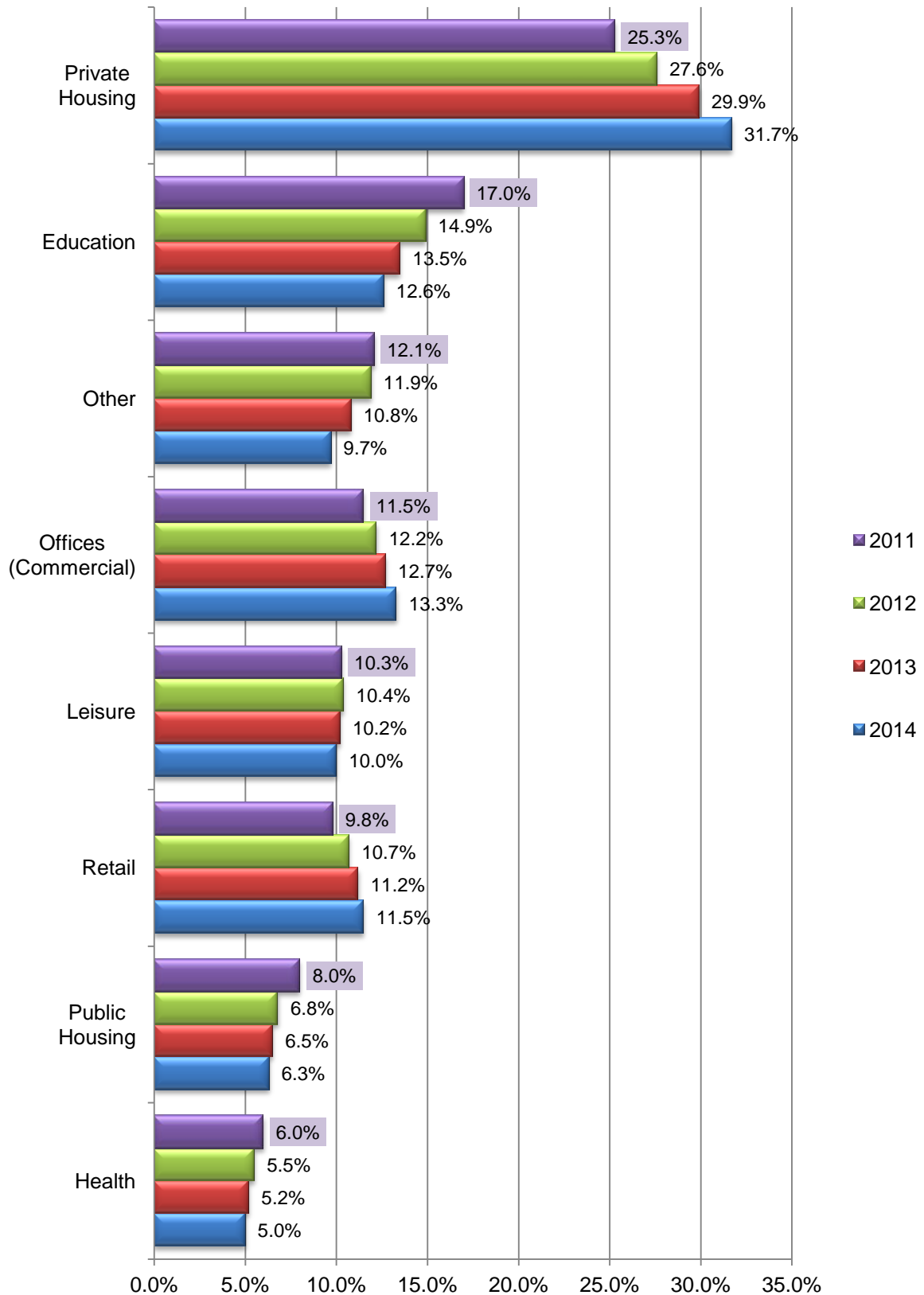


Figure 1.2.7: Estimated Market Split for 2012 – 2014 Compared to 2011

Figure 1.2.7 shows the estimated market split for 2012, 2013 & 2014 (compared to 2011) as predicted by the Construction Products Association, (2012), which is only predicting growth in the Private Housing, Office (Commercial) and Retail markets. Historic data of the sector split for BAASL shows that Education and Health have been consistently high for the company (as illustrated in Figures 1.2.2, 1.2.4 and 1.2.6) and even with the predicted reduction in these areas, BAASL are still forecasting that Education and Health will remain two of their key areas. This is due to the market focus of the key contractors that BAASL work with, and their past experience in delivering these types of projects. All Government funded projects within the Health and Education sectors need to adopt BIM by 2016, which reinforces the need for BAASL to consider a strategy for BIM adoption.

The company portfolio includes major new build projects at the University Hospital of North Staffordshire and Wythenshaw Hospital in Greater Manchester, together with extensive refurbishment contracts at Hospitals in Merseyside and North Wales. They have also completed a large number of new school and academy projects for the Manchester, Tameside and Wolverhampton BSF frameworks. All schools and hospitals have complex specifications relating to areas such as security, occupancy comfort and functionality, so the introduction of BIM (and its ability to construct and modify the building in a virtual world) will give the end user assurance of how the building will perform prior to starting construction.

BAASL are also an accredited supplier and installer within the 'Scape' refurbishment framework for schools. The Scape website gives the following company definition: *'Scape System Build Ltd is a Local Authority controlled company wholly owned by Derby City, Derbyshire County, Gateshead, Nottingham City, Nottinghamshire County and Warwickshire County Councils in equal shares. Scape began trading 1 April 2006 and acts as a Contracting Authority and Central Purchasing Body as defined in the EU Procurement Directives. Our vision is to be leaders in collaborative working, providing cost effective solutions by using simple, easy to use and hassle free processes which deliver an inclusive and engaging experience for our clients and the communities they serve,'* (Scape, 2011).

As well as benefiting new build projects, BIM would also support refurbishment projects like Scape, (2011), as the BIM will contain intelligent data of all the existing materials and components that

have been identified for replacement and therefore eliminating the need to research large volumes of archive data and produce detailed site surveys.

BAASL work with a number of large Main Contractors such as Laing O'Rourke, Carillion, Kier, ISG and Balfour Beatty, liaising directly with their design teams, project Architects, Engineers and systems suppliers. Figure 1.2.8 highlights their position within the supply chain and also indicates the boundary of this dissertation.

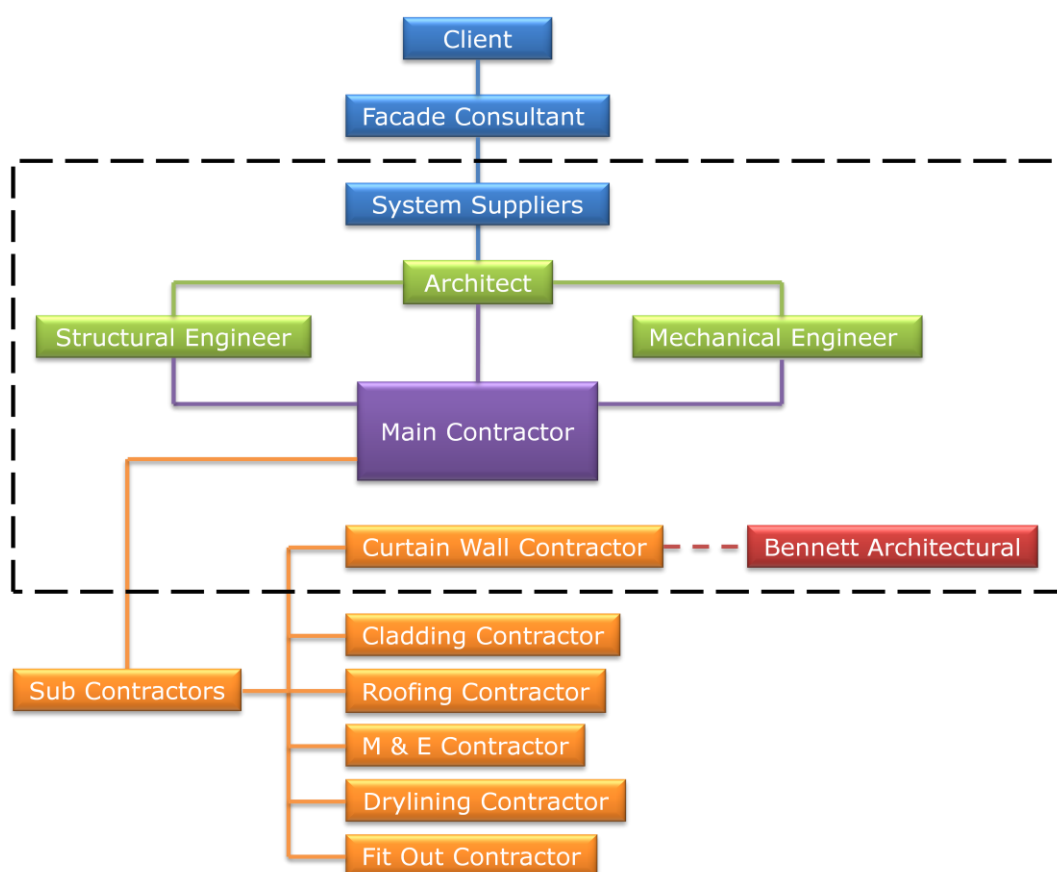


Figure 1.2.8: The Project Supply Chain

To date there is no evidence to suggest the company is losing potential projects as a result of not currently working with BIM. However, BAASL have identified the need to research its philosophy, as they are being questioned more about their current capabilities and future intentions for BIM by the Main Contractors within their client database. Requests have been received from four of the large National Contractors with one in particular inviting BAASL, and other members of their supply chain, to a half-day workshop which aims to provide an introduction to BIM from the perspective of suppliers and sub-contractors to ISG, (ISG, 2012). The full invitation can be seen in **Appendix A**.

At a conference hosted by the WMCCE on 31 January 2012 entitled: '*Breaking Down the Barriers to BIM Adoption*,' the head of BIM implementation at the Cabinet Office; David Philip, stated that BIM protocols will be driven by the supply chain rather than the Government. Although this statement allows for flexibility around the implementation of BIM, it lacks clarity for the individual BIM partners, and especially the SME manufacturing companies within the supply chain.

One of the key decisions for a SME (and other BIM partners) is choosing the right BIM software. The Government has stated that it will not specify or endorse any one particular software provider, which as well as encouraging competition between the various providers, does create a potential issue regarding the ability to transfer data across the software packages. In an attempt to address this, BuildingSmart have launched an initiative called 'Open BIM' where software providers certify that their software will interface with other providers who also sit under the open BIM umbrella.

David Jellings of SmartBIM Solutions told Construction News that open BIM was important to help the flow of transparent data across supply chains and added that a recent seminar on SMEs showed that more than 50 technology platforms had been identified, which needed a common platform to share data gathered on projects, (Fitzpatrick, 2012).

1.3 BAASL Business Development

When measuring the efficiency of a company the main focus should be on their internal processes and business plan.

During a meeting with the Managing Director of BAASL on 5 March 2012, certain key areas were identified where the company wish to advance the business. These particular areas support the vision that BAASL want to establish themselves as a reputable service provider who can deliver projects on time, maintain a high level of accuracy, and increases turnover and profit year on year.

In Section 5.3, a more detailed review of the improvements required to support the MD's wish will be carried out in order to determine the areas where BIM is best suited to support the business development.

1.4 Aims and Objectives

This dissertation is aimed at a specific SME curtain wall sub-contractor; however it also recognises that it will benefit other curtain wall sub-contractors in the construction industry. Figure 1.4.1 provides a schedule of the objectives linked to the research methods, and also indicates the relevant chapter in which the subject is discussed together with the intended deliverables.

	Objectives	Research Method	Chapter / Deliverables
1	Review the philosophy of BIM and its drivers	Desk based study of British Standards and industry journals	2.1 - 2.2 / Understand the benefits of BIM
2	Analyse BAASL's current methods of working and relate to BIM	Desk based study of internal procedures and discussions with departmental managers	2.3 - 2.4 / Establish where BIM may assist BAASL's current working methods
3	Establish the current adoption levels of BIM	Desk based industry review	2.5 / Quantify industry adoption levels, and show where BAASL are in the context of BIM
4	Appraise the knowledge-base and awareness of BIM within BAASL's Key Contractors and ascertain their expectation of BAASL	Canvass BAASL key Contractors by email	4.1 / Define what BAASL's BIM (current and future) outputs need to be
5	Establish whether BAASL's supplier network have the capability to support BAASL with BIM information	Canvass various BAASL suppliers by email - ensuring coverage of all products as a minimum	4.2 / Design a supplier network capable of supporting BAASL
6	Establish the market sector focus over the next 5 years in order to forecast BAASL's need and timescale for BIM adoption	Desk research of industry journals and meetings with Kawneer and BAASL Managing Director	4.3 / Confirm BAASL's need for BIM, including time scale for adoption
7	Appraise the most appropriate BIM software for BAASL	Canvassing BAASL's supply chain and review industry data to establish the most appropriate software provider	4.4 / Identify the most appropriate BIM software for BAASL to invest in
8	Determine the long-term impact of BAASL adopting BIM, including the consequences of <u>not</u> adopting BIM	Consult BAASL Managing Director and review industry views and experiences	5.1 – 5.4 / Quantify resource, training, timescale, cost and ROI
9	Devise a BIM implementation strategy for integration into the BAASL business plan	Review of the Questionnaire findings together with BAASL's business development plan	5.5 / Design an implementation strategy capable of supporting BAASL's business plan

Figure 1.4.1: Objectives linked to Research Methodology

2.0 LITURATURE REVIEW

2.1 What is BIM?

BIM is not a single piece of software; it is a way of working. The phylosophy being that the BIM partners communicate and collaborate by exchanging information throughout the total life of the building. The following definition is given by the British Standards Institution:

The building information model (BIM) is a set of information that is structured in such a way that the data can be shared. A BIM is a digital model of a building in which information about a project is stored. It can be 3D, 4D (integrating time) or even 5D (including cost) – right up to ‘nD’ (a term that covers any other information). As a receptacle for project information, BIM has massive versatility and potential, (Nisbet, N, et al, 2010).

Definitions:

- **2D/3D:** *Modelling in two or three geometric dimensions.*
- **4D:** *Modelling to include schedule/ programme data and simulations.*
- **5D:** *Modelling to include cost data and simulations.*
- **nD:** *Modelling to include a variety of data and simulations, covering, for example, time/schedule, cost, carbon impact, energy use, etc. (n represents the number of these ‘dimensions’), (Connaughton, J, 2012)*

Common BIM Terms:

Lonely BIM - *is used in reference to early level 2 projects where only one party uses BIM technologies.*

Collaborative BIM - *is the converse of Lonely BIM and can be construed as being when all designing parties are utilising BIM. There is, however, no agreement as to whether level 2 BIM is truly ‘collaborative’, although if all parties are producing 3D models and working collaboratively then there is no reason for this not to be the case. ‘Social BIM’ and ‘Integrated BIM’ (iBIM), are also used to describe the same activity, (Sinclair, D, 2012).*

BIM provides a concept for describing and displaying information required in the design, construction and operation of constructed facilities. It can bring together the diverse sets of

information used in construction into a common information environment - reducing, and often eliminating, the need for the many types of paper documentation currently in use, (ISO 29481-1:2010).

How does BIM work? A BIM system can, of course, produce drawings but is no longer based on lines, shapes and text boxes but on data sets that describe objects virtually, in the same way that they will be handled physically. However, the real difference is in the true interoperability and the capability for proper integration, allowing the inputs of the various professionals and specialist to come together in the Building Information Model, (Smith, M, 2011).

Peter Barker, Architectural Director at Ryder Architecture and Operations Director of the BIM Academy, gives the following brief description of the CAD evolution: *'Speaking as one who experienced firsthand the transition from the drawing board to 2D CAD in the late 1980s, the shift to 3D BIM has been far more fundamental and significant. 2D CAD essentially replicates the single line graphical processes of the drawing board and, with a few exceptions, involves the use of unintelligent unrelated objects. This method of working has been unable to keep up with the demands of a very risk averse industry which demands greater certainty in design, cost and programme whilst accommodating increasing levels of complexity and depth in the information to be delivered,' (Barker, P, 2011).*

The *'BIM Overlay to the RIBA Outline Plan of Work'* published in May 2012, makes the following statement with regard to the understanding of the term BIM: *'The most effective way to understand BIM is to refer to the widely used BIM Maturity Diagram prepared by Mervyn Richards and Mark Bew in 2008, as illustrated in Figure 2.1.1.*

This diagram is important as the maturity levels (level 0, 1, 2 and 3) are widely referred to in the industry to the extent that the Government's phased implementation is based on these levels: from summer 2012 projects will be required to implement level 2 BIM, with the Government's aspirations being to have fully collaborative BIM with all project and asset information, documentation and data being electronic as a minimum by 2016.

Importantly, the diagram acknowledges the impact that both data and process management have on BIM,' (Sinclair, D, 2012).

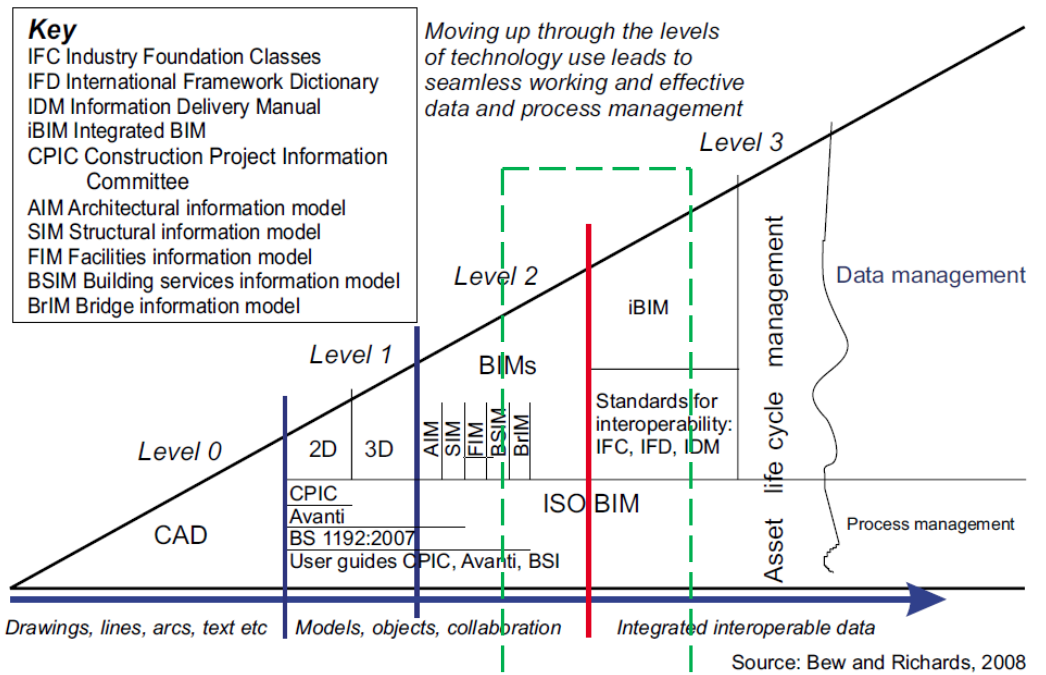


Figure 2.1.1: BIM Maturity Levels

Maturity level 2 by 2016

Many publications about BIM offer definitions of the 3 maturity levels, however the 'BIM Overlay to the RIBA Outline Plan of Work' published in May 2012, goes on to give probably the clearest definitions:

Level 0

Level 0 BIM, as defined by this diagram, is the use of 2D CAD files for production information: a process that the majority of design practices has used for many years. The important point to be derived from the diagram (from the horizontal line separating data and process management which does not commence until level 1 BIM) is that common standards and processes in relation to the use of CAD failed to gain traction as the use of CAD developed.

Level 1

Level 1 BIM acknowledges the increased use of both 2D and 3D information on projects. For architects, 3D software has increasingly been used as a conceptual design tool during the early project stages (typically RIBA stages C & D) and for visualisation of the finished project for presentation to the client. This form of BIM where only one party utilises the benefits of the model is frequently referred to as 'Lonely BIM' – the BIM model is not used collaboratively between team

members. The use of 3D tools beyond this stage has commonly been limited to large infrastructure projects. On such projects, the use of 3D models by trade contractors is also becoming more commonplace. The larger M&E contractors have embraced BIM to assist their design processes using supplementary checks undertaken with proprietary software to ensure that co-ordination issues are resolved during the design phase rather than on site. This is a significant step forward towards the aim of minimising waste and inefficiencies in current design and construction processes.

In terms of processes, level 1 embraces the need for management processes to sit alongside design processes. The work of CPIC and Avanti commenced concurrent with early level 1 BIM projects and set out new processes for managing information which are now embedded in BS 1192:2007, Collaborative production of architectural, engineering and construction information – Code of practice. Further work is currently being undertaken to develop and improve these standards in order to standardise certain aspects of the design process and create consistency in the way the industry works from project to project.

Level 2

Level 2 BIM requires the production of 3D information models by all key members of the Integrated Team. However, these models need not co-exist in a single model. By understanding and utilising BS 1192:2007, designers can ensure that each designer's model progresses in a logical manner before it is used by another designer or a designing sub-contractor. It is not anticipated that the legal, contractual or insurance issues currently utilised by the industry will change for level 2 but it is fair to say that level 2 BIM does expose some of the deficiencies of current contractual documentation. For example, the role of the Model Manager needs to be considered and the roles and responsibilities of the various designers and contracting parties need to be clearer, particularly in relation to Performance Specified Work. The outputs required at each stage will also require greater definition, and in turn this will require the Lead Designer to clarify the inputs that they require at each stage of the design in order to co-ordinate the design as it progresses.

Level 2 BIM requires the current fragmentation of the design team from designing subcontractors to be replaced by Integrated Teams working collaboratively under new forms of procurement using 'plug and play' working methods.

Level 3

The greatest BIM challenges arise when moving from level 2 BIM to level 3 BIM and the perceived 'holy grail' of the single project model. With level 2 resolving the methodology of all the designers working in 3D, the challenge with the single model will not be the collaborative use of the information: it will be harnessing the information in the model so that it is of greater use. For the information to have more value, software Interoperability will be required and the BIM Maturity Diagram acknowledges this (see box under iBIM). With level 3 BIM it will be possible for:

- *early 'rough and ready' design analysis on environmental performance minimising iterative design time;*
- *cost models to be quickly derived from the model using new costing interfaces;*
- *health and safety aspects associated with the construction and maintenance of the building to be analysed parallel with the design; and*
- *asset management, KPI, and other feedback information to be aligned with intelligent briefing, enabling information in the model to develop during design and to be used as part of a Soft Landings approach, and to inform and improve future projects.*

Design processes will need to be developed to their next level of refinement so that there are clear and established methods setting out how many parties can work in the same model environment at the same time. These processes aligned with better scope of service and responsibility documents will allay the fears of some legal or insurance observers, but it has to be acknowledged that the implications and legal issues associated with copyright, responsibilities and scope of services need to be identified and considered further if level 3 BIM is to be successful.

Some observers seem to believe that the single project model will be a 'free for all' but this will not be the case and the software already exists to give read and/or write authorities to each user, and with more sophisticated design management programming techniques it will be possible to prevent designers working on the same area at the same time: for example, ensuring that the M&E engineer is not adding the grilles to the ceiling plan at the same time that the architect is amending it, (Sinclair, D, 2012).

2.2 BIM Drivers

The construction industry has always relied upon the supply chain partners to disseminate information in order that a complete and functional building can be realised. Historically the industry has found it difficult to do this successfully, resulting in projects running over budget, encountering high rework costs, and failing to meet programme.

The launch of the Egan report in 1998 outlined the need for the construction industry to communicate and collaborate on projects in order to improve efficiency and quality. On 8 May 2008 (a decade on), Building reported that: *'Most in the industry say the Egan report is still on the agenda. But although the industry is moving in the right direction, we are well wide of his targets,'* (McMeeken, R, 2008).

On 30 June 2010 the British Standard Institution (BSI) published BS ISO 29481-1:2010, Building information modelling - Information delivery manual. The introduction to this part of the standard states that: *"An information delivery manual (IDM) provides significant help in getting the full benefit from a building construction information model (BIM). If the information required is available when it is needed and the quality of information is satisfactory, the construction process itself will be greatly improved,"* (ISO 29481-1:2010).

Thirteen years after the release of the Egan report, the Government recognised the need for further improvement in communication and collaboration, and decided to take a positive approach towards driving change.

The Cabinet Office announced the Government's new Construction Strategy 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, (Poletayeva, E, 2011). The criteria were that all publicly funded Government projects worth £5m and above, are to use BIM at Maturity Level 2 by 2016.

This intention announced by the Government has sent out a clear message to the whole UK construction supply chain, and as a result BIM has fast become a topic that can no longer be ignored within the UK construction industry.

The BSI B/555 Roadmap (2012 Update), gives the following definition for Maturity Level 2: *'Managed 3D environment held in separate discipline "BIM" tools with attached data. Commercial data managed by an Enterprise resource planning (ERP). Integration on the basis of proprietary interfaces or bespoke middleware could be regarded as "pBIM" (proprietary). The approach may utilise 4D Programme data and 5D cost elements.'*

So why does the UK need BIM? In short, poor productivity. Between 1996 and 2006 there was a 25% increase in the retail price index. For comparison, automobile costs rose a minuscule 1.5% and construction costs rose by a staggering 89%. The industry needs to change and BIM offers substantial opportunities for increasing efficiency, (Muse, A, 2012).

2.3 Current Methods of Working

The construction and facilities industry has historically used a document-based way of working, through drawings and reports, and has communicated through 'unstructured' text such as letters and emails. Documents are embedded in the contractual arrangements – and in the very culture – of the industry. However, documents have a fundamental weakness. When a document is produced, by hand or computer, it is presented on paper or in a computer file as an unstructured stream of text or graphic entities. This can be understood and checked by human beings, but the lack of structure and meaning in the presentation means that it is inherently difficult to reuse or check. It cannot be used computer to computer – in other words, it is not computable, (Nisbet, N, et al, 2010).

When considering the potential impact of BIM on any company, it must think about both the impact on what they output to external partners / customers, and the impact on how these outputs are generated internally within the company. For this reason it is important to understand the current methods of working within BAASL which can best be defined as maturity level 1 (2D) when measured in terms of the BIM Maturity Diagram prepared by Richards and Bew in 2008.

This section sets out to give an overview of the current methods of working within BAASL, and to highlight the current inefficiencies within their process for later analysis when considering a BIM implementation strategy. The BAASL working methods have been split into three key sections; The Tendering Process, The Design Process and The Manufacturing and Installation Process with each supported by a flow diagram. The process symbols indicated in each section with a 'dashed' rectangular boarder represent the processes where BIM could offer support.

2.3.1 The BAASL Tendering Process

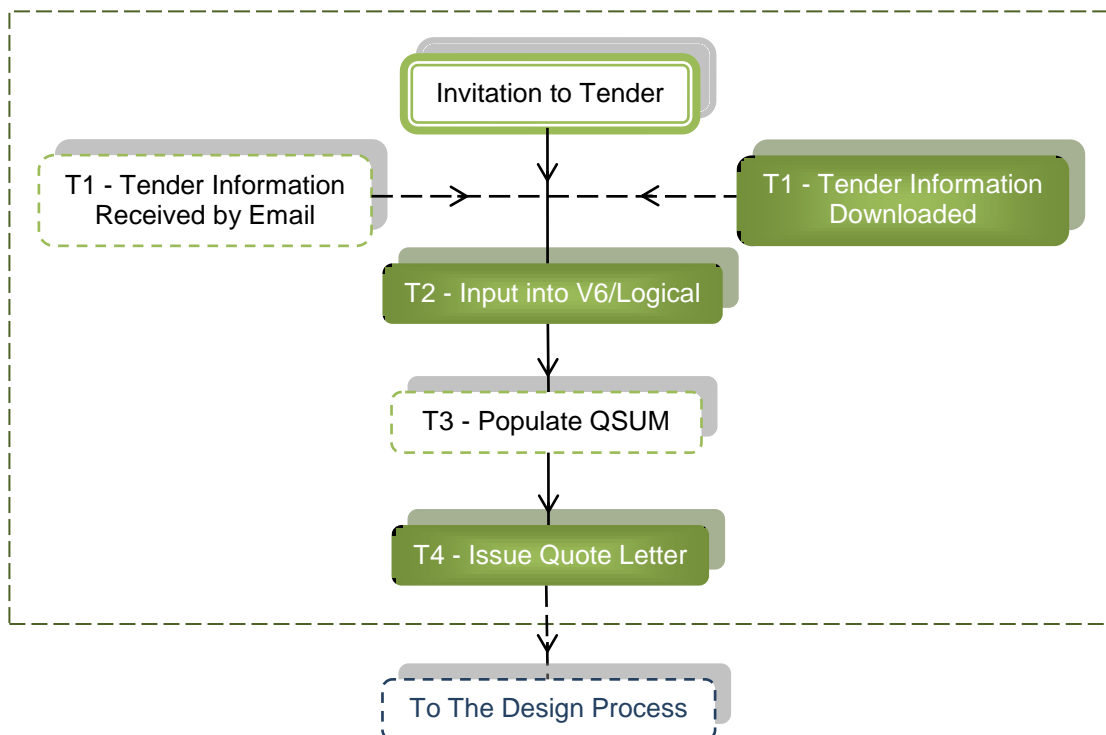


Figure 2.3.1.1: The BAASL Tendering Process

T1 - Drawings and NBS Specifications are either received via post (paper copies and/or disc), email or downloaded from project extranet sites such as Asite, BIW, 4Projects and Buzzsaw and become the reference source for preparing the BAASL quotation. Figure 2.3.1.2 is a screen shot of the Asite extranet where project documents and information is stored and shared.

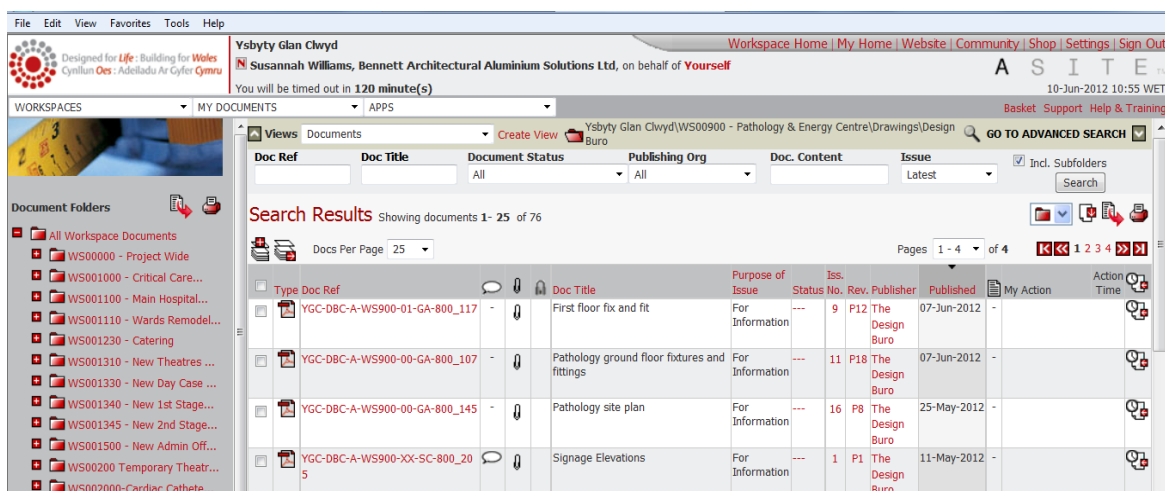


Figure 2.3.1.2: Project Extranet

4Projects give the following definition of their software which provides a collaborative environment for the project supply chain:

'Our collaboration software allows users from disparate locations to keep all emails, photos, drawings, documents, forms and data, in fact any type of electronic file, in one place. The project extranet also enables reporting, searching, automation of processes, and provides a full audit trail. Combined, these tools provide a powerful yet simple to use project extranet, accessible anywhere, anytime with just an internet connection,' (4Projects, 2012).

T2 - Each curtain wall screen, window and door is manually input into the system supplier's estimating software (V6 or Logical) by the BAASL estimators for cost analysis. The software creates a complete BOM for the project and will optimise all individual extrusions and components. Figure 2.3.1.3 is a screen shot of an example curtain wall screen which has been input into the V6 software.

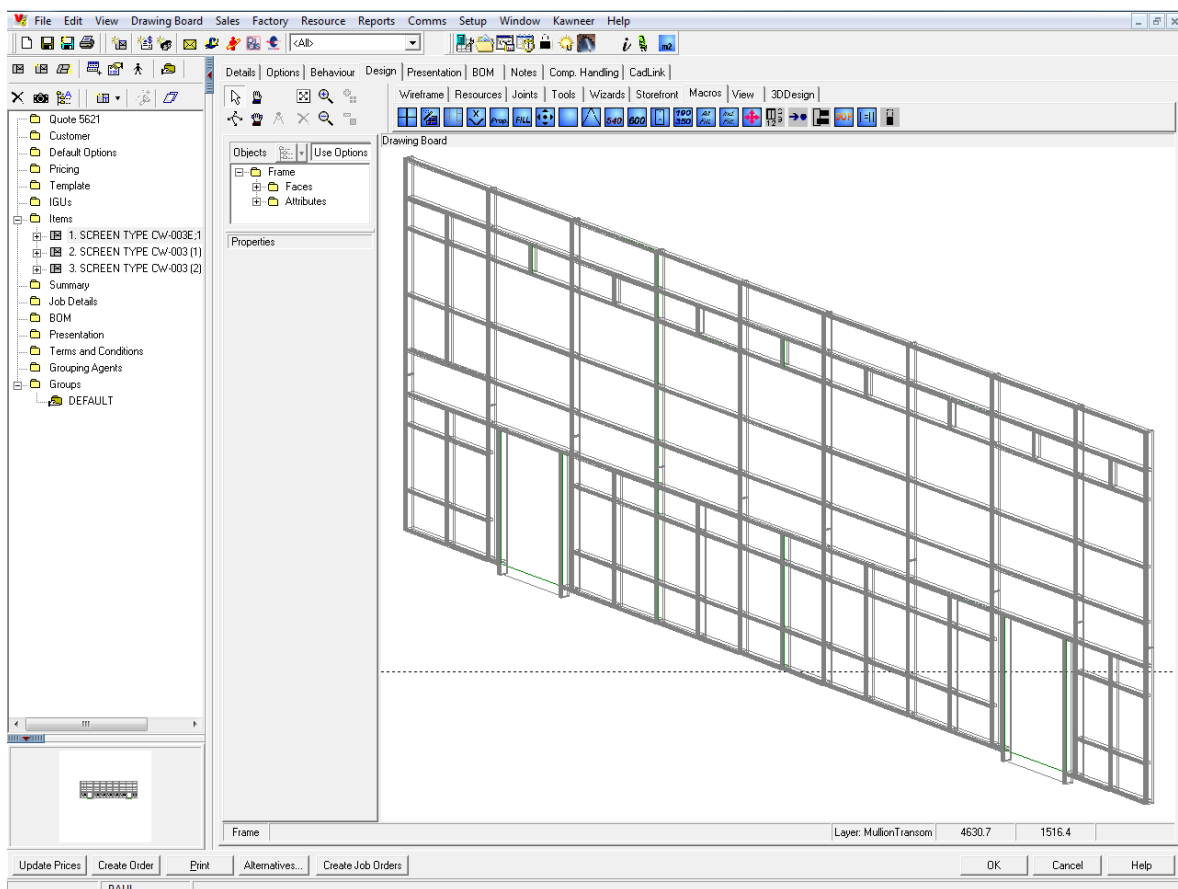


Figure 2.3.1.3: V6 Screen Shot

Basic elevation drawings of each screen are generated from the software and used to supplement the BAASL quotation.

Both the V6 and Logical software packages are capable of producing itemised and average U-Value reports, however only the Logical software can produce a structural analysis report. When inputting into the V6 software independent structural checks are carried out using proprietary software and spreadsheets.

T3 - Data from the estimating software is electronically exported and used to populate BAASL's Excel Quotation Summary Sheet. Figure 2.3.1.4 is an extract of the Quotation Summary Sheet showing some of the pricing fields which make up the overall quotation.

QUOTATION SUMMARY SHEET										
Status:								QTY	1	1
Specification:										
Client:								PRODUCT	600TE	600TE
Project:										
Title:										
NOTES	CODE	CATEGORIES	MARGIN %	BILL PAGE TOTALS	LUMP SUM TOTALS	CATEGORIES	W01	W02	BILL PAGES AND ITEMS	
	1000	ARCHITECTURAL KCH OUTPUTS								
GLASS RATES	1001	Kawneer				12				
	1002	Glass Architectural				13				
	1003	Works Labour (Fabrication)				14				
TEAM DAY RATE	1004	S/C Installation - £45.00/SQM				15				
	1005	S/C Silicone				16				
BOLTED GLASS RATES	2000	BOLTED GLASS								
DOORS	2001	Glass Frameless				18				
	2002	Frameless Fittings				19				
	2003	Pilkington Planar Glass				20				
	2004	Pilkington Fittings				21				
	2005	S/C Installation				22				
	2006	S/C Silicone				23				
	3000	OTHER ITEMS								
	3001	Aluminium Others				25				
	3002	Structural Glazing				26				
	3003	Trickle Vents				27				
	3004	Louvres / Brise Soleil (supply only)				28				
	3005	Ironmongery				29				
	3006	Mastic				30				
	3007	Timber				31				
	3008	Fixings / Fastenings				32				
	3009	Painting / Anodising				33				
	3010	Panels				34				
	3010	Pressings / Brackets / Panels				35				

Figure 2.3.1.4: Quotation Summary Sheet

Costs for ancillary items such as window actuators, automatic door gear, louvres, fire screens etc are manually input into the same Excel Quotation Summary Sheet which is formulated to calculate an overall quotation figure.

T4 - A quote letter is manually created using Microsoft Word and clearly defines the scope and system specifications together with the limitations of the BAASL quotation. This quotation package is submitted to the Main Contractor by either email or courier.

2.3.2 The BAASL Design Process

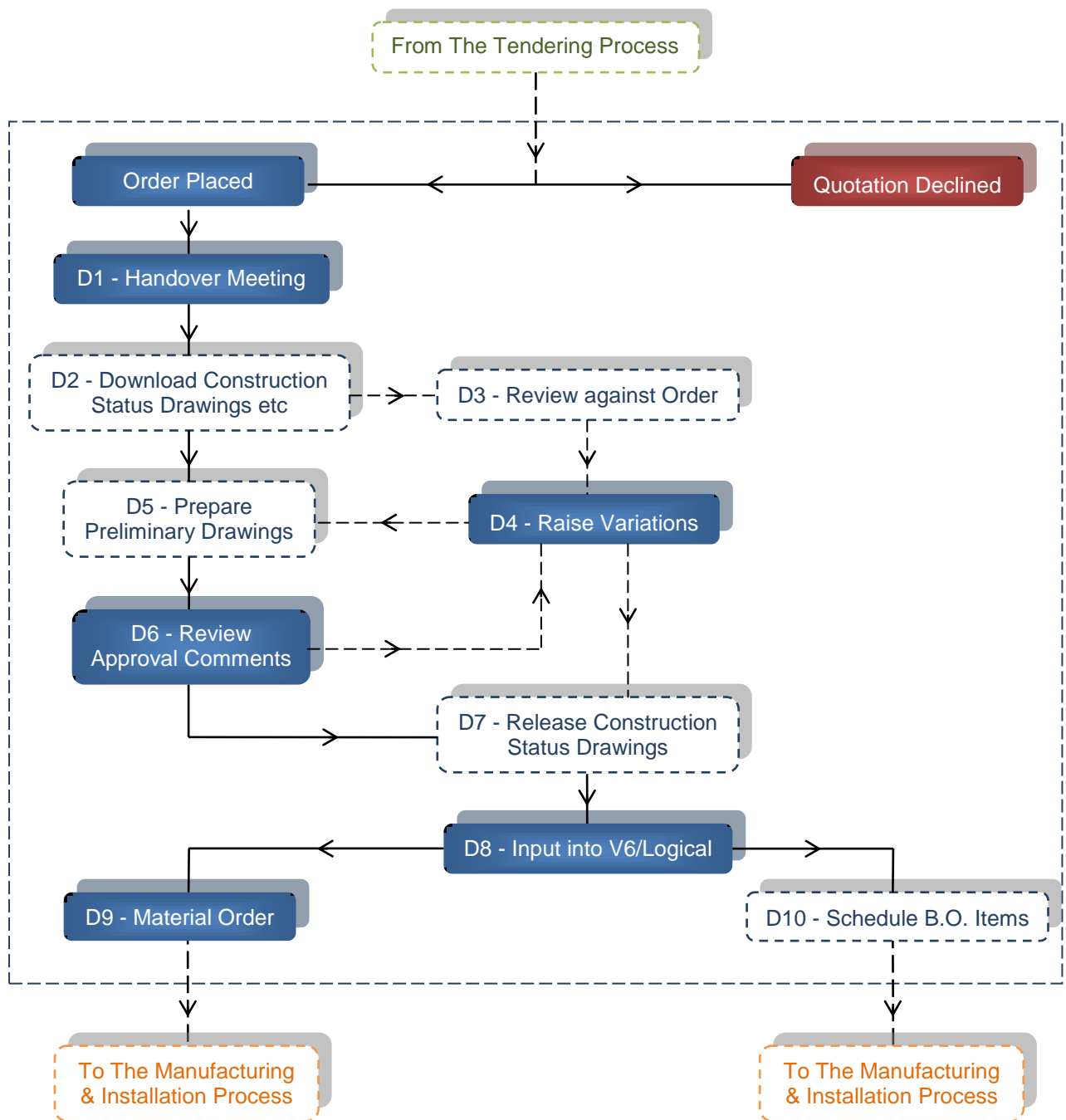


Figure 2.3.2.1: The BAASL Design Process

D1 - Following the pre-let meeting and receipt of the Main Contractors order or letter of intent, an internal handover meeting is chaired by the BAASL Project Manager. At this meeting the scope of the project is discussed together with all pertinent information and correspondence generated through the tendering process.

- D2 - Most of the projects that BAASL undertake utilise extranet technology to manage and control documents. The BAASL Design Technician will download all relevant construction status drawings and specifications from the extranet (Asite, 4projects, Buzzsaw etc - see Figure 2.3.1.2 showing a typical extranet page layout). All relevant Architects, Engineers and Cladding Contractors 2D drawings are downloaded and saved on the BAASL network in .pdf format together with .dwg versions of pertinent layout and interface details.
- D3 - The Design Technician carries out a document review by comparing the construction status drawings and specifications against the tender information in order to highlight any misalignments/changes.
- D4 - Details of any misalignments are passed to the BAASL Quantity Surveyor and Project Manager for their review and action in the form of variations to contract.
- D5 - With the aid of AutoCAD the BAASL Design Technician produces 2D drawings from a basis of standard blocks from the BAASL CAD library, and from extracts taken from the Architects .dwg drawings if available. The project specifications are included on the 2D drawings which are then uploaded onto the extranet for approval/comment by the Architect and Main Contractor.
- D6 - Approval comments are reviewed by the Design Technician who then updates the BAASL working drawings accordingly. If the approval comments constitute changes against the original order, the BAASL Quantity Surveyor and Project Manager are notified so that variations can be raised.
- D7 - The BAASL drawings are now raised to construction status and released to all parties as working drawings.
- D8 - The BAASL Processing Technician manually inputs each curtain wall screen, window and door into the same V6 or Logical software used at tender stage. The initial input made to generate the estimate is not used at this stage as the time it would take to check and amend each entry prior to generating the material order and fabrication reports, would far exceed the time to re-input them.

D9 - The material order for all the curtain wall, window and door extrusions (and components) is generated from the V6 or Logical software and released to the Purchasing Department for procurement.

D10 - Procurement schedules for glass, gaskets, brackets and pressings are generated manually by the Processing Technician, with an electronic check carried out against the V6 or Logical software reports for the glass and gaskets only. Pressing and bracket details are not created within the V6 or Logical software and therefore have to be checked manually against the construction issue drawings.

2.3.3 The BAASL Manufacturing & Installation Process

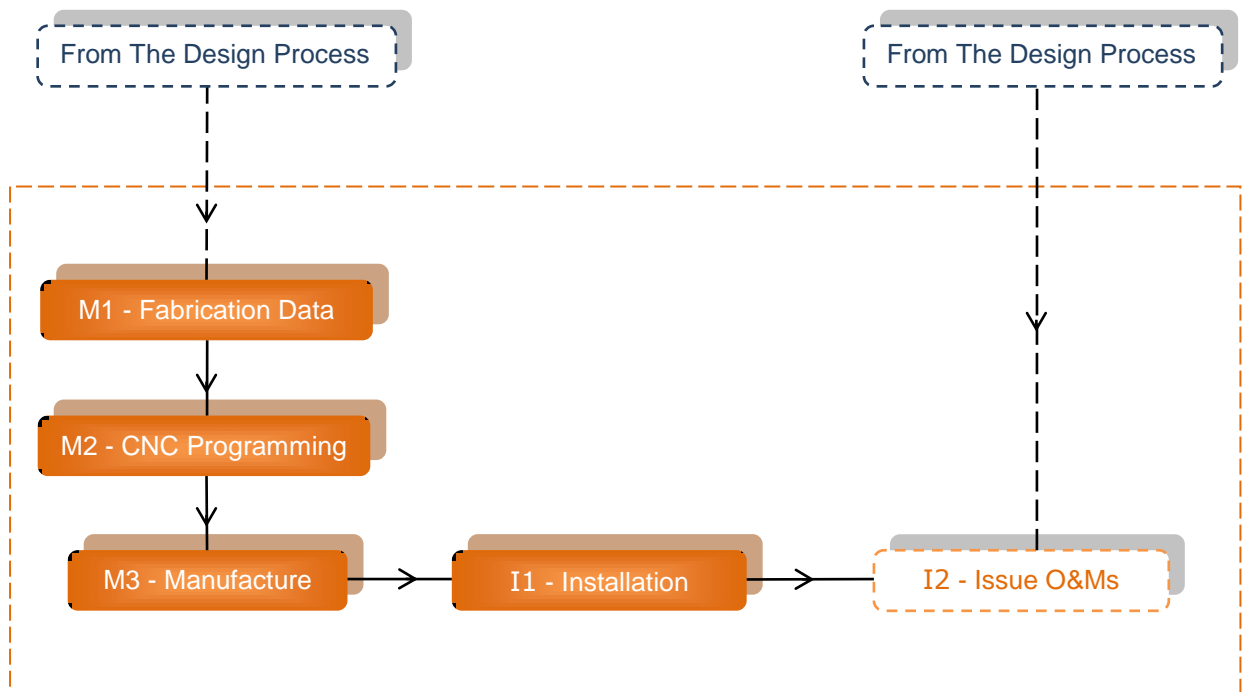


Figure 2.3.3.1: The BAASL Manufacturing & Installation Process

M1 - Paper copies of construction status drawings together with the fabrication reports are issued internally to the BAASL Processing Manager.

M2 - Using this information, the Processing Manager programmes the saw and CNC machine and produces basic arrangement drawings of each curtain wall screen to show the unique mark numbers for each screen member. BAASL do not currently have a direct link-in available from the V6 or Logical software to carryout this function automatically.

M3 - The Processing Manager notifies the Production Manager that the CNC programming is complete and hands over the paper copies of the construction status drawings and fabrication reports. The Production Manager ensures that all items are manufactured in accordance with the project programme.

I1 - All manufactured and bought out items are delivered to site in accordance with the project programme. Paper copies of all BAASL drawings and schedules are held on site by the

fixing team for reference during the installation. All documents are controlled and superseded as necessary in accordance with the companies ISO 9001 procedures.

Method statements and risk assessments are prepared manually by the BAASL Project Managers using Microsoft Word and Excel. Electronic copies are issued to the Main Contractor, and paper copies sent to site for guidance and review by the fixing team during installation.

I2 - On completion of the installation, as built drawings are issued to the Main Contractor as part of the O&M Manuals. The O&M information is collated manually from various sources and issued in electronic format to enable successful operation and maintenance of the building by the end user.

2.4 BIMs Aims and Objectives

When considering the benefits of BIM, we can hypothesise about reducing waste, shorter time on site during the construction phase of the project and generating information for better facilities management. Michael Smith also endorses these thoughts by stating that:

'Managing building information using a building information model can lead to substantial cost savings, from design and construction through to maintenance. The model saves time and waste on site, and extra coordination checks are largely unnecessary; the information generated from the model will lead to fewer errors on site caused by inaccurate and uncoordinated information.'

'When all members of the construction team work on the same model, from early design through to completion, changes are automatically coordinated across the project and information generated is therefore of high quality. Information Technology is an integral part of today's commerce, and transferring information from designers to the producers / constructors is an example where, with the availability of modelling software, the tools are in place. We simply need to understand the process for using them,' (Smith, M, 2011).

In the NBS National BIM Report 2012, David Philp, Head of BIM Implementation at the Cabinet Office and BIM Programme Director at Balfour Beatty, outlines the potential value to the Client in the following statement:

'Although much has been written about BIM, few have truly considered it from the perspective of the Client. While better enabling the design and build process (especially helping tell the story and enable better user understanding), the real big value proposition lies in the bandwidth consequent to practical completion where the data (in our case COBie) and model outcomes can be used to ensure optimal asset performance. Our captured data will allow us to start measuring what really happens in the asset usage, how the systems are actually operated ('Is it easier and more productive for a nurse, teacher or FM staff to use that asset?'). Modelling for better user outcomes and being able to feed this data back to inform future projects is where the real Client value proposition sits,' (Philip, D, 2012b).

An article by the NIBS gives the following definition of COBie; *'Today, most contracts require the handover of paper documents containing equipment lists, product data sheets, warranties, spare*

part lists, preventive maintenance schedules, and other information. This information is essential to support the operations, maintenance, and the management of the facilities assets by the owner and/or property manager.

Gathering this information at the end of the job, today's standard practice, is expensive, since most of the information has to be recreated from information created earlier. COBie simplifies the work required to capture and record project handover data.

The COBie approach is to enter the data as it is created during design, construction, and commissioning. Designers provide floor, space, and equipment layouts. Contractors provide make, model, and serial numbers of installed equipment. Much of the data provided by contractors comes directly from product manufacturers who can also participate in COBie,' (East, W, 2012). Although this definition is from an American source, it gives a good account of COBie and its role within the UK construction industry.

The BIM philosophy sets out to strengthen project communication and collaboration right from the beginning during the concept design through to the demolition of the building at the end of its life. All data collated is embedded in the BIM during the design and construction phases and is then used during the facilities management of the building through to its eventual decommission and dismantling.

Building information modelling provides a platform to construct a building in the virtual world (where clashes and issues can be resolved with minimal cost and disruption) before the actual building construction and maintenance become a reality. From the citations above it is apparent that providing that the BIM is managed and coordinated effectively, BIM projects stand to realise major benefits.

The flow diagram in Figure 2.4.1 brings together the whole BAASL process from the invitation to tender right through to the submission of the operation and maintenance manual, and highlights the eight areas where the introduction of BIM may improve the way BAASL currently work.

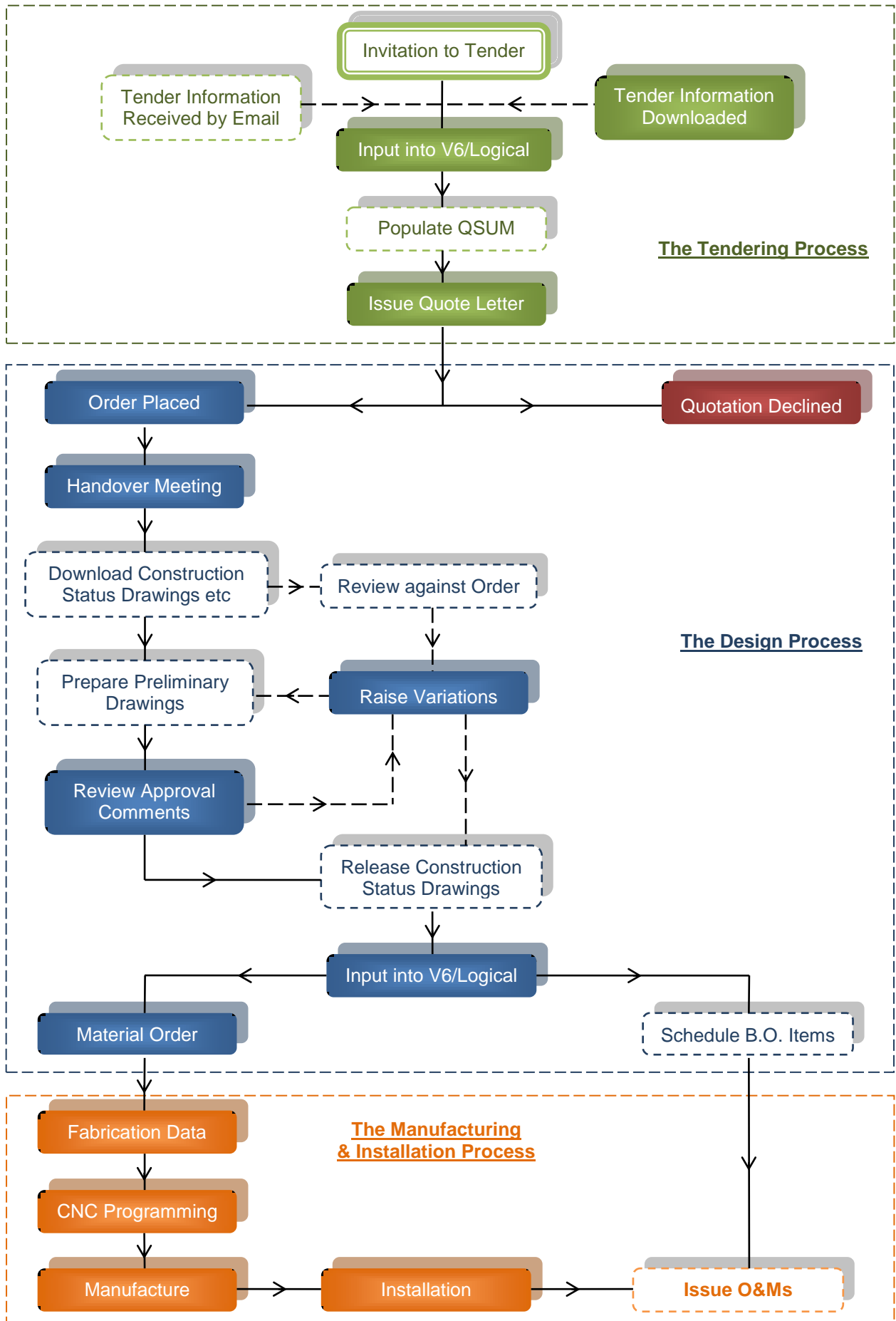


Figure 2.4.1: The BAASL Process Flow Diagram

2.5 Current Adoption Levels of BIM

The second National BIM survey carried out by NBS was released in February 2012 and indicates that BIM adoption has increased significantly in the past 2 years.

The NBS press release on 8 February 2012 states that: *'Results from an annual industry-wide survey undertaken by NBS have provided the most comprehensive and accurate picture of UK BIM (Building Information Modelling) and its growing influence within the built environment industry.'*

Unquestionably one of the hottest topics in construction, the adoption of BIM has recently been described as "unstoppable" by Paul Morrell, the government's chief construction adviser, who has reiterated over the last 12 months the intention to make BIM compulsory for public projects.

NBS's National BIM Survey was completed in late 2011 by nearly 1,000 construction professionals representing a range of business sizes and disciplines from across the industry including architecture, engineering and surveying,' (NBS, 2012b).

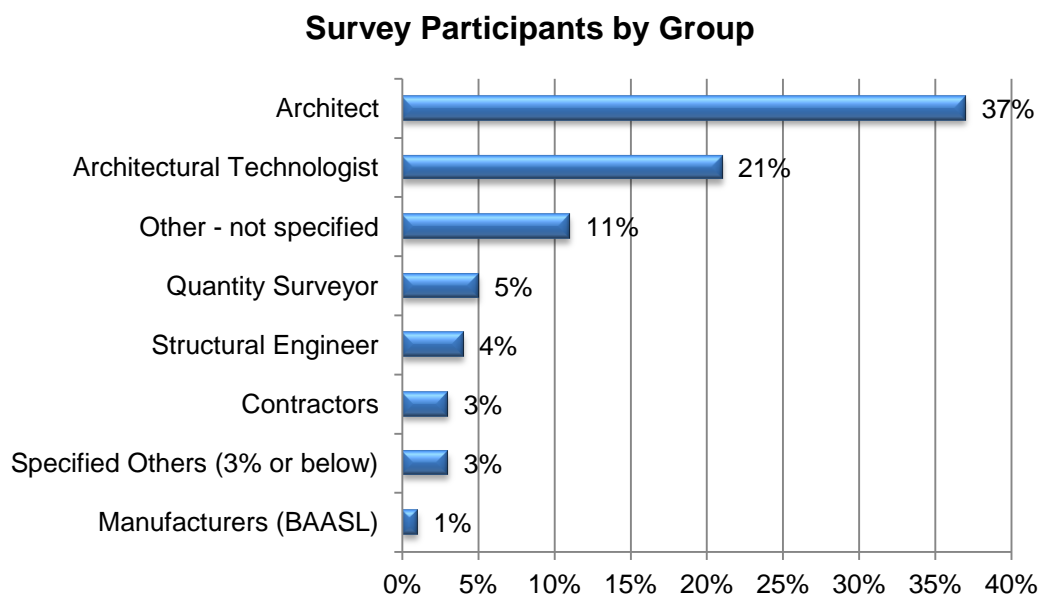


Figure 2.5.1: Survey Participants by Group

Figure 2.5.1 shows that Architects were by far the largest participating group, with over 200 being RIBA members according to a report on the NBS website, (NBS, 2012a). Manufacturers such as BAASL only account for 1% of the survey participants as indicated in Figure 2.5.1.

The groups who participated in the online NBS BIM Survey 2012 give a good indication of the current levels of BIM awareness and adoption within the industry.

Architects and the hierarchy of Main Contractors appear to currently have the greatest awareness and adoption levels of BIM within the industry. This is being driven by:

- the Government strategy;
- the demands of the Client;
- the desire to be market leaders;
- and the threat of being excluded from the tendering process.

Looking further down the supply chain at many of the smaller sub-contractors, the awareness and adoption levels of BIM appear to reduce.

The key findings from the NBS 2012 Survey, show the progress made within the industry over the last 2 years:

- Almost a third (31%) of construction professionals are now using BIM – this figure is up from 13% in 2010 as indicated in Figure 2.5.2.

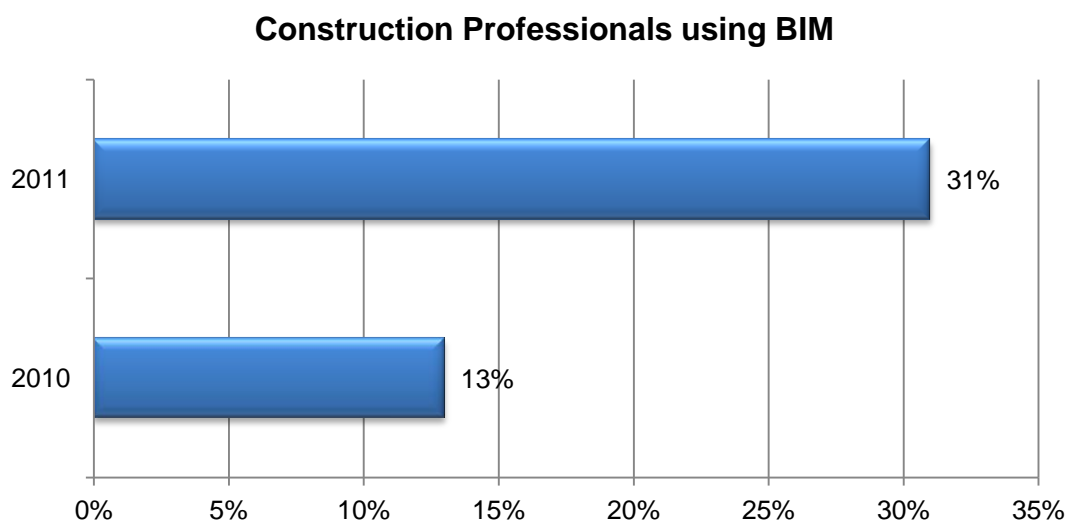


Figure 2.5.2: Percentage of Construction Professionals using BIM

- The number of those unaware of BIM has halved – with just over a fifth (21%) still unfamiliar with the technology compared to 43% in 2010 as indicated in Figure 2.5.3.

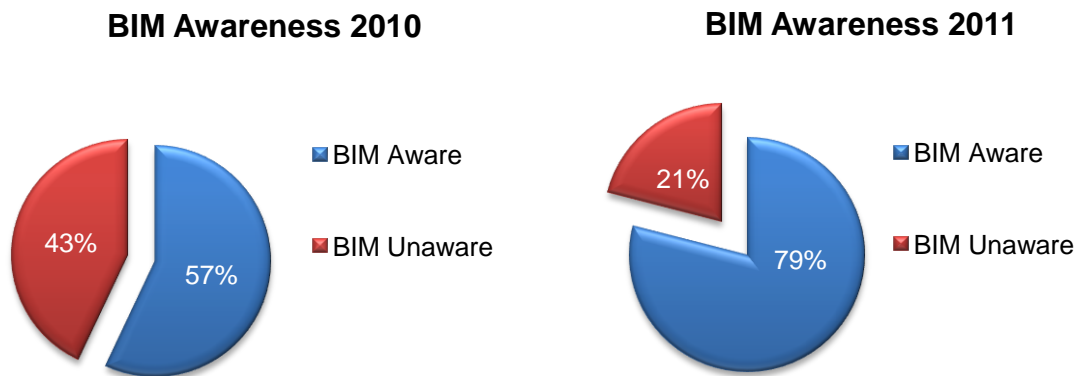


Figure 2.5.3: BIM Awareness Comparison as a Percentage

- Three quarters of those aware of BIM predict they will be using it by the end of 2012 – and almost 19 out of 20 people expect to be using it in five years' time.
- More than 80% agreed BIM improves the coordination of construction documents – with 65% of those using the technology saying BIM delivered cost efficiencies, (Malleeson, A, 2012).

Commenting on the survey in the NBS press release on 8 February 2012, Dr Stephen Hamil, Director of Design and Innovation and Head of BIM at RIBA Enterprises, said:

'The survey clearly shows that in the UK the question is no longer will BIM be adopted but how quickly? The fact that three quarters of those aware of BIM predict they will be using it on projects by the end of the year shows the speed with which things are moving.'

It is the job of the construction industry data providers and software companies, such as NBS, to provide the tools necessary to make the adoption of BIM an easy process. Whether it's specification information, technical guidance, manufacturer product information or geometric objects, the digital information that is produced must be structured to work in the BIM environment,' (NBS, 2012b).

BAASL are currently in the 69% of construction professionals not using BIM, however they are within the 79% who are aware of BIM.

2.6 Problems Facing BIM

In October 2011, Martyn Day supported the concerns over the speed of adoption and the investment required by UK companies by reporting:

'Building Information Modelling (BIM) has had a lot of hype over the years, yet the industry has been slow to change or adopt this new technology. It is estimated that as few as 10 percent of firms in the UK construction industry use BIM software on their projects. This compares to approximately 60 percent in the USA.

While those in the private sector still have complete control over their choice of design methodology, the decision to enforce BIM on government infrastructure and building projects will force many firms to invest in new training and software. Without this they will not be included in future government contracts. This is without doubt an industry transformative decision,' (Day, M, 2011).

Martyn Day's 2011 article goes on to discuss further problems surrounding BIM and can be summarised as follows:

- Return on investment
- Software incompatibility
- Achieving a single BIM
- Co-ordination and management of the BIM
- Controlling change within the BIM
- Late or incorrect data entries
- Learning to work with other project participants
- The impact of front loading the design process – more early decisions made
- Programme control
- People's skill levels – their ability to change and be re-trained
- Contract structures
- Cost of implementation!

(Day, M, 2011)

The industry concerns highlighted in Martyn Day's article (Day, M, 2011) are concerns also shared by BAASL, and must be considered when designing their implementation strategy.

Although the results of the NBS National BIM Survey 2012 show a significant improvement in the adoption and awareness of BIM, Richard Waterhouse puts the findings into perspective in his National BIM Report 2012 Introduction, with the following statement:

'Unfortunately, the second NBS National BIM Survey provides a potentially worrying picture of a divided UK construction industry in which real progress has been made but where real areas of inertia remain. The leap in the percentage of those who are both aware of and use BIM is offset by the large portion of the industry that remains unaware. At a time when government is pushing the industry towards this innovative collaborative environment, our research indicates that far from ignoring the drive towards BIM, one in five remain in blissful ignorance of BIM's existence,' (Waterhouse, R, 2012).

There are still issues surrounding BIM to be addressed as captured by the same NBS survey where it was also found that:

- *BIM remains poorly defined and understood with four out of five of those questioned agreeing that the industry is not yet clear on what BIM is.*
- *The perceived expense and time commitments involved in BIM remain problematic, particularly for smaller businesses with almost two-thirds of respondents agreeing that BIM is too expensive to consider at the moment, (Malleon, A, 2012).*

With these issues in mind, this dissertation sets out to give clarity to a SME sub-contractor in terms of their role within BIM, and to develop an implementation strategy that will enable cost analysis.

Like any other curtain wall manufacturer, BAASL are not immune from the same concerns and issues surrounding BIM, however they do recognise the need to be proactive in their approach to BIM and not to be reactive once the rest of the industry begins to make advances. The uncertainty within the industry will be based around the low percentage of companies currently using BIM, resulting in a limited amount of knowledge and measureable data surrounding its ROI.

2.7 BIM Interaction

BIM will encompass all stakeholders who contribute information towards the design, construction and operation of a building as outlined in Figure 2.7.1.

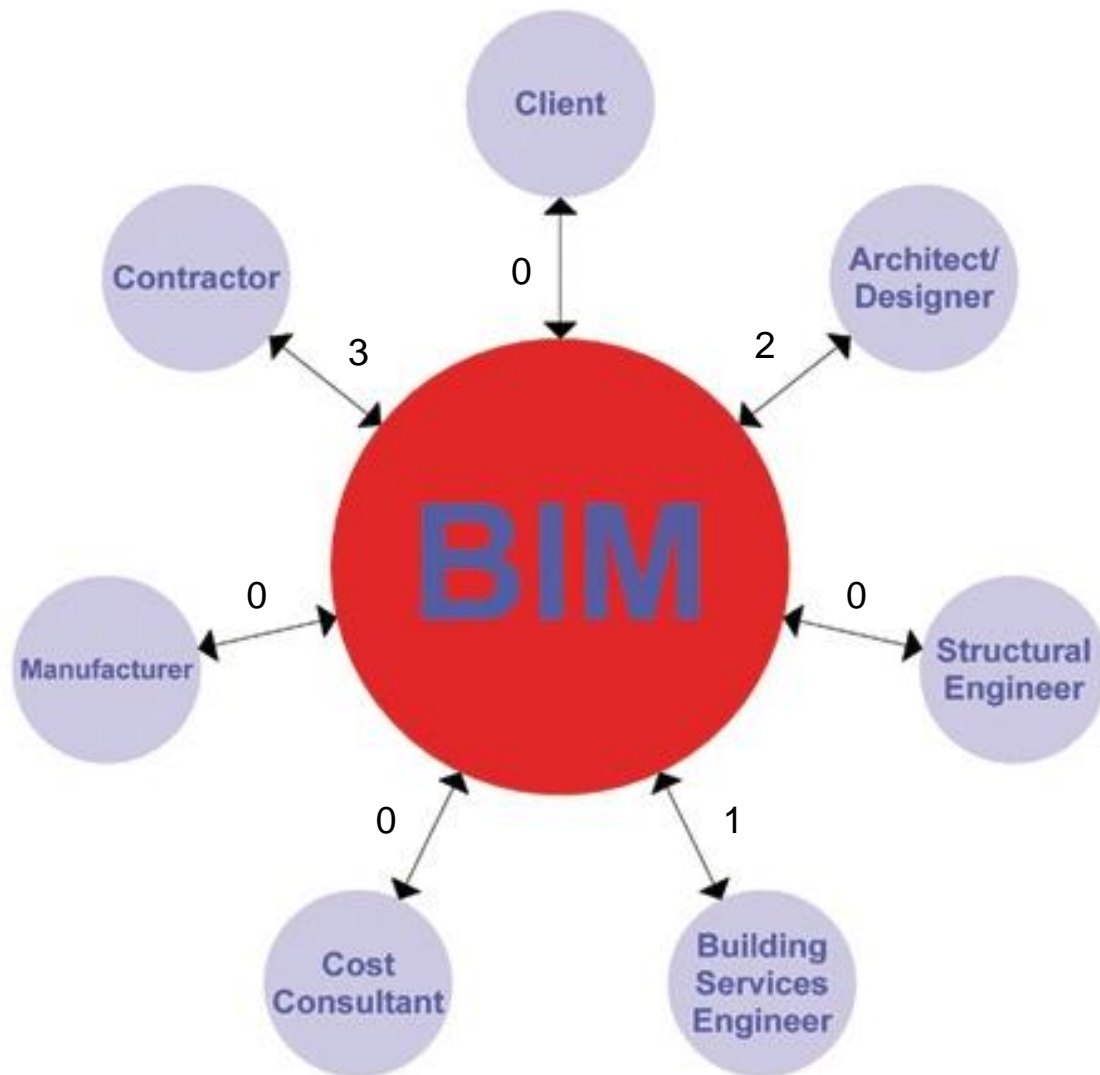


Figure 2.7.1: How members of the project team interact through BIM, (Puckett, K, 2011).

The numbers against each of the double ended arrows indicate BAASL's current level of involvement with the various BIM members, on a scale of 0 – 5 (0 being no engagement and 5 being full engagement).

At the head of the BIM supply chain is the Client who at the forefront of the project has the greatest opportunity to influence BIM adoption and stands to be the biggest benefactor of a process which sets

out deliver key benefits such as performance certainty, overall cost savings and robust FM information.

The BuildingSMART publication released in June 2010, outlines some of the benefits for the BIM supply chain members:

'The technologies that underpin BIM have their roots in shared, structured information which, once created, can be used up and down the value chain.'

BIM has the power to encompass numerous functions, from checking planning regulations, through design, fabrication and construction to operations and FM right through to decommissioning and demolition, if need be – it can serve a project from cradle to grave. Its core strength is that all the parties contribute to the central model and draw from it.

Benefits include clash detection, reducing the cost of changes, clearer scheduling and swifter fabrication using data from the project BIM. There are competitive advantages and green benefits.

Benefits to companies and the wider industry are incremental. As a BIM-aware and practised supply chain emerges, so a better co-ordinated industry can reap the benefits. Clients and industry leaders are encouraged to show the way, allowing all the parties to experience cost certainty, reduced risk and higher quality,' (Nisbet, N, et al, 2010).

In a recent article by David Philip, he encourages companies to 'start now' by quoting advice from Mark Twain; *'The secret of getting ahead is getting started. The secret of getting started is breaking your complex, overwhelming tasks into small manageable tasks, and then starting on the first one,'* (Philip, D, 2012a).

3.0 RESEARCH METHODOLOGY

Using the methodology of desk research, questionnaires and interviews with company directors, this dissertation aims to establish the current adoption level (and predicted growth) of BIM throughout the UK glazed facade supply chain, and to determine the BIM expectation for BAASL by its client base. With the expectations outlined, it will then suggest how BAASL may implement BIM into their business model and also consider the impact of doing so.

This chapter sets out to clarify the chosen research methods, and to explain how they were actioned in order to collate the necessary results for later analysis.

3.1 Desk Based Study of Online Publications from Industry Bodies

3.1.1 National BIM Survey 2012

The survey results from the National BIM Report 2012 have been used to determine the awareness and adoption levels for BIM across the industry. These NBS survey results were chosen because of the industry relevance of the NBS, and because the results could be measured against those from a previous NBS survey. The National BIM Report 2012 was based on a survey carried out during October and November 2011 which was a follow up to the first NBS survey conducted in 2010. Both surveys were conducted online with more than double the number of participants taking part in 2011 (around 1000), compared to the number who took part in 2010.

The survey was aimed at a range of disciplines and business sizes in order to get the views of all the design team members who will collaborate with the BIM. The survey set out to ascertain people's current usage and awareness of BIM, the predicted use of BIM, and people's attitude towards BIM. It was felt that the results from the survey would give BAASL (and the industry as a whole) a sense of how far BIM had progressed during the period between the two surveys, together with how quickly it was likely to progress in the future.

3.1.2 Industry Publications

As BIM is a fast growing topic there have been many articles published during recent years, with greater focus since the Government's strategy was announced on 31 May 2011. Many industry

publications have been referred to during the writing of this dissertation; BSI Publications, NBS Publications and Industry Magazines, with more details given in the references, Section 9.

3.1.3 BIM Conferences

BIM conferences and workshops have been prevalent during 2011 and 2012, with valuable insights gained at two conferences hosted by the WMCCE: '*Breaking Down the Barriers to BIM Adoption*' held on 31 January 2012, and '*BIM and OPENBIM – the story so far*' held on 12 July 2012.

Both conferences were opened by David Philip who is BIM Programme Director for Balfour Beatty currently under secondment to the Cabinet Office as Head of BIM Implementation, and featured key speakers from Architectural practices and Main Contractors. The format of presentations and break out workshops enabled delegates to interact and discuss their experiences and concerns surrounding BIM.

At the first BIM conference the message was very much one of starting out on the BIM journey, and encouraging companies to begin to understand their role within BIM, think beyond their current ways of working and then ask themselves what they want to achieve.

The second conference centred around the progress of BIM in the twelve months since the Government strategy announcement, and the subject of 'Open BIM' which is designed to facilitate the flow of information and the interoperability between the different software packages.

3.2 Email Questionnaires

This dissertation aims to assess how BIM will impact on a SME Curtain Wall Sub-contractor within the UK, with the main consideration centering around the requirements of the key contractors they work for, and the capabilities of their material suppliers. Even though BAASL are the focus for this work, the basis for the information gathering can be adopted by any SME as they too must build their strategy around the requirements and capabilities of their supply chain.

There are four fundamental areas of communication/interaction within any curtain wall sub-contracting company where BIM requirements need to be considered. These are areas where information is exchanged and business relationships are formed, so it is important to canvass these groups when assessing a companies BIM strategy.

Group 1: Main Contractors – will invite curtain wall sub-contractors to tender projects and will be the ones who impose their way of exchanging project information/data when a contract is entered into. It is therefore essential to understand how Main Contractors's intend to collaborate with BIM, as they will be responsible for delivering the BIM to the Client.

Group 2: Architects – are imposed upon the curtain wall sub-contractor as they will undoubtedly be in place before any sub-contractor (and probably Main Contractor), and will dictate the BIM format for the design information/data exchange and coordinate the BIM for the Main Contractor.

Group 3: System Suppliers – all curtain wall sub-contractors need to be aware of the BIM strategy of all their System Suppliers, as what they decide to do and when they plan to do it, will impact their business considerably.

Group 4: General Suppliers – this is one area where curtain wall sub-contractors do have an element of control (unless the Supplier is nominated in the specification) as they can choose the companies they trade with; subject to specification compliance, quality and cost. Canvassing their current Supplier network to assess their BIM capabilities will be essential.

In Section 2, Figure 2.7.1 shows the Main Contractor and Architect as key members of the BIM team, who will be the link between the building Client and the remaining project members. Although the two groups have an equal standing in terms of their role and importance in the BIM, Figure

2.5.1 shows a fundamental gap between them in terms of their participation in the NBS National BIM Survey 2012.

The System Suppliers and General Suppliers have not been identified as specific BIM members or survey participants in Section 2. These two groups will work alongside the key members identified in Figure 2.7.1; the System Suppliers partnering with the Main Contractor and Architect, and the General Suppliers with Manufactures such as BAASL.

The dissertation requires opinions and specific information from individuals rather than statistical data, and for this reason an email questionnaire format was chosen rather than using one of the many online survey providers. As all of the companies who were canvassed are known to BAASL, it was hoped that this would made it easier to identify the appropriate recipient and therefore improve the chances of a response.

Four questionnaire templates were created for distribution to: Main Contractors, Architects, System Suppliers and General Suppliers, as it was considered that a single questionnaire would be difficult to administer bearing in mind the diversity of BAASL's supply chain members.

3.2.1 Main Contractors

BAASL's definition of a 'Key Contractor' is a Contractor who they have developed a strong working relationship with; a Contractor who their Sales team meet on a regular basis and offer technical support during the tendering process.

During 2011 BAASL worked with 24 Main Contractors on projects of varying size and values, with seven of these companies regarded as BAASL's 'Key Contractors' who were to be the target for the questionnaires. Figure 3.2.1.1 shows the percentage of BAASL's turnover that was spent with various Main Contractors. All of the seven Key Contractors were contacted in an attempt to identify the most appropriate questionnaire recipient, however this proved a difficult exercise as many did not have a designated BIM Manager or Co-ordinator or, if they did, some were not prepared to give out their contact details. In most cases the questionnaires were sent out to Design Managers who either completed the questionnaires themselves or passed them on to the relevant member of staff.

Percentage Turnover by Main Contractor 2011

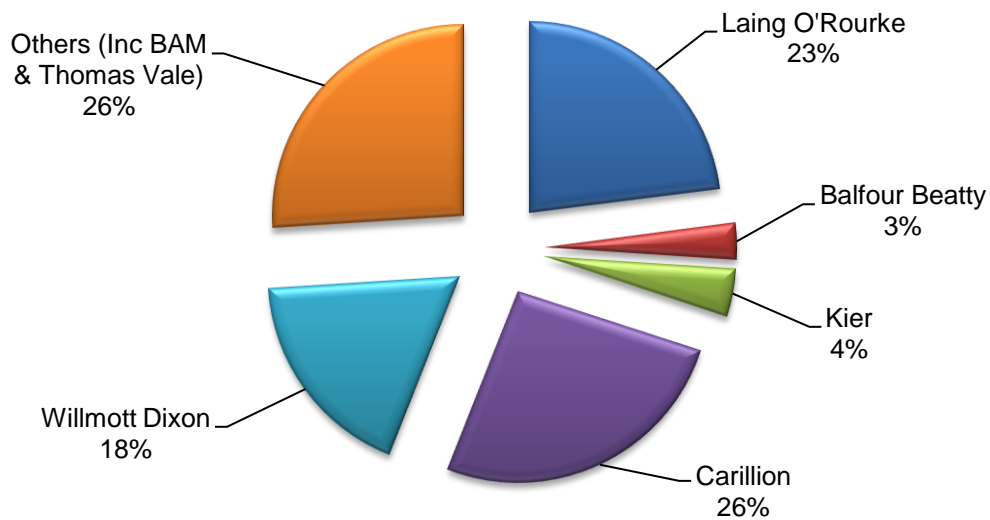


Figure 3.2.1.1: Percentage Turnover by Main Contractor 2011

Questions were tailored towards the Main Contractor in an attempt to establish their BIM awareness, adoption levels, expectations of their sub-contractors, and timescales. The top seven Main Contractors were each sent a questionnaire of which three were completed and returned. The Main Contractor questionnaire can be seen in **Appendix B1**. The following companies were canvassed with further details found in the references, Section 9:

- Laing O'Rourke
- Kier
- Balfour Beatty
- Carillion
- Willmott Dixon
- BAM
- Thomas Vale

At a recent BIM conference hosted by WMCCE, Steve Green from Thomas Vale stated that although the company had around six hundred employees, there were currently only five who were actively involved with BIM, and therefore five hundred and ninety five who had very little or even no knowledge of BIM! This scenario may well be typical of main contractors and could explain the problems experienced in identifying recipients for the questionnaires.

3.2.2 Architects

BAASL target their projects by evaluating either the Contractor who has secured the project (preference given to one of BAASL's Key Contractors), the sector that the project is in (i.e. Health, Education, Commercial, Retail etc.) the type / complexity of project (in terms of the impact on the current design and production work load) or a combination of all three. Rarely will BAASL have the opportunity to select a project on the account of who the Architect is, as the Architect will have been appointed before the Main Contractor.

Although BAASL's contractual obligations are with the Main Contractor, it was considered beneficial to canvass the BIM knowledge of Architectural practices, as they are the main driver of the design process and correspond direct with the BAASL design team on each project. The BIM awareness and adoption level of the Architect will play a key role in determining the BIM strategy for the whole project as they are currently the most likely party to be the owners of the project BIM, and therefore will dictate the requirements for the SME's.

BAASL need the opinion of Architects that they have a history of working with in different market sectors in order to get a cross section of opinion. The two sectors where BAASL have been most active since 2009 were chosen; Health and Education, and two further sectors where they have a history of success; Commercial and Retail, as seen in Figures 1.2.2, 1.2.4 and 1.2.6.

The Architect questionnaire that was emailed out can be seen in **Appendix B2**. The following four Practices were canvassed with further details found in the references, Section 9:

- The Design Buro (Health)
- Chapman Taylor (Retail)
- Ellis Williams Associates (Education)
- AEW Architects (Commercial)

Identifying suitable recipients at the Architectural practices proved an easier process than with the Main Contractors, which is probably due to the fact that all of the Architectural team work intermately with the building CAD. There was also a better response rate from the Architects with three out of the four questionnaires completed and returned, which backs up the findings of the

NBS BIM Survey 2012 where Architects were by far the largest participating group. It should be expected that Architects have the greater BIM awareness, as they are the ones involved in the concept design of the building and will therefore be under pressure from the Client to initiate BIM.

3.2.3 System Suppliers

System suppliers produce extruded aluminium profiles for their own ranges of curtain wall, window and door systems. They also produce product manuals which give detailed guidance to their fabricators for the design, fabrication and installation of each system. Many curtain wall fabricators across the country work with a number of system suppliers, whereas BAASL are a committed Kawneer dealer/fabricator who consistently use Kawneer systems for over 90% of their projects. This statistic is demonstrated in Figures 3.2.3.1, 3.2.3.2 and 3.2.3.3 which shows the system supplier split for BAASL's 2009, 2010 & 2011 projects.

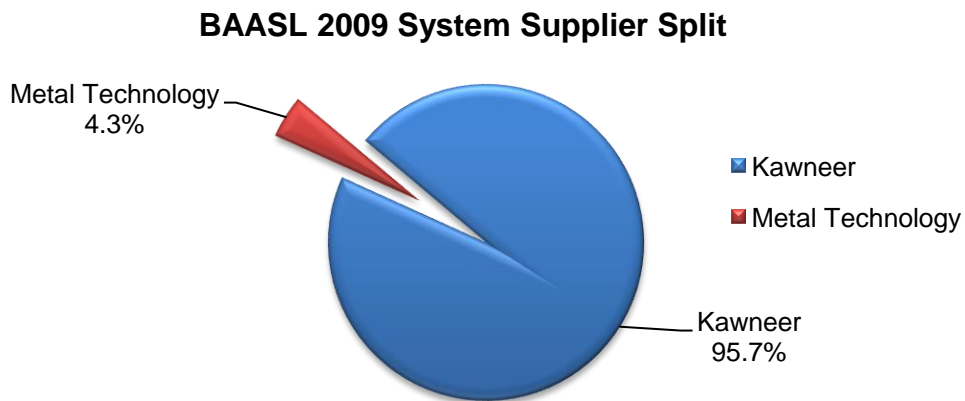


Figure 3.2.3.1: BAASL 2009 System Supplier Split

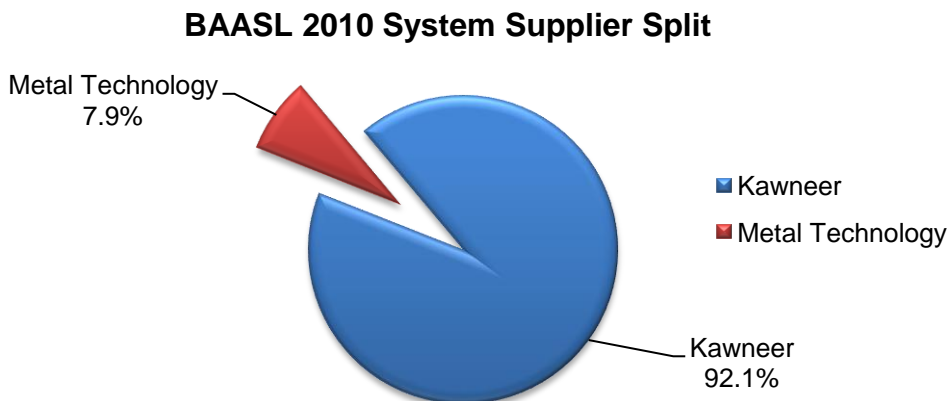


Figure 3.2.3.2: BAASL 2010 System Supplier Split

BAASL 2011 System Supplier Split

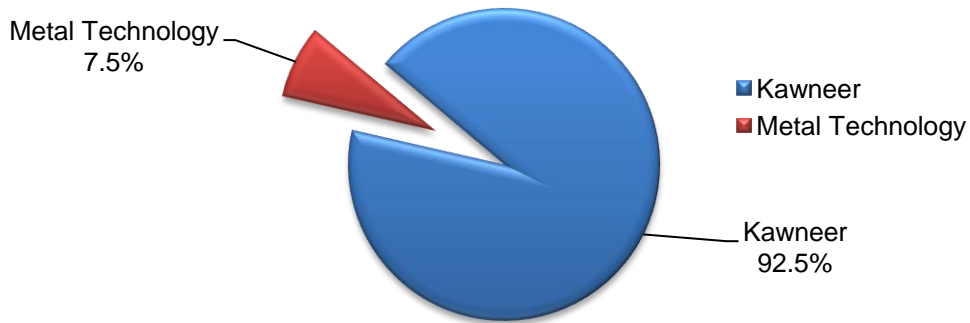


Figure 3.2.3.3: BAASL 2011 System Supplier Split

Both Kawneer and Metal Technology were sent questionnaires designed for system suppliers and can be seen in **Appendix B3**. It is important for BAASL to understand the current BIM awareness and their forward strategy for BIM for both suppliers, as their attitude and approach to BIM will have a significant affect on BAASL. This statement is true for all fabricators across the industry, as the system supplier is the one, who by creating ‘BIM objects’, has an excellent opportunity to get their system embedded early into the project BIM.

Systems Supplier Turnover for 2010 (£m)

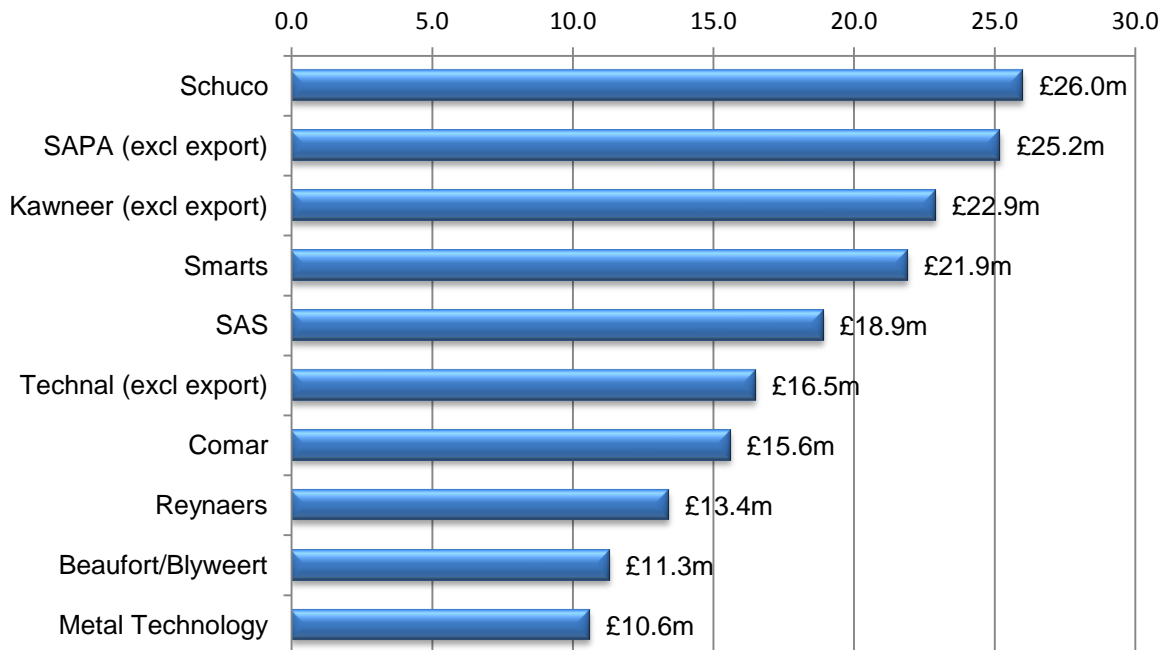


Figure 3.2.3.4: System Supplier Turnover for 2010 (£m)

The actions of the various System Suppliers will greatly influence the fortunes of the many SME dealers across the UK. In 2010 Kawneer were one of the top three suppliers in the UK and have a considerable influence on the curtain wall market. The statistics in Figure 3.2.3.4, are the figures filed at Companies House for 2010, and reflect Kawneers stature in the market place.

3.2.4 General Suppliers

It was important to canvass the awareness and knowledge of BIM within BAASL's supplier network as these companies may need to provide information in a format that will support their BIM obligations. BAASL currently work with a number of suppliers of varying size who provide products ranging from anchor fixings to automatic doors.

In order to gather opinions across the range of suppliers, it was necessary to target product areas rather than just the suppliers who BAASL do the most business with. Targeting suppliers by turnover with would limit the results to only one or two product areas as evidenced in Figure 3.2.4.1 which shows the percentage turnover figures for various product ranges. Like any curtain wall sub-contractor, by far the highest turnover areas will be in Aluminium and Glass.

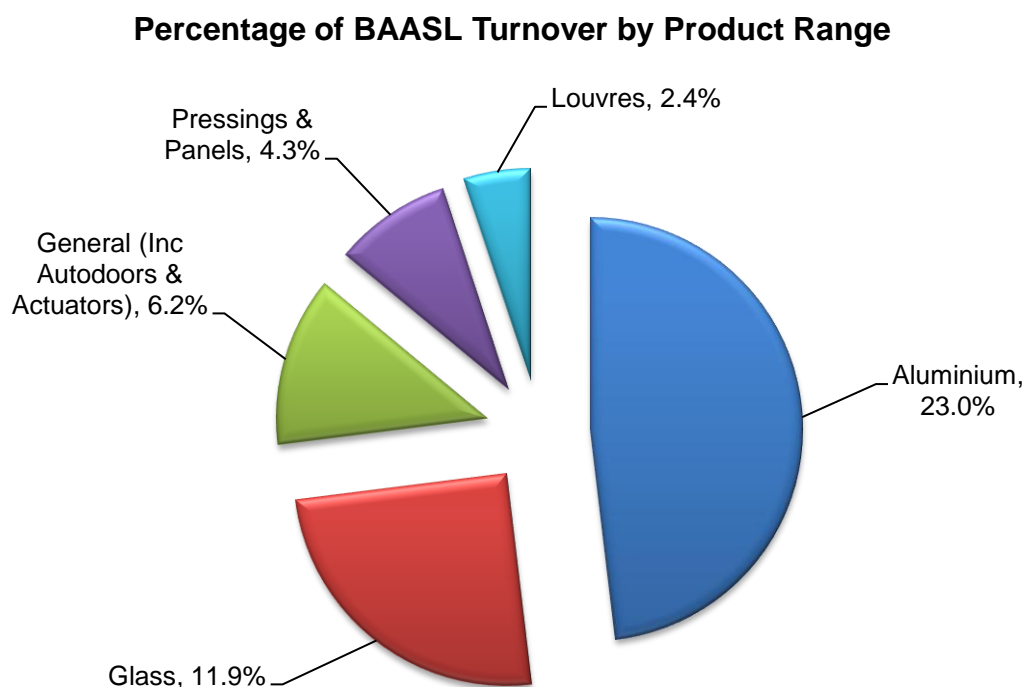


Figure 3.2.4.1: Percentage of BAASL Turnover by Product Range

The suppliers of key bought-in items such as: Automatic Doors, Glass, Pressings/Brackets, Window Controls, Louvres and Fixings needed to be canvassed, so questionnaires were sent out to the suppliers who are most prominent in these product areas for BAASL. The General Supplier questionnaire can be seen in **Appendix B4**.

Supplier	Product	Predicted BIM Engagement (1-5)	Response
GEZE	Automatic Doors	5	✓
Ingersol Rand	Automatic Doors	5	✓
Horton	Automatic Doors	5	✓
Dual Seal	Glass	3	✓
System 3	Glass	3	✗
Ravensby Glass	Glass	3	✗
Eltherington	Pressings/Brackets	1	✗
Redshield	Pressings/Brackets	1	✓
Newbrel	Pressings/Brackets	1	✗
Dyers	Window Controls	4	✗
SJ Fry	Window Controls	4	✗
SE Controls	Window Controls	4	✗
NACO	Louvres	3	✓
Bridge Louvres	Louvres	3	✓
Renson	Louvres	3	✓
Fischer	Fixings	2	✓
Hilti	Fixings	2	✗

Figure 3.2.4.2: General Supplier Questionnaire List

Figure 3.2.4.2 shows that out of the seventeen suppliers canvassed only nine responded which was disappointing, and coincidentally six of the nine came from only two categories. This response rate is indicative of the hypothesis that BIM awareness reduces down the supply chain. A column has been included in Figure 3.2.4.2 entitled 'Predicted BIM Engagement' which is to reflect how BAASL rate the importance/complexity of the suppliers information (5 being the highest).

3.3 Director Interviews

3.3.1 BAASL Managing Director

On 5 March 2012, the Managing Director of BAASL was interviewed in order to establish his views on BIM, his current awareness and understanding of BIM, and whether he had considered how BIM might impact/influence the company's business plan moving forward.

As a subscriber of the industry magazine *Construction News*, the MD had gained a general understanding of BIM from articles by Fitzpatrick, (2012), who discusses the subject of 'open BIM' where contractors are encouraged to help small firms with BIM regardless of the software they use, and Philip, (2012a), who announces that 'BIM is here and now' and explains why SMEs should get on board with BIM.

The BAASL MD is very open to the idea of BIM and is interested in exploring its potential benefits to the company; both internally and externally. The MD's is looking to advance the business by: increasing its reputation as a service provider, delivering projects on time, maintaining a high level of accuracy, and increasing turnover and profit year on year and is keen to see how BIM will be best suited to support the business development - this will be looked at further in Section 5.

A further meeting was held on 2 August 2012 to discuss the market sectors that BAASL will be targeting moving forward and will be discussed later in this chapter.

3.3.2 Kawneer Managing Director

As BAASL are a Kawneer UK dealer who specify their systems on over 90% of their projects, they consider it important to understand the stance that they are taking with regard to BIM. As a system supplier, Kawneer UK are positioned higher in the supply chain than BAASL so the action they take and when they take it will impact significantly on BAASL's BIM opportunities.

On 20 July 2012 a meeting was held with Kawneer UK's Managing Director where it was discovered that they had already started on their BIM journey. They have started to create 'BIM Objects' for some of their glazing systems, and hope to make these available for general use within the next six to nine months.

'BIM Objects' can be created for all building elements such as windows and curtain wall systems and contain intelligent information about that product. The objects are embedded in the BIM for later reference throughout the life of the BIM.

Kawneer UK are part of the world wide Alcoa group, with Kawneer North America already having BIM objects available to download from their website for their range of systems. The glazing systems in the UK are different than those in North America, mainly due to the differing climate and regulations, so the UK division need to develop their own BIM objects for their range of systems.

Figure 3.3.2.1 shows a screen shot of the BIM library format on the Kawneer NA website, with Figure 3.3.2.2 showing the download area where the BIM objects for the various systems can be downloaded by Architects and embedded in the project BIM.

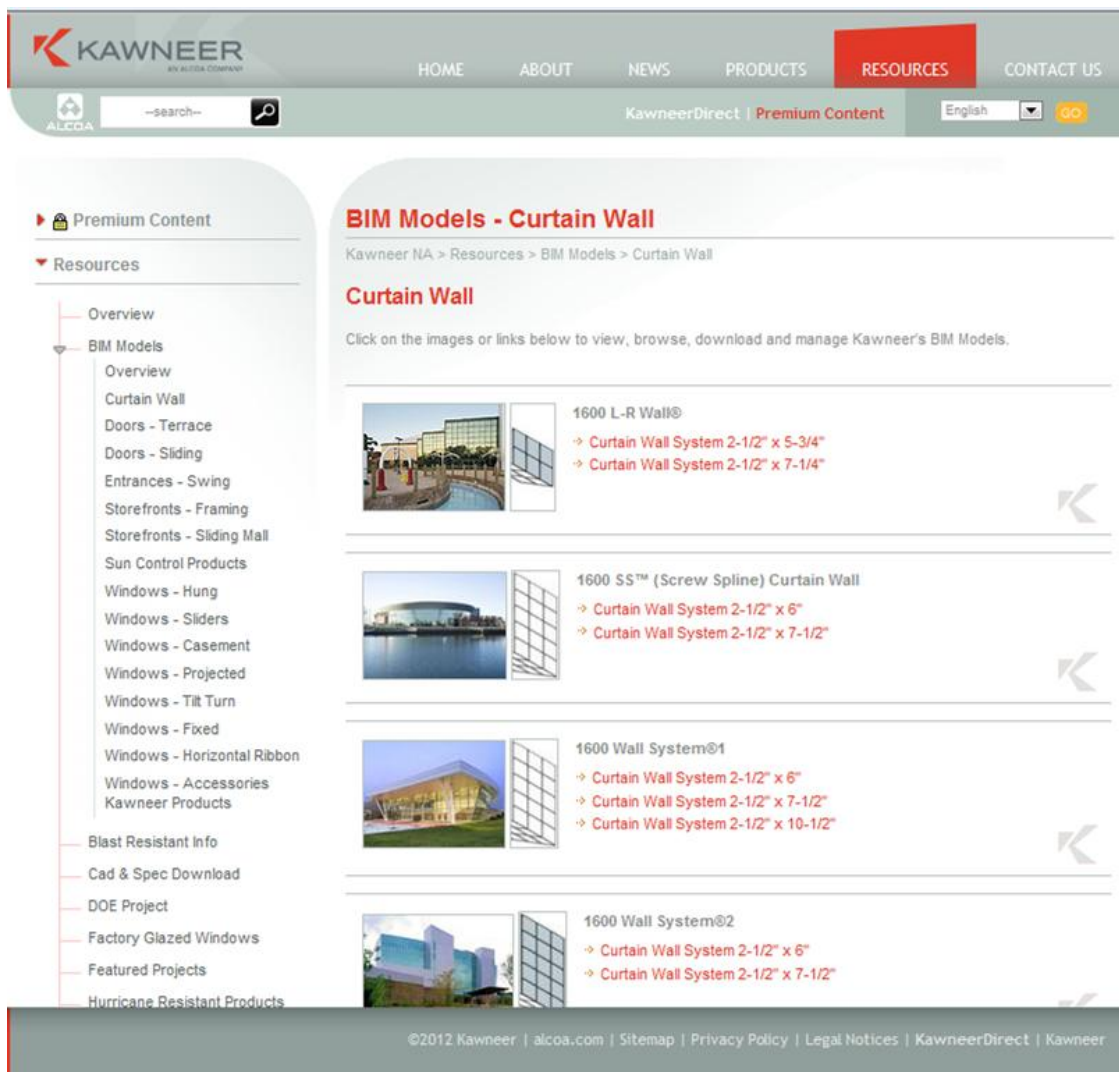


Figure 3.3.2.1: Kawneer NA BIM Library

Kawneer NA: Kawneer-1600_LR_5-34

Download selected

Show All Files **9 files for download**

- 1 RVT file **Select All**
Kawneer - 1600_LR_5-34
Revit
4736K
- 1 DWG file **Select All**
Kawneer - 1600_LR_5-34
AutoCAD 2007/LT2007
108K
- 1 DWF file **Select All**
Kawneer - 1600_LR_5-34
AutoCAD
8K
- 1 DGN file **Select All**
Kawneer - 1600_LR_5-34

Model Number - 1600_LR_5-34

Types/Specifications

Air Infiltration	0.06 CFM @ 6.24 psf
------------------	---------------------

Description

Economical stock length system designed for low-rise applications.

Key Features Include:

- Low rise curtain wall system for stock length sales

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Figure 3.3.2.2: Kawneer NA BIM Object Download Area

4.0 EVALUATING THE IMPACT OF BIM ON BAASL

4.1 Identify what BAASL's Customer Network Expects of Them

It was important to canvass the opinions of BAASL's Main Contractors and Architects in order to establish what they will expect of them in the 'BIM world.' BIM advocates communication and collaboration but is purely a way of working; leaving the finite details of how this is ultimately achieved to the supply chain itself. It is therefore essential that curtain wall sub-contractors such as BAASL engage with their own supply chain to establish the communication formats.

Appraising the demands of their customer network was BAASL's first priority, however it is also important to canvass members of their supplier network as well to determine if they can support BAASL with BIM compliant information. The findings from the supplier questionnaires will be reviewed later in Section 4.2.

In order to gather the necessary information, email questionnaires were sent to companies from the four groups identified in Section 3.2; Main Contractors, Architects, System Suppliers and General Suppliers, with Figure 4.1.1 summarising the questionnaire statistics.

Group	Questionnaires Sent	Questionnaire Responses	% Response Rate
Main Contractor	7	3	43%
Architect	4	3	75%
System Supplier	2	1	50%
General Supplier	17	9	53%
TOTAL	30	16	53%

Figure 4.1.1: Questionnaire Statistics

4.1.1 Findings from the Main Contractor Questionnaires

The answers given on the Main Contractor questionnaires are very consistent across the three companies and reveal the following findings:

- 1) All are aware of BIM.
- 2) All anticipate a restructure of project programmes.
- 3) 2 out of 3 anticipate using BIM regardless of project size.
- 4) All anticipate the need for curtain wall sub-contractors to collaborate using BIM technology.
- 5) None have set a time scale for when sub-contractors need to be BIM compliant.
- 6) All agree that the whole curtain wall package will need to be in BIM format.
- 7) All of the data formats requested will be interoperable through an IFC system.
- 8) 2 out of 3 will use AutoDesk Revit software.
- 9) All agree that earlier information/data will be required.
- 10) 1 out of 3 is predicting data drop points in accordance with PAS1192 – 2:2012.
- 11) All agree that there are no immediate plans to exclude sub-contractors without BIM capabilities from their tendering process.

One of the seven Main Contractors, who did not answer the questions, still provided the following statement by email:

'We are using BIM in the Midlands and it is been used more across the country. I have not yet personally used it, but do understand its advantages. We find clients like it and are starting to write it into a requirement of their design brief at tender stage. The problem we are finding is getting designs and contractors up to speed with producing information in the correct format. We now employ a BIM modeller to collate this information from the various forms it arrives in, and then we can use it to its true potential,' (Wilson, N, 2012).

The questionnaire results from the Main Contractors are summarised in Figure 4.1.2.

Main Contractor Questions		MC1	MC2	MC3
1	Is your company already running projects using BIM technology at Maturity Level 2 (if so what percentage of projects)?	Yes (?%)	Yes 20%	Yes (?%)
2	Have you seen (or do you anticipate) a restructuring of project programmes to suit information flow as a result of BIM?	Yes	Yes	Yes
3	Will your company be adopting BIM on all of its projects regardless of type and size?	No	Yes	Yes
4	Will your company require all of its Curtain Wall Sub-contractors to collaborate using BIM technology?	Not yet	Eventually	Yes
5	If so, has your company established a time scale for when Curtain Wall Sub-contractors need to be BIM compliant?	Not yet	No	Not yet
6	Which elements of the Curtain Wall Sub-contractors information/data will your company require in BIM format?	Eventually All	All	All
7	In what format will information/data be required from Curtain Wall Sub-contractors?	Eventually 3D	IFC & COBie	dwg / nwd
8	Has your company decided on a particular software provider?	Revit	Revit	Navisworks
9	Do you anticipate the requirement for earlier information/data during the tendering and design process?	Yes	Yes	Yes
10	Have specific 'data drop' points been established?	No	PAS1192 – 2:2012	Not sure
11	Will Curtain Wall Sub-contractors without BIM capabilities be excluded from your companies tendering process?	Not at the moment	Unlikely at the moment	Possibly in the future

Figure 4.1.2: Main Contractor Responses

4.1.2 Findings from the Architect Questionnaires

Again there is an element of consistency with the answers from the three Architectural Practices who responded, and can be analysed as follows:

- 1) All are either already using BIM or are in the process of introducing it.
- 2) 2 out of 3 are already running BIM projects.
- 3) 2 out of 3 anticipate a restructure of project programmes.
- 4) 2 out of 3 anticipate using BIM regardless of project size.
- 5) Only 1 is currently liaising with a system supplier.
- 6) All anticipate the need for curtain wall sub-contractors to collaborate using BIM technology.
- 7) None have set a time scale for when sub-contractors need to be BIM compliant.
- 8) Both data formats requested will be interoperable through an IFC system.
- 9) 2 out of 3 will use AutoDesk Revit software.
- 10) 2 out of 3 agree that earlier information/data will be required.
- 11) None have set any specific data drop points.
- 12) All believe that there are no immediate plans to exclude sub-contractors without BIM capabilities from their tendering process, but may be eventually.

The questionnaire results from the Architects are summarised in Figure 4.1.3.

Architect Questions		A1	A2	A3
1	Has BIM already been implemented into your organisation?	Yes	Yes	In the process of
2	Is your organisation currently using BIM (if so what percentage of projects)?	Yes 10%	75%	Will be very soon
3	Have you seen (or do you anticipate) a restructuring of project programmes to suit information flow as a result of BIM?	Yes	We believe so	More effort required
4	Will your organisation be adopting BIM on all of its projects regardless of type and size?	Yes	Yes	Remains to be seen
5	Is your organisation liaising with 'System Suppliers' such as Kawneer with regard to BIM?	Yes	Not yet	Not yet but are aware
6	Will your organisation require Curtain Wall Sub-contractors to collaborate using BIM technology?	Yes in the future	Preferably	Yes we anticipate this happening
7	If so, has your organisation established a time scale for when Curtain Wall Sub-contractors need to be BIM compliant?	Not yet	Main Contractor led	Project specific
8	In what format will information/data be required from Curtain Wall Sub-contractors?	IFC	dwg	dwg
9	Has your organisation decided on a particular software provider?	Vectorworks	Revit	Revit
10	Do you anticipate the requirement for earlier information/data from Curtain Wall Sub-contractors during the early design stages?	Yes	Yes	Probably not
11	Have specific 'data drop' points been established?	Not yet	Not yet	Client driven
12	Will Curtain Wall Sub-contractors without BIM capabilities be excluded from the tendering process?	We believe so eventually	Not necessarily	Not initially but may be eventually

Figure 4.1.3: Architect Responses

4.1.3 Conclude the findings from BAASL's Customer Network

The questionnaire responses support the hypothesis that Main Contractors and Architects are the groups with the greatest awareness of BIM, and places them within the 79% of construction professionals aware of BIM identified in Figure 2.5.3.

The results show that both groups are using or intend to use BIM on all projects regardless of size, and anticipate the need for curtain wall sub-contractors to collaborate using BIM technology, so this is something that BAASL, and all other curtain wall fabricators, must prepare for. Although BIM adoption for BAASL appears inevitable, none of the respondents could give a time scale for when this needs to happen. Curtain wall fabricators must gauge for themselves and consider whether to lead the way or wait until a definite transition point can be established, whilst also bearing in mind the potential tender exclusion predicted by both groups.

There is also a consensus regarding the need for restructuring project programmes, to facilitate the requirement for earlier information and data in the design process, which will need to be reviewed against the SME's current processes and procedures. The current way of working across the industry delivers the O&M information towards the end of the build process in order to guarantee 'as built' information. However, with the BIM philosophy a virtual build takes place before construction starts and will drive the need for accurate information earlier in the design process, which will also facilitate the early release of O&M information.

Two thirds of both Main Contractors and Architects have already adopted, or plan to adopt, 3D CAD software packages as standard. The consequences of this will be appraised later in this section.

4.2 Review the BIM Capabilities of BAASL's Supplier Network

The questionnaire responses from BAASL's customer network make it clear that BAASL will need to adopt the BIM way of working, which supports the statement from Dr Stephen Hamil, (2012b), that in the UK the question is no longer will BIM be adopted but how quickly? The questionnaire findings may be considered representative of the industry in general as BAASL are not the only sub-contractor to work with the canvassed Main Contractors and Architects; merely one of their many supply chain members.

With the expectations of BAASL's customer network established, they need to review the capabilities of their supplier network and their ability to support BAASL during their BIM journey. All curtain wall sub-contractors who intend entering into a BIM way of working will need to carry out a similar exercise with their own suppliers.

The suppliers were split into two groups: System Suppliers and General Suppliers because the business relationships are structured very differently.

In the 1960's BAASL partnered with a system supplier, becoming one of Kawneer's National Dealers, and have stayed loyal to them ever since, as evidenced in Figures 3.2.3.1, 3.2.3.2 and 3.2.3.3. Supply chain partnering such as this, means that the System Supplier has a major influence on the dealer's business strategy.

With general suppliers however, the relationship is not as binding giving the sub-contractor freedom to switch suppliers in order to comply with specification and quality requirements, meet financial constraints, and to maximise commercial opportunity.

Section 4.2.1 looks at the findings from BAASL's System Suppliers, with Section 4.4.2 analysing the those from their General Suppliers.

4.2.1 Findings from the System Supplier Questionnaires

Unfortunately only one of the two System Suppliers returned a completed questionnaire which was disappointing, however it was from BAASL's main system supplier; Kawneer. The answers were very encouraging for BAASL, and the other dealers in the UK, as they show that Kawneer are very aware of BIM in the market place, and are being proactive in developing BIM information.

The fact that they are making a commitment to have 75% of their products available within 12 months, gives clarity to the dealers and allows them to structure both their own implementation and business strategies. As a top three System Supplier, it is important for Kawneer to move quickly as there is evidence to suggest that Schuco (the leading System Supplier; see Figure 3.2.3.4) are leading the BIM push. When asked the question in a recent article: *'Is Schuco a front runner in introducing BIM disciplines?'* Peter Caplehorn, Technical Director of Scott Brownrigg Architects, gave the following response: *'Yes I believe that they're pretty advanced. I have no direct experience of any other systems company being at the same place, although I do know that there are a lot of people in the supply chain in other areas who are really pushing this forward.'* (Schuco, 2012). Although the article was published by Schuco themselves, it would be unwise for other system suppliers to ignore this claim.

The questionnaire responses are also encouraging in terms of; Kawneer's willingness to involve their dealers in their BIM adoption strategy, the importance of getting their product specified in the early BIM, and the fact that they are using AutoDesk Revit which is also the software of choice for two thirds of the Main Contractors and Architects questioned.

The questionnaire results from the System Suppliers are summarised in Figure 4.2.1.1.

System Supplier Questions		SS1	SS2
1	Is your company aware of BIM?	Yes	TBA
2	Does your company have a BIM Coordinator/Manager?	Yes	TBA
3	Is your company currently liaising with Architects and Main Contractors regarding BIM?	Yes	TBA
4	Is your company currently considering a BIM implementation strategy within the company?	Yes – Investment unavoidable	TBA
5	If so has your company set a timescale for BIM adoption?	Within 12 months for 75% of our products	TBA
6	Will your company be involving their dealers/fabricators as they consider BIM adoption?	Yes – if dealers show interest	TBA
7	Has your company considered how they will support their dealers/fabricators with BIM information/data?	Not yet	TBA
8	Some industry reports suggest that changing specification will become harder once specific systems are embedded early into the BIM model – have you considered the potential impact of this?	Yes – we are working with this in mind	TBA
9	Has your company decided on a particular software provider?	AutoDesk Revit	TBA

Figure 4.2.1.1: System Supplier Responses

4.2.2 Findings from the General Supplier Questionnaires

Of the seventeen general suppliers questioned, nine responded as summarised in Figure 4.2.2, and can be analysed as follows:

- Only one supplier was unaware of BIM.
- Even though general awareness was good, only three of the nine were currently looking at BIM and considering implementation.
- Their lack of BIM knowledge reflects in the fact that the majority are uncertain of the impact on their company.
- Eight of the nine suppliers can already provide all O&M documentation in various electronic formats.
- Eight of the nine can also provide full product information earlier in the design process.
- None of the suppliers are currently providing information/data for entry into BIM models.

The questionnaire responses show that BAASL's general suppliers are among the 79% of construction professionals aware of BIM as identified in Figure 2.5.3. However only one third of respondents are currently looking at a BIM implementation strategy, which indicates how the pressure to implement BIM will cascade down the supply chain as demand from the members above increases. The suppliers current lack of involvement with BIM is also reflected in the NBS National BIM Survey participants shown in Figure 2.5.1, where only 1% came from manufacturing.

The questionnaire results from the General Suppliers are summarised in Figure 4.2.2.1.

How will BIM impact on a SME Curtain Wall Sub-contractor in the UK?

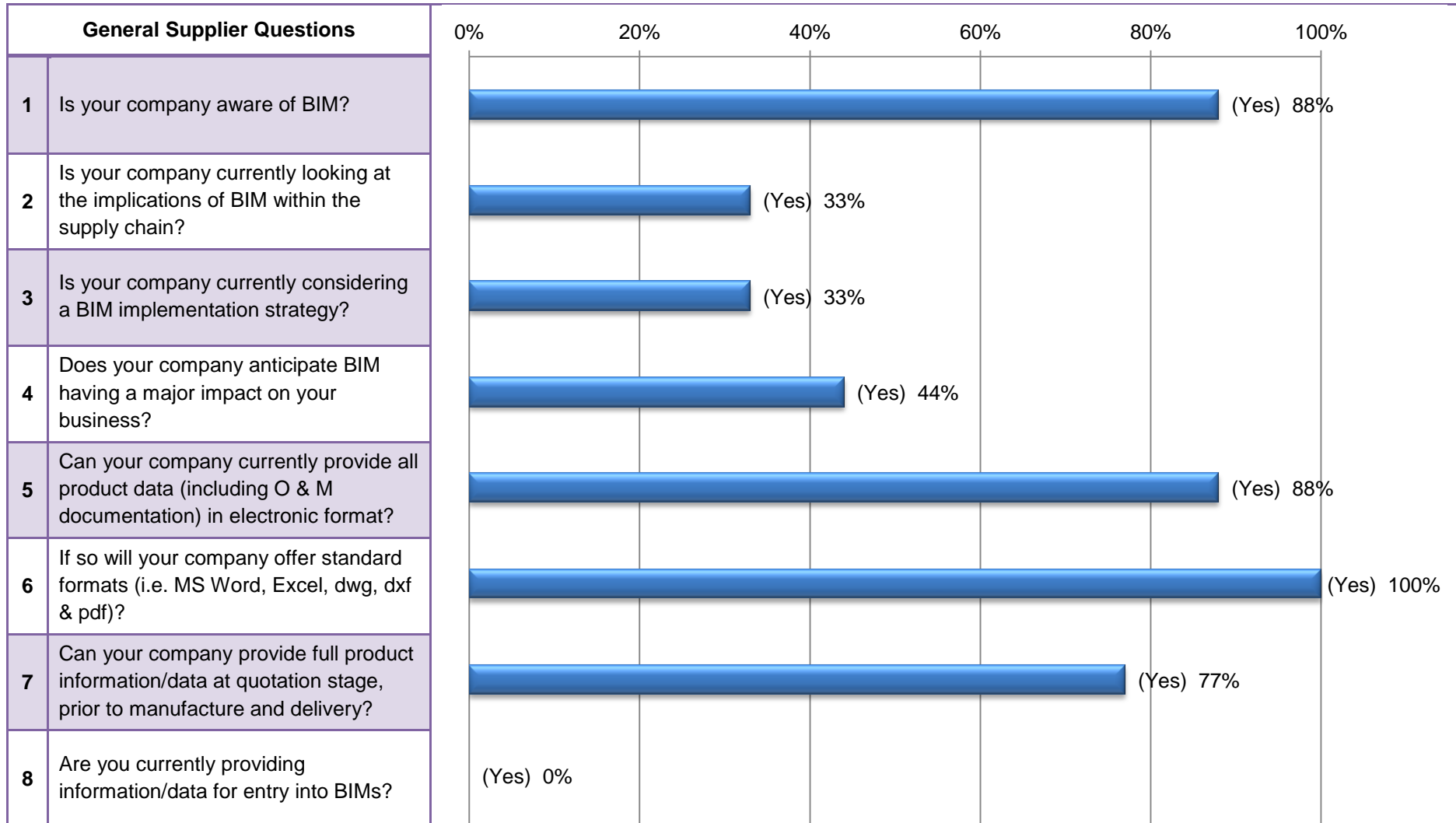


Figure 4.2.2.1: General Supplier Responses

4.2.3 Conclude the findings from BAASL's Supplier Network

It was evident from the responses that the suppliers of complex products that link to a BMS, such as automatic door gear and window actuators, are more focused on the impact of BIM than the suppliers of ancillary items such as pressings and brackets. This finding is understandable as it reflects the level of BIM information required across the various supplier categories which is encouraging for BAASL and other systems fabricators. Figure 3.2.4.2 shows how BAASL rate the suppliers BIM engagement and the complexity of the information required from the various categories by rating them on a scale of 1 – 5 (1 being low complexity and 5 being high).

The responses from the questionnaires suggest that BAASL and other Kawneer curtain wall fabricators will not be held back by their system supplier, but they may need to pull their general suppliers along the BIM road. SME curtain wall sub-contractors need to identify what information they need, which format they need it in, and at what stage it will be required so that they can communicate this back to their existing suppliers (plus any new suppliers) to identify those who can support them. Those who need to provide support but cannot, will then become apparent and must be excluded from their supplier network.

The questionnaire findings, show that the Main Contractor and Architect are already capable of delivering projects using BIM technology, and that the System Supplier is currently liaising with both these parties regarding BIM information. The findings also indicate that none of the General Suppliers are currently providing data for BIMs, and like many SME curtain wall sub-contractors; neither are BAASL.

Figure 4.2.3.1 gives a diagrammatic representation of the questionnaire findings in relation to the BIM activity of Main Contractors through to suppliers. These findings support the hypothesis that there is a greater BIM awareness and adoption level amongst Architects and Main Contractors at the top of the BIM supply chain, than there is amongst Manufacturers and Suppliers at the lower end of the supply chain, and here lies the challenge for the SME sub-contractor!

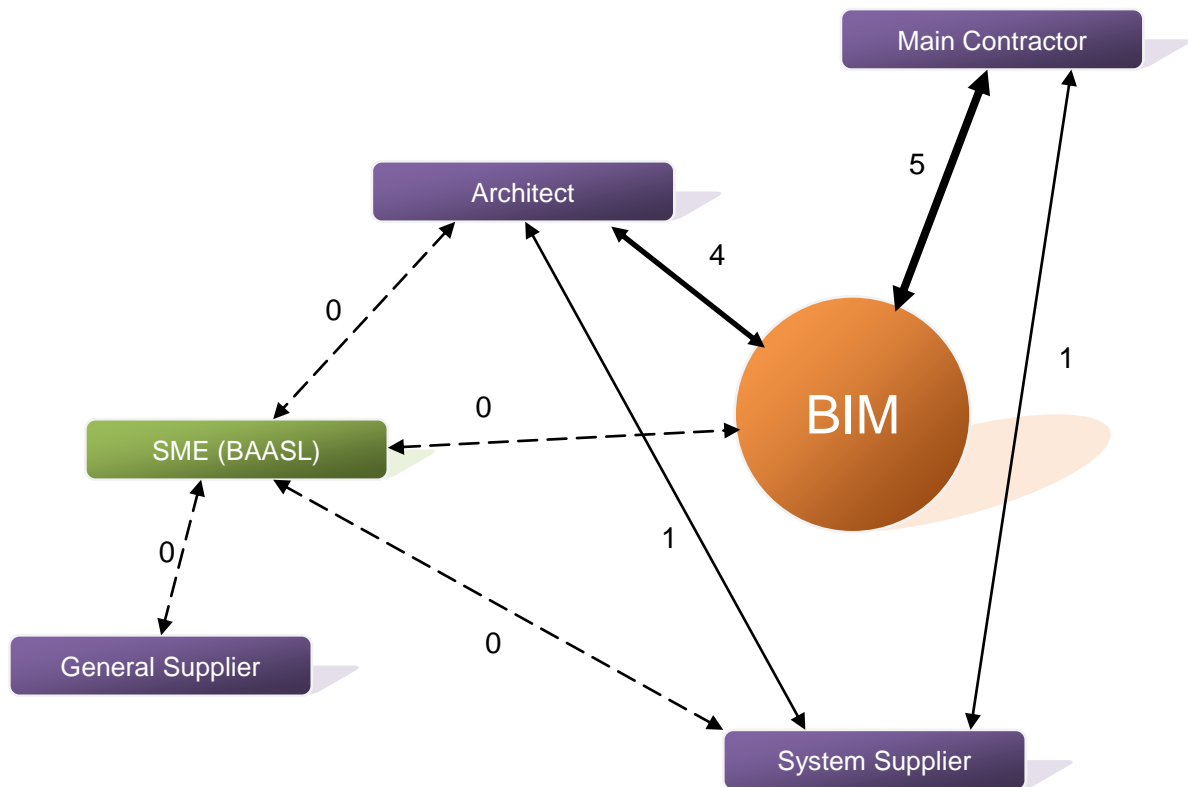


Figure 4.2.3.1: BIM Activity

In Figure 4.2.3.1 the strength of the BIM relationship between the supply chain members and/or the BIM itself is represented by the thickness of the arrow and the number assigned to the arrow, for example:

- Thick arrows with high numbers depict a strong relationship,
- Dashed arrows with low numbers depict a weak or no relationship.

4.3 Establish BAASL's Target Market Sectors

A meeting was held with the BAASL MD on 2 August 2012 to discuss the market sectors that the company will be targeting moving forward. The structure of the company's new five year business plan is currently being drawn up, and will be in place by April 2013. Although not yet finalised it will be forecasting that BAASL will still be active in the Health and Education sectors even though the industry is forecasting a down turn in both areas.

The chart in Figure 4.3.1 shows the forecast changes in the curtain wall market from 2010 to 2015 in the Office (Commercial), Education, Health and Apartment (Residential) sectors, (Palmer Market Research, 2011)

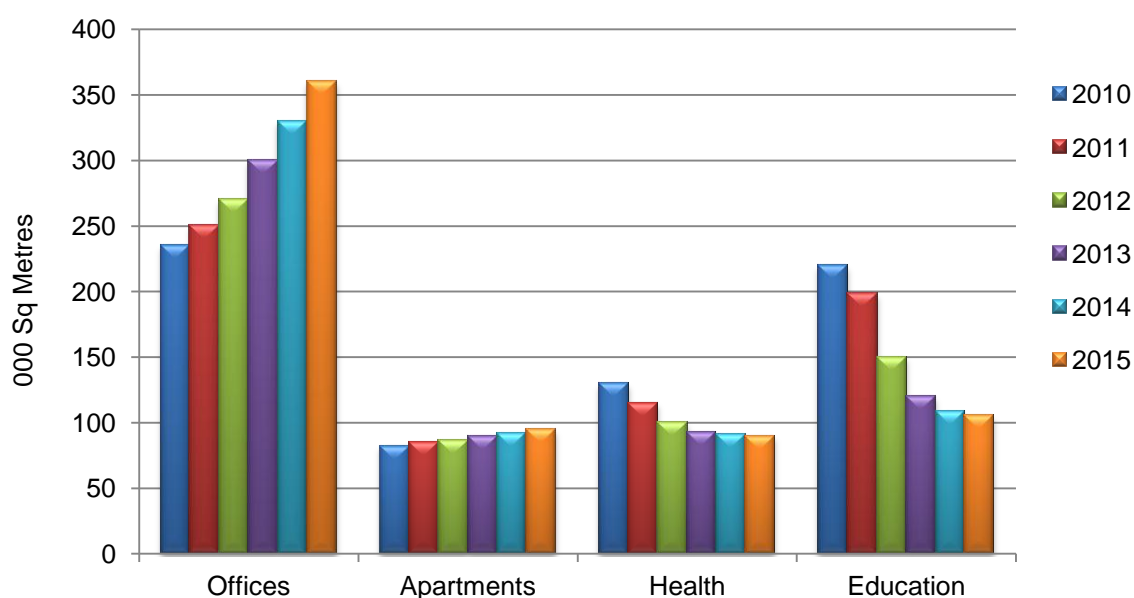


Figure 4.3.1: Forecast Changes in the Curtain Wall Market 2010 to 2015

Although the industry is forecasting a decline in two key sectors for BAASL: Education buildings forecast to decline by a half and Health buildings by a third, (Palmer Market Research, 2011), BAASL are still confident that their business model will deliver continued success in these sectors.

Following the termination of the BSF scheme, the DfE is still committed to rebuilding schools across the UK over the next five years; with the first of the schools coming to market in “early autumn” 2012. The new PSBP scheme will see an initial batch of 42 schools funded by a £400m direct capital grant, followed by a further 219 schools funded by a £2bn PFI programme, (Hayman A, 2012).

Figures 1.2.2, 1.2.4 and 1.2.6 indicates BAASL's success during the BSF framework programme due to their partnering with eight of the twelve contractors who were selected for the National Contractors Framework by the PfS back in 2009. The close relationship that BAASL have with these contractors bodes well for the initial batch of 42 schools under the new PSBP scheme following the announcement that they will be awarded to Contractors on the current framework. BAASL can also be encouraged by the fact that although their leading Key Contractor, Laing O'Rourke are not on the current framework list, they will be able to bid for the 219 schools scheduled for the £2bn PFI programme under a new Contractor Framework. Figure 4.3.2, 4.3.3 and 4.3.4 show the impact of Laing O'Rourke on their business from 2009 to 2011 respectively.

Percentage Turnover by Main Contractor 2009

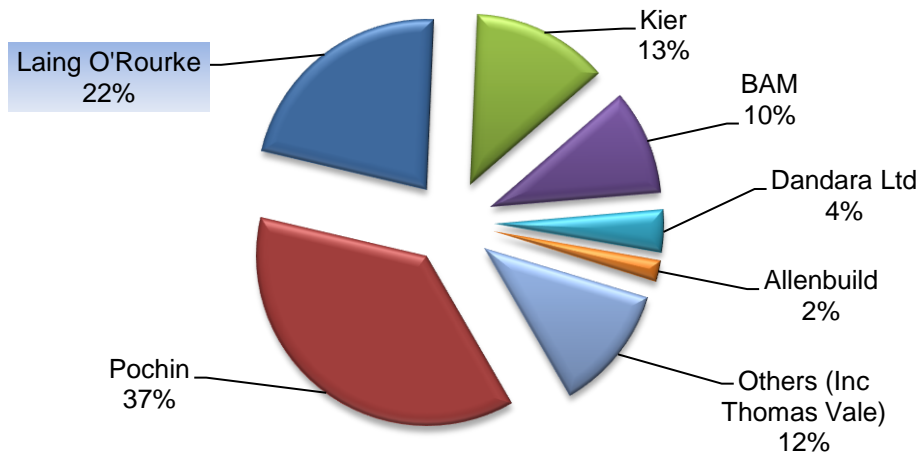


Figure 4.3.2: Percentage Turnover by Main Contractor 2009

Percentage Turnover by Main Contractor 2010

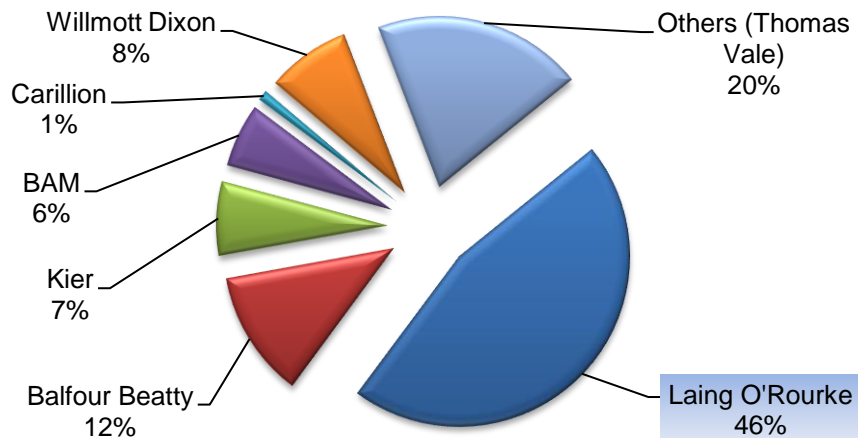


Figure 4.3.3: Percentage Turnover by Main Contractor 2010

Percentage Turnover by Main Contractor 2011

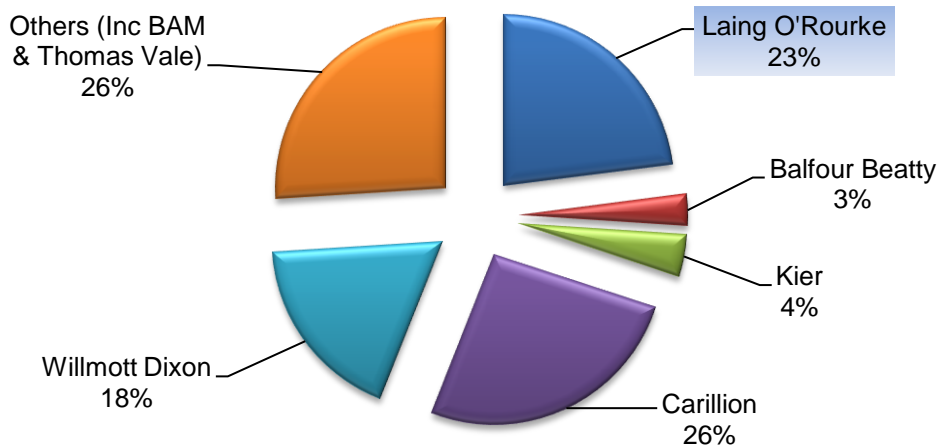


Figure 4.3.4: Percentage Turnover by Main Contractor 2011

As outlined in Section 1.2, BAASL are an accredited supplier and installer within the 'Scape' refurbishment framework for schools, (Scape, 2011), and are experiencing a rise in refurbishment enquiries coming into the business as indicated in Figure 4.3.4 which indicates the volume of refurbishment enquiries since 2010.

Volume of Refurbishment Enquiries: 2010 - 2012

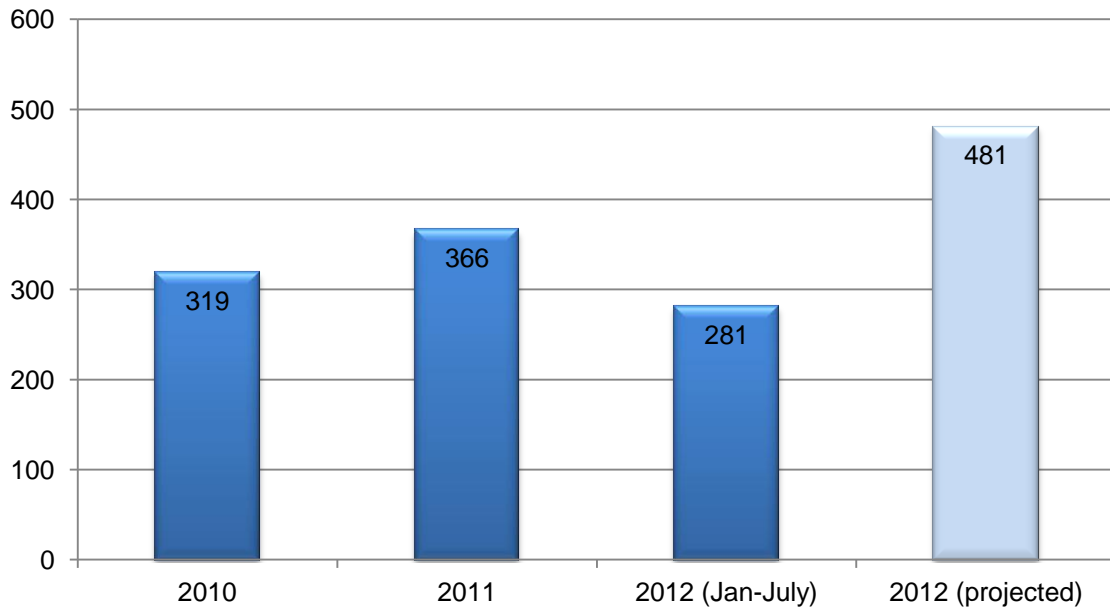


Figure 4.3.5: Volume of Refurbishment Enquiries: 2010 - 2012

This trend supports the fact that the new build projects are being scaled down over the next five years, yet there is still a need to upgrade the schools that were previously identified for rebuilding.

BAASL are also forecasting continued work within the Health sector following their partnering with Laing O'Rourke on an extensive hospital refurbishment project in North Wales, encompassing both new build and refurbishment projects throughout the hospital complex which are programmed to run into 2015. In addition to this, BAASL successfully launched their own range of mental healthcare windows in 2009 which has seen an increase in the number of projects in this sector year on year as indicated in Figure 4.3.5.

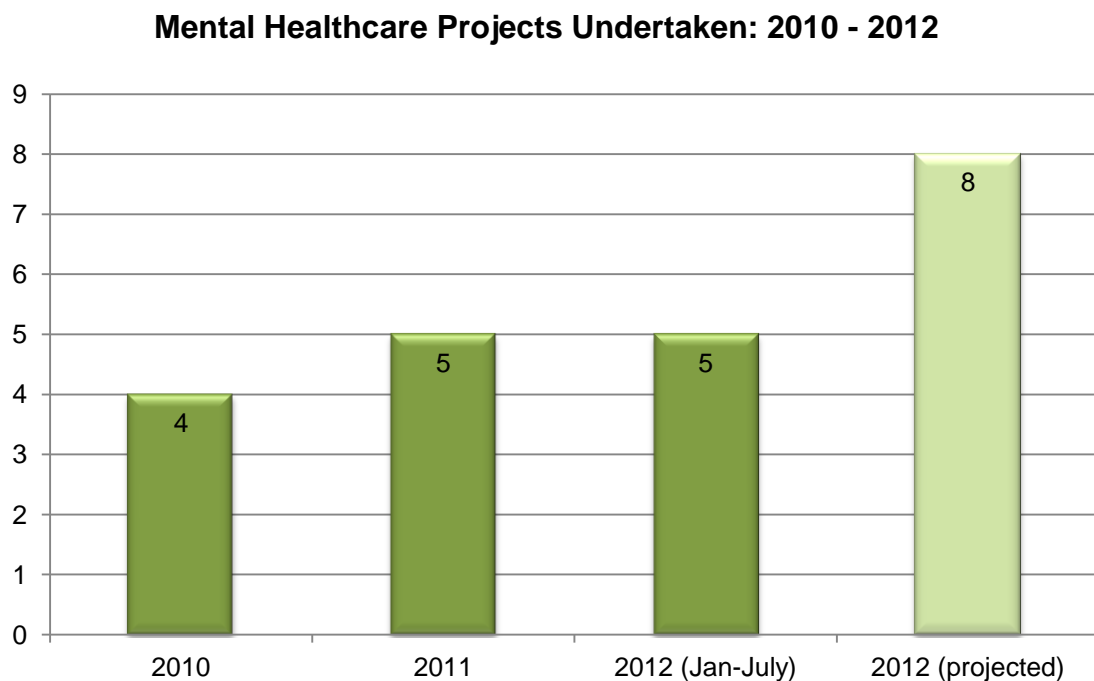


Figure 4.3.6: Mental Healthcare Projects Undertaken: 2010 - 2012

Based on BAASL's business plan and their intention to remain active in Government backed projects, BAASL have to look at an implementation strategy for BIM capability before 2015, as will any other curtain wall sub-contractor within the industry who targets the same market sectors.

4.4 Appraise the Most Appropriate BIM Software for BAASL

One of the concerns raised by the industry regarding BIM adoption, especially for SME's, is the potential risk of software incompatibility, (Day M, 2011), which can be compared to the VHS v Betamax dilemma in the early 1980's. Before the NBS carried out their BIM survey in October 2011, they decided to canvass opinion on CAD usage by asking the following question; "*When producing CAD drawings, which of the following tools do you mainly use?*" (Malleon, A, 2012).

Figure 4.4.1 illustrates the findings from this question.

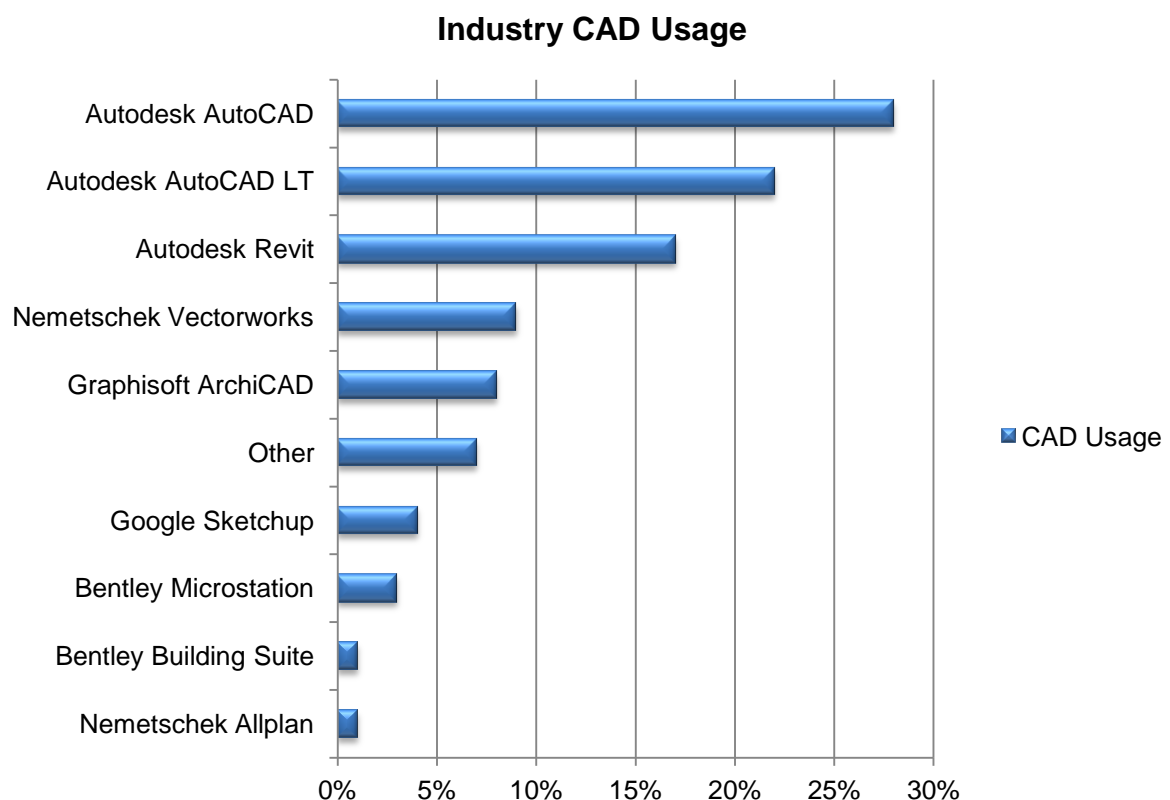


Figure 4.4.1: Industry CAD Usage

It was found that Autodesk, in one form or another, accounted for over two-thirds of the 'mainly used' CAD packages, (Malleon, A, 2012). The results from the questionnaires sent out to BAASL's customer network endorse the NBS findings as two-thirds of Main Contractors and Architects are using, or will be adopting, Autodesk Revit as their BIM software. BAASL currently use Autodesk's 2D AutoCAD to generate 2D drawings, so their natural progression would be to retain an Autodesk product for 3D modelling such as Revit.

Following the launch of 'Open BIM' it is no longer necessary for an SME curtain wall manufacturer to adopt the same software as used for the project BIM. An article in Construction News by Tom Fitzpatrick makes the following statement about the open BIM: *'Constructing Excellence and BuildingSMART are leading the open BIM alliance with software vendors Tekla and Graphisoft, calling for supply chain members to be able to transfer intelligent BIM data regardless of the software tools they use. They hope to sign up contractors to promote a universal approach to collaborative design, construction and operation of buildings based on open standards. The move is part of an international effort to ensure BIM data can be shared across platforms and software providers,'* (Fitzpatrick, 2012).

With the emergence of open BIM, BAASL and all other curtain wall sub-contractors will be able to adopt a software platform of their choice provided that it supports 'Open BIM'. Choosing a software platform that does not, would potentially limit the projects that the sub-contractor can tender for. However, when considering the most appropriate software platform, all companies must to be clear about what they need to contribute to the BIM and how they need to do it, as it may transpire that a costly 3D CAD package is not necessary!

5.0 DEVISE A BIM IMPLEMENTATION STRATEGY FOR BAASL

Before any business adopts a new way of working, they must consider the impact of doing so in terms of defining; resource, training, time, cost and ROI. This section will consider these points and propose a suitable strategy for BAASL and other curtain wall sub-contractors to consider.

5.1 Assessing Skill Levels and Training Needs

BAASL are an Investors in People accredited company who keep comprehensive training records of all employees, and encourage personal development through their appraisal system. Examples of the Design Technicians training records can be seen in **Appendix C1 – C4 inc.**

Businesses considering BIM adoption, must identify the key people who need to be trained. The article written by Peter Caplehorn, (Schuco, 2012) has the following view on the key people within a curtain wall fabrication company: *‘Certainly the front-line designers. That’s where you start with this, because it is all about design. Then after that it would be the project managers, because how the production is run and how you call off particular bits of metal and how that works in the factory all has to be synchronised in line with how the model is developing.’* Figure 2.4.1 supports the view of Peter Caplehorn by identifying BAASL’s design process as being the area where BIM will have the greatest impact.

A company should appoint a BIM Manager or Coordinator who can oversee the process at a high level, and liaise with BIM representatives from other companies. The manager will be responsible for building a structure around key people within the company and coordinating the BIM adoption. Although BIM is not purely 3D CAD, this position may be best suited to someone with a design background who has good knowledge of building construction and the design process itself; having good visualisation skills together with programme and sequence awareness will be fundamental to the role. Once an individual with these credentials has been identified, the potential BIM Manager should acquire sufficient knowledge by attending seminars and workshops on BIM, and liaising with managers from other companies within the BIM supply chain.

Figure 5.1.1 shows a typical BIM structure that can be adopted by a SME curtain wall sub-contractor who wishes to run a project through the business using the BIM methodology.

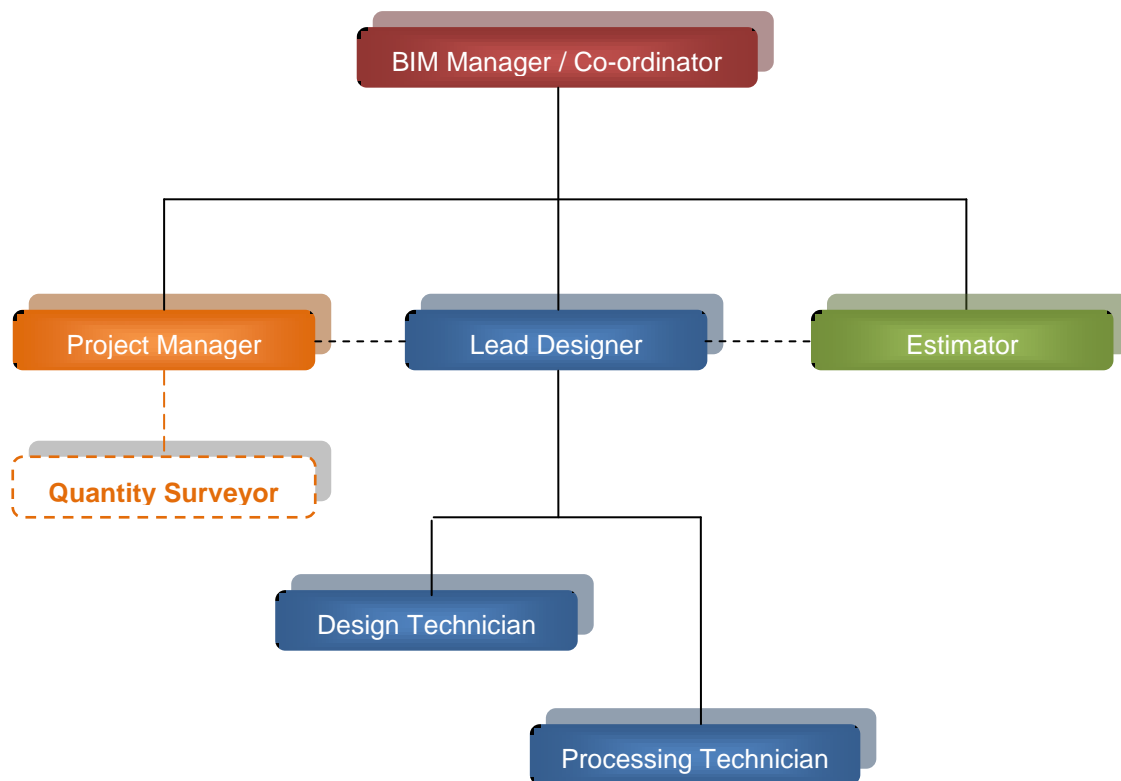


Figure 5.1.1: A Typical Company BIM Structure

As the **BIM Manager** will be managing the internal process rather than the BIM itself, formal training may not be required as managerial and organisational skills will be paramount for the role, together with a good understanding of how the whole BIM process works. However, other members of the 'BIM Team' will all require various degrees of training in order to fulfil their role.

The **Estimator** will need to access the BIM to extract information relating to quantities and specifications in order to generate material take offs for the various elements within the SME's package. The training for the Estimator will focus on understanding the model in terms of navigation and data collation.

The involvement of the **Project Manager** will vary from SME to SME depending on their job role within the organisation. All Project Managers will be responsible for the project programme so access to the installation sequence will be essential. In time they will also need to access the BIM for H&S and O&M information. Training requirements will be similar to those for the Estimator where the focus will be on extracting information rather than complex inputs.

For a typical SME the **Lead Designer** will be responsible for managing the BIM itself and he/she will need to be fully conversant with the BIM software, be responsible for data creation, and coordinate the contribution of the **Design and Processing Technicians**. It will be important and beneficial to train more than one Designer, so by creating an initial mini design team (members identified in blue in Figure 5.1.1) they will be able to discuss problems and exchange ideas during the early stages of implementation. The Lead Designer will need to understand the protocols of the BIM to ensure that model structures and file formats are adhered to in order to maintain interoperability through the supply chain.

As BIM progresses within the industry and incorporates 4D and 5D technology, Quantity Surveyors will use the model to monitor construction progress, identify cost and time delays due to change, and to quantify monthly valuations.

Sinclair, (2012), makes the following observation with regard to BIM training: *'One of the greater industry challenges will relate to training, particularly in relation to teamwork and collaborative approaches to design and construction, and the next generation of collaborative designers and contractors will need to embrace new working methods and leave behind some old assumptions and role stereotypes.'*

5.2 Time Scale and Cost Analysis

5.2.1 Time Scale for Adoption

The Cabinet Office announced the Government's intention to require collaborative 3D BIM on its projects by 2016, (Poletayeva, E, 2011). However depending on the SMEs business plan, it may be prudent to consider earlier adoption in order to ensure that the company is working with an acceptable level of efficiency by 2016. The criteria were that all publicly funded Government projects worth £5m and above, are to use BIM at Maturity Level 2 by 2016.

As outlined in Section 2.1: Level 2 BIM requires the production of 3D information models by all key members of the Integrated Team. However, these models need not co-exist in a single model. By understanding and utilising BS 1192:2007, designers can ensure that each designer's model progresses in a logical manner before it is used by another designer or a designing subcontractor, (Sinclair, D, 2012).

In the Construction News article 'BIM is here and now,' Philip, (2012a), is quoted as saying: 'It is not a fad, its real and its now. You cannot afford to wait until 2016; the early adopter departments have already started their BIM embarkation – can you really afford to miss out?'

Peter Barker, Director of Ryder Architecture gives the following advice based on the experience of BIM adoption by the company: 'The lesson we learnt is that there is never an ideal time to make the change on a project but when you do, make sure the staff have the training, support and encouragement they need. Another tip – ensure that those who have the training are given the opportunity to put this into practice on a live project as soon as feasible otherwise the knowledge will be lost,' (Barker, P, 2011).

The time it takes to for an SME to implement an efficient BIM way of working is difficult to predict, as it will depend upon the complexity of their involvement, how receptive staff are to retraining and the level of investment available. Each SME will have to make their own judgement on a time frame for BIM adoption, however they should not overlook the advice given by people such as David Philip and Peter Barker, and the evidence from the questionnaires in Section 4, where Main Contractors and Architects are showing significant adoption levels at the beginning of the design process.

5.2.2 Cost Analysis

Cost analysis is difficult to quantify as resource, software and training requirements will vary considerably from SME to SME. When questioned about how much will BIM cost; Philip, (2012a) summaries the issue well:

'We are asked this question a lot; however we think this should be reframed as either; what's the cost to my business if we don't do it? or what is the typical return on investment if you implement BIM?

The cost of BIM implementation is proportional to what outcomes you want to achieve from BIM. If treated as a business change programme, the principal cost will be in staff time, BIM awareness and training etc.

The inconvenient truth is that you are likely to need some new digital tools; however, again the cost of this will depend on what you need to do with modelling, data creation or management. Most BIM design review tools are free.

Typically BIM authoring tools, depending upon complexity, will be around the same as the price (depending where you live in the UK) of a pint and a half of beer a day'.

Economic climate together a companies business strategy will inevitably influence their decision and timing of possible implementation; however, David Philip raises a very good argument for reframing the question regarding cost.

All evidence collated in this dissertation only strengthens the hypothesis that the BIM concept of working is gathering momentum, and encourages all businesses to quickly understand their level of contribution and how to deliver it.

All SMEs who identify the need for BIM adoption must consider acting quickly as waiting until they are excluded from tendering certain projects, will be too late. Holding back until the eleventh hour will allow competitors to gain an advantage and present them with a very steep learning curve towards effective and cost efficient integration.

5.3 Determine the Long Term Impact of BAASL Adopting BIM

As stated in Section 3, the MD of BAASL has identified certain areas of the business which require further development and improvement, and is interested to see how BIM will be best suited to support the business development. Figure 5.3.1 shows the key areas identified and suggests the support the BIM could potentially offer.

Area for Improvement/Development		Potential BIM Support	
1	OTIF performance	✓	Better quality of information available in the BIM at the beginning of the SME design process
2	Drive down re-make costs	✓	Early model simulation and clash detection will help reduce error prior to manufacture
3	Improve and strengthen our reputation as a service provider	✓	Improving areas 1 & 2 will enhance BAASL's reputation
4	Raising Employee skill levels	✓	BIM training will help do this
5	Develop the concept of offering Maintenance contracts	✓	BIM will deliver coherent FM information for development of maintenance strategies
6	Increase turn over and profitability year-on-year	✓	Improvement in areas 1 – 4 will contribute to achieve this objective
7	Investigate the impact of BIM, and its possible implementation	✓	Already under review
8	Eliminate double data inputting into the V6 and Logical software (firstly by the Estimator and secondly by the Processing Technician)	✗	This is unlikely to change with the introduction of BIM, however opportunities may materialise if the model can interface with the V6 and Logical software
9	Eliminate the method of drawing items in 2D CAD and then recreating the same items later in the process in the V6 and Logical software.	✗	Again, this is unlikely and will depend on whether the model can interface with the V6 and Logical software
10	The ability to automatically generate take-off schedules.	✓	BIM will facilitate this function
11	The transfer of production data from the V6 and Logical software, direct to the saw and CNC machining centre.	✗	This will be subject to a separate review of internal processes
12	Automatic collation of O & M manuals for each project.	✓	Product data will be embedded in the model as design and installation progresses

Figure 5.3.1: BIM Support for Business Development

Of the twelve areas for improvement or development listed in figure 5.3.1, it is anticipated that the introduction of BIM will help support the nine areas where a tick is indicated.

So far this section has looked at the areas where BIM can help enhance the long term performance and reputation of the business, however there are also areas that need to be considered for potential exposure of the company:

Legal / Contractual Issues: As outlined by Sinclair, (2012), in Section 2.1: *'It is not anticipated that the legal, contractual or insurance issues currently utilised by the industry will change for level 2 but it is fair to say that level 2 BIM does expose some of the deficiencies of current contractual documentation. For example, the role of the Model Manager needs to be considered and the roles and responsibilities of the various designers and contracting parties need to be clearer, particularly in relation to Performance Specified Work.'*

Information sharing: With the prospect of intelligent data being embedded in the BIM, comes the concern over access to and sharing of information and the potential for company exposure. Clear guidelines must be defined in order to protect companies, especially with the future prospect of 4D BIM and the inclusion of cost.

Productivity: Implementing BIM will undoubtedly impact on the company's productivity whilst people are trained and before they become proficient with its way of working. Adopting the approach of introducing BIM for all new projects from a given date should not impact on existing projects, but may create a bottle neck depending on the volume and complexity of the new projects. An alternative approach for an SME could be to create two design teams within the business and 'cherry pick' the projects to run using BIM (unless the contract dictates) until skill levels are high enough to cope with the full project workload.

5.4 Assessing Return on Investment

If BAASL or any other SME decide on the early adoption of BIM, current indicators used in this dissertation suggest a real possibility of securing more work with certain Main Contractors and Architects who are already making the decision to run projects using BIM. As more projects are run using BIM, and if the predicted benefits are realised, it appears inevitable that Main Contractors and Architects will adopt BIM on all their projects, making it standard practise within their businesses.

It will be difficult to quantify the ROI for BIM adoption in monetary terms as the initial investment for each individual SME will vary depending on the following criteria:

- Their chosen software platform
- The number of user licenses
- The upgrading of existing hardware systems
- The amount of additional resource required
- Current skill levels of staff will dictate training requirements

The most appropriate way to assess ROI is to consider the potential long term commercial gain for the company. The findings in Section 4.3 show that BAASL will be targeting the Health and Education market sectors over the next five years, so this is where their ROI needs to be measured.

Failure to implement BIM within their business would seriously jeopardise their success in securing future work in their chosen sectors and would require a total rethink of their long term business plan. As their business model has been structured around the Health and Education sectors, and they are predicting continued success in these areas, it would be a waste of the time and effort that has already been invested in the company to tailor it this way.

BAASL have proof that their business model delivers success, therefore their main focus has to be on sustaining this model by implementing a BIM strategy that satisfies both the business and its customers for the next 5 years.

For a company such as BAASL, the effects of NOT implementing BIM would leave them facing the following issues to address:

- The inevitable loss of turnover in the Health and Education sectors
- The need to review their current business plan and target new sectors
- The restructuring of their business model away from Health and Education projects
- The need to build relationships with Main Contractors who operate in other sectors
- A missed opportunity to support the business development

For these reasons the real ROI for BAASL would be the continued success in the Health and Education sectors, coupled with the potential to support the business development plans outlined in Section 5.3.

A similar analogy can be done for the industry as a whole should it decide NOT to pursue a BIM approach. Such a decision would create serious consequences for the construction industry in terms of not embracing the opportunity to:

- Reduce waste
- Shorten time on site
- Take advantage of clash detection
- Construct the building in the virtual world prior to actual construction on site
- Give the client early assurance of construction costs
- Give the client early assurance of running costs
- Give the client early assurance on the building performance
- Provide comprehensive FM information

Most of the hype and publicity surrounding BIM talks of these potential gains for the Client and the facilities management of the building. However, the reality is that all members of the supply chain stand to benefit from BIM providing that everyone is prepared to communicate and collaborate openly. Admittedly this comes with an initial cost outlay which unfortunately is unavoidable if the industry is to succeed.

5.5 Proposed Implementation Strategy

This section sets out to design a BIM implementation strategy that can be adopted by any typical SME curtain wall sub-contractor who has already made BIM adoption part of their business plan.

The structure of the implementation strategy is built around the key areas discussed in Sections 4 and 5 and identifies the following processes as being fundamental in achieving successful implementation:

- Advertise internally and interview existing staff members
- Assess the skills and suitability of existing staff members
- Advertise externally and interview for new resource if required
- Appoint team members
- Identify the most suitable BIM software platform
- Review hardware capabilities and upgrade or replace if required
- Software investment
- Initiate Software training
- Identify and initiate first BIM project
- Review first project performance

The strategy will map out the above processes against a time frame which is achievable for the SME and at the same time focuses on the Government requirement for all its projects to use collaborative 3D BIM by 2016.

With this in mind, the flow diagram in Figure 5.5.1 sets out the implementation processes against an allotted time frame of two and a half years, which if initiated by April 2013, gives the SME the opportunity to complete at least one BIM project prior to the Government deadline. A post project review meeting should be carried out following completion of the first BIM project; giving the SME the opportunity to modify the strategy if necessary, and/or extend the period prior to further implementation.

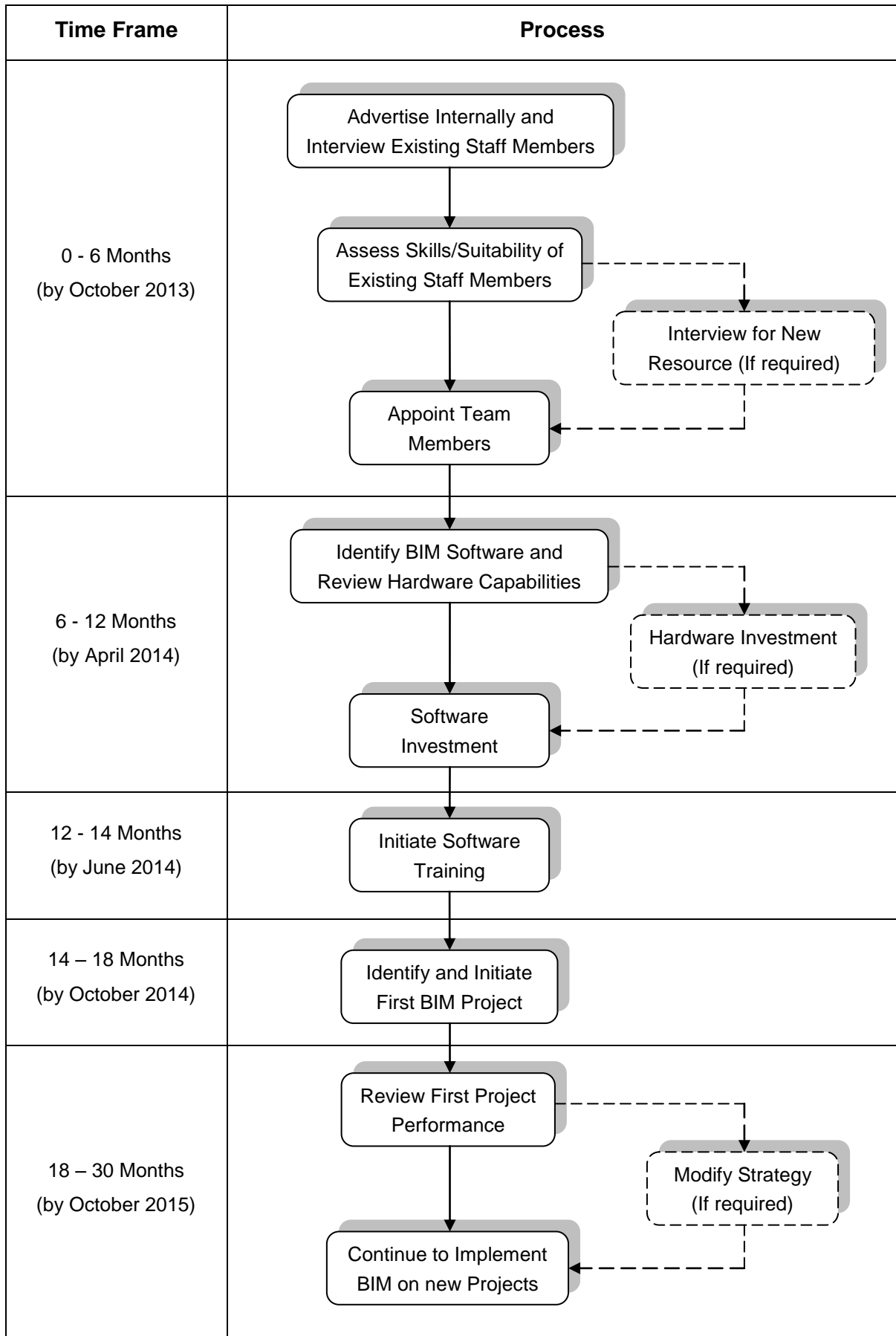


Figure 5.5.1: Implementation Strategy Flow Chart

6.0 DISCUSSION

6.1 Environmental and Economic Interdependencies

As the subject matter of the dissertation is relatively new, and curtain wall SMEs are yet to implement BIM, there is limited data available to substantiate the anticipated benefits of its methodology. However, from the research undertaken there is plenty of historic data to highlight the inefficiencies within the construction industry and the requirement for a collaborative way of working such as BIM.

This dissertation has established that BAASL must look towards BIM adoption in order to sustain their successful business model and to enhance their business development. This statement will be true for many of BAASL's competitors within the curtain wall market, as it appears inevitable that all members of the construction supply chain will need to contribute to a project BIM by 2016 if they are to advance their business.

Working on the hypothesis that all companies wishing to work on Government backed projects will implement BIM by 2016; what will set a SME curtain wall sub-contractor such as BAASL apart from their competitors? If industry wide adoption of BIM is a given; then BAASL need to focus on the variables in order to find opportunities to set themselves apart.

Areas of opportunity will be:

- **Economic Impact:** Having the ability to provide intelligent BIM data before their competitors and not waiting until 2016 when the majority of SMEs will be thinking about BIM adoption.

Develop expertise in order to engage customers at different stages of BIM; i.e. have the data and skills available to assist Architects in the early design stages and increase BAASL's chances of becoming a named supplier before the glazing package is awarded.

- **Environmental Impact:** Use BIM as a USP and an enhancement to BAASL's Environmental Management System and recent ISO14001 accreditation. BIM's ability to reduce waste and improve building performance will improve the environmental impact of projects and therefore the environmental credentials of BAASL.

- **Sustainability:** Taking advantage of the above opportunities stands to raise BAASL's commercial profile in the glazing market and the likelihood of increased turnover and profit. Reinvestment of profit will help to support and fund future developments in BIM adoption and sustain BAASL's position in the glazing market.

6.2 Limitations of the Work

When considering the impact of BIM, the dissertation has concentrated on the industry demands on SMEs with regard to design and FM information as this is the area undergoing the most significant change from current working methods. It has not considered the impact on the manufacturing and installation aspects of the company other than the hypothesis that a BIM way of working will reduce the volume and cost of rework, and also reduce the amount of time on site.

These potential benefits can only be measured following the completion of at least one BIM project; however more realistic results will be established by assessing a number of completed projects over a period of time. As it may take up to three years for BAASL to complete the implementation strategy, and even longer to complete a number of BIM projects, it has not been possible to review the outcome in this dissertation or to measure the results of BAASL implementing BIM.

7.0 CONCLUSIONS AND RECOMMENDATIONS

This dissertation set out to analyse the impact of BIM on a SME curtain wall sub-contractor within the UK, and although the focus centred around a specific SME, the objectives and findings can be utilised by others within the curtain wall sector.

The dissertation addresses the individual issues that await BAASL, and other SMEs considering BIM adoption, and after reviewing these issues has designed a strategy suitable for implementation. This strategy will be reviewed with BAASL's MD on 19 September 2012 prior to submitting to all Board members for their inclusion in the Company's new 5 year business plan scheduled for implementation in April 2013.

Based on the original objectives of the dissertation, the following conclusions can be drawn.

7.1 Objective 1 – *'Review the philosophy of BIM and its drivers'*

The British Standards and industry journals used for the desk based study in Chapter 2 gave a clear understanding of this objective in terms of defining the types of BIM, how BIM works and the various maturity levels of BIM. However, further clarity is required with regard to the level of collaboration for level 2 BIM adoption.

Research findings also identify concerns over current contractual documents with regard to the roles and responsibilities of the various designers and contracting parties that will be created by the adoption of level 2 BIM.

The Latham report in 1994 and the Egan report in 1998 failed to deliver the much sort after improvement within the construction industry; however it is clear to see that the Government's commitment to BIM is the main driver for its implementation, coupled with the BIM's promise to reduce waste, cost and energy consumption.

7.2 Objective 2 - *'Analyse BAASL's current methods of working and relate to BIM'*

BAASL have robust departmental procedures which are regularly reviewed and managed through their ISO9001 Quality Management System. These formalised procedures helped to facilitate a comprehensive review of their working methods where it was found that the design process could be best supported by the adoption of BIM.

Research in this area centred on BAASL's current methods of working and will need expanding to analyse the impact of integrating a BIM way of working. The potential introduction of new software and new data drop points within the project programme will require a review of current internal processes to ensure the company are working efficiently; however this will only be possible once implementation has been initiated.

7.3 Objective 3 – *'Establish the current adoption levels of BIM'*

With the drive towards BIM adoption being relatively new to the industry, research material in this area proved to be limited, with no specific data relating to SMEs within the curtain wall sector. The NBS surveys were considered the most appropriate source of information for quantifying BIM adoption levels; however the surveys were by no means far reaching across the industry with the majority of participants concentrated in the Architectural sector.

Notwithstanding this limitation, the aim of this objective was still met in terms of establishing the shift in adoption and awareness levels of BIM over a two year period.

7.4 Objective 4 – *'Appraise the knowledge-base and awareness of BIM within BAASL's Key Contractors and ascertain their expectation of BAASL'*

This objective was extended to include the thoughts of Architects who, although not contracted to BAASL, will have a major influence on the Main Contractor in terms of BIM adoption.

The methodology of email questionnaires was used to gather information, returning a combined response rate in excess of 50%. Although there were concerns over the NBS survey results used in Objective 3, the questionnaire responses do support those findings in terms of adoption levels. The questionnaires also clarify that Contractors and Architect will require BAASL to provide BIM data; however they do fall short of defining exactly what the data needs to be and a time scale for it. Further research will need to be done to determine the format of the data required from BAASL in terms of whether it will be COBie or full 3D as this will dictate their software platform.

7.5 Objective 5 - *'Establish whether BAASL's supplier network have the capability to support BAASL with BIM information'*

As with Objective 4, questionnaires were used to gather information which once again returned a combined response rate in excess of 50%. The findings from the two supplier groups; System and General, show that BAASL need to closely monitor the BIM progress forecast by their System Supplier so as not to impede their own progress, and must tailor their General Supplier network so that it will be able to provide the necessary support.

Further research will need to be done in this area to establish the specific data formats that BAASL will be requesting from their suppliers, as the questionnaires were based on current industry standard formats.

7.6 Objective 6 – *'Establish the market sector focus over the next 5 years in order to forecast BAASL's need and timescale for BIM adoption'*

This objective was met following discussions with the Managing Director of BAASL and Kawneer. It was discovered that BAASL's sector focus is based on their successful business model rather than the industry forecast. It was concluded that the BSF, PSBP and PFI framework schemes form the basis of BAASL's focus and will drive their need for BIM adoption.

The current industry driver for the timing of BIM adoption is that announced by the Government; however Objectives 8 & 9 go into more detail on other factors influencing timescale.

7.7 Objective 7 – *'Appraise the most appropriate BIM software for BAASL'*

The questionnaire responses, NBS survey findings and industry articles were used to research this objective. Although the research does identify one provider as currently being the leader in the market; the emergence of 'Open BIM' has lessened the dilemma of SMEs choosing the wrong software platform by endorsing the sharing of information across the various platforms and providers.

7.8 Objective 8 – ‘Determine the long-term impact of BAASL adopting BIM, including the consequences of not adopting BIM’

Due to the lack of data relating to BIM adoption within curtain wall sub-contractors, industry views were limited to those of Architectural practices and to some general observations surrounding the challenges of changing people’s current way of working.

The recommendation for BAASL to adopt BIM has been justified by the support it can offer to the development of the business (see Figure 5.3.1). The research has also highlighted areas of potential risk to the business and need further research to prevent commercial exposure. These areas of risk however are not limited to BAASL and are areas that need to be considered across the industry as a whole.

This dissertation does not quantify the initial financial cost, or long term financial benefit, of adopting BIM, as this will need a more detailed analysis of resource, training, IT investment and post project review.

7.9 Objective 9 – ‘Devise a BIM implementation strategy for integration into BAASL’s business plan’

The objective of designing an implementation strategy capable of supporting BAASL’s business plan has been met (see Figure 5.5.1). It was also important to combine the individual processes of the strategy with a realistic time frame to meet the Government deadline.

This objective is limited to designing a strategy suitable for implementing a BIM way of working, and a more detailed analysis will be required to establish each company’s individual requirements for additional resource, training and IT investment.

7.10 Recommendations for Future Work

The research has identified areas where further analysis would prove useful to BAASL and the supply chain in general following the implementation of BIM.

- Review the impact on the manufacturing process in terms of:
 - Information flow;
 - Accuracy of information;
 - Amount of rework;
 - Efficiency / Cost.

- Review the impact on the installation process in terms of:
 - Time spent on site;
 - The quality of, and access to on site information;
 - Efficiency / Cost.

- Review the impact on the design process in terms of:
 - Flow of information
 - Integration with internal processes
 - Efficiency / Cost.

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9.0 APPENDICES

Appendix A: ISG Email, 21 August 2012

ISG's Construction Academy – training dates

We have a number of training courses taking place within ISG over the next 6 months with a number of places available.

Booking Process

If you would like to book on any of the below training courses then please contact our preferred supplier **HSS on 08457 667799** to complete your booking.

Building Information Modelling (BIM)

Building Information Modelling (BIM) is an increasingly important tool and way of working in the construction industry, and is also a real opportunity to get ahead of the competition - and to make sure you can maintain your position as a preferred supplier to ISG. In line with ISG's strategy and policy for adoption and implementation of BIM within the ISG business, a number of supply chain awareness and readiness sessions are being organised to support this important culture change.

The first of these sessions is "Demystifying BIM" where subcontractors and designers can learn the "why and the what" around BIM, and how BIM can affect the suppliers and preferred partners in a BIM literate organisation such as ISG.

This introductory session will explain BIM to you, and the targets and drivers, and can lead you towards a second session which explores BIM technology and its applications on projects. This is not an opportunity to be sold software, but rather for you to understand about BIM and its implications to you as a preferred supplier to ISG.

Building Information Modelling – Demystifying BIM

This half-day course provides an introduction to BIM from the perspective of suppliers and subcontractors to ISG. It looks at the principles, terminology and application of BIM, and is run by Professor Andrew Thomas of Room4 Consulting and one of the co-authors of the BIM report and strategy that support clients and suppliers on the challenges and opportunities of BIM implementation.

Course Objectives

- To help delegates
- Demystify BIM and to deal with the big question: What is BIM?
- Consider its application to their own business
- To undertake a simple exploration of the principles, drivers and terminology
- Review future development opportunities and business needs in their own businesses
- Learn from an open Q&A session and discussion

Training Dates

Course 1 – London 24th September 2012; Start Time – 9.00; Finish Time – 1.00

Appendix B1: Email Questionnaire Template (Main Contractor)

Dear Sirs,

At Bennett Architectural we are assessing the current status of Building Information Modelling (BIM) within our client database in order to develop an implementation strategy for BIM within the business. With this in mind I am currently writing a dissertation on the topic as part of my degree course at Bath University, in which I will be reviewing Main Contractors requirements and expectations of Curtain Wall Sub-contractors such as ourselves.

As one of our 'Key Contractors', we see the evolution of BIM as an opportunity to further strengthen the relationship between our companies, and would very much appreciate your responses to the questions below relating to BIM. If you have any queries or wish to discuss any of the questions, please email me and I will give you a call.

Please be assured that any information given will be used in confidence; sources will NOT be identified, and the information will NOT be used for non-study purposes. If you are interested in the results of my research in this area, please let me know and I will forward a copy to you.

- 1) Is your company already running projects using BIM technology at Maturity Level 2 (if so what percentage of projects)?
- 2) Have you seen (or do you anticipate) a restructuring of project programmes to suit information flow as a result of BIM?
- 3) Will your company be adopting BIM on all of its projects regardless of type and size?
- 4) Will your company require all of its Curtain Wall Sub-contractors to collaborate using BIM technology?
- 5) If so, has your company established a time scale for when Curtain Wall Sub-contractors need to be BIM compliant?
- 6) Which elements of the Curtain Wall Sub-contractors information/data will your company require in BIM format?
- 7) In what format will information/data be required from Curtain Wall Sub-contractors?
- 8) Has your company decided on a particular software provider?
- 9) Do you anticipate the requirement for earlier information/data during the tendering and design process?
- 10) Have specific 'data drop' points been established?
- 11) Will Curtain Wall Sub-contractors without BIM capabilities be excluded from your companies tendering process?

Please feel free to include any further information, together with any questions that you may have.

Can I kindly request your reply by **16 July 2012**, and also offer my thanks for your time and input which as well as being of value to myself, will no doubt benefit both our companies in the future.

Best Regards

Paul Johnson

Design Manager



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Appendix B2: Email Questionnaire Template (Architect)

Only showing introduction paragraphs and Architect specific questions:

At Bennett Architectural we are assessing the current status of Building Information Modelling (BIM) within our client database in order to develop an implementation strategy for BIM within the business. With this in mind I am currently writing a dissertation on the topic as part of my degree course at Bath University, in which I will be reviewing Main Contractors requirements and expectations of Curtain Wall Sub-contractors such as ourselves.

We see the evolution of BIM as a positive move within the industry, and an opportunity to strengthen our relationships with both Architects and Main Contractors. In order to assess our current position and future requirements for BIM, we would very much appreciate your responses to the questions below. If you have any queries or wish to discuss any of the questions, please email me and I will give you a call.

Please be assured that any information given will be used in confidence; sources will NOT be identified, and the information will NOT be used for non-study purposes. If you are interested in the results of my research in this area, please let me know and I will forward a copy to you.

- 1) Has BIM already been implemented into your organisation?
- 2) Is your organisation currently using BIM (if so what percentage of projects)?
- 3) Have you seen (or do you anticipate) a restructuring of project programmes to suit information flow as a result of BIM?
- 4) Will your organisation be adopting BIM on all of its projects regardless of type and size?
- 5) Is your organisation liaising with 'System Suppliers' such as Kawneer with regard to BIM?
- 6) Will your organisation require Curtain Wall Sub-contractors to collaborate using BIM technology?
- 7) If so, has your organisation established a time scale for when Curtain Wall Sub-contractors need to be BIM compliant?
- 8) In what format will information/data be required from Curtain Wall Sub-contractors?
- 9) Has your organisation decided on a particular software provider?
- 10) Do you anticipate the requirement for earlier information/data from Curtain Wall Sub-contractors during the early design stages?
- 11) Have specific 'data drop' points been established?
- 12) Will Curtain Wall Sub-contractors without BIM capabilities be excluded from the tendering process?

Please feel free to include any further information, together with any questions that you may have.

Appendix B3: Email Questionnaire Template (System Supplier)

Only showing introduction paragraphs and System Supplier specific questions:

At Bennett Architectural we are assessing the current status of Building Information Modelling (BIM) in order to develop an implementation strategy for BIM within the business. With this in mind I am currently writing a dissertation on the topic as part of my degree course at Bath University, in which I will be analysing the impact of BIM on Curtain Wall Sub-contractors such as ourselves.

We see the evolution of BIM as an opportunity to further strengthen the relationship between our companies, and would very much appreciate your responses to the questions below relating to BIM. If you have any queries or wish to discuss any of the questions, please email me and I will give you a call.

- 1) Is your company aware of BIM?
- 2) Does your company have a BIM Coordinator/Manager?
- 3) Is your company currently liaising with Architects and Main Contractors regarding BIM?
- 4) Is your company currently considering a BIM implementation strategy within the company?
- 5) If so has your company set a timescale for BIM adoption?
- 6) Will your company be involving their dealers/fabricators as they consider BIM adoption?
- 7) Has your company considered how they will support their dealers/fabricators with BIM information/data?
- 8) Some industry reports suggest that changing specification will become harder once specific systems are embedded early into the BIM model – have you considered the potential impact of this?
- 9) Has your company decided on a particular software provider?

Please feel free to include any further information, together with any questions that you may have.

Appendix B4: Email Questionnaire Template (General Supplier)

Only showing introduction paragraphs and Supplier specific questions:

At Bennett Architectural we are assessing the current status of Building Information Modelling (BIM) within our supplier database as we look to develop an implementation strategy for BIM within the business. With this in mind I am currently writing a dissertation on the topic as part of my degree course at Bath University, and will be reviewing the requirements and expectations of our Main Contractors with regard to product information.

We see the evolution of BIM as a positive move within the industry, and would very much appreciate your responses to the questions below relating to BIM. If you have any queries or wish to discuss any of the questions, please email me and I will give you a call.

- 1) Is your company aware of BIM?
- 2) Is your company currently looking at the implications of BIM within the supply chain?
- 3) Is your company currently considering a BIM implementation strategy?
- 4) Does your company anticipate BIM having a major impact on your business?
- 5) Can your company currently provide all product data (including O & M documentation) in electronic format?
- 6) If so what formats can your company offer (i.e. Microsoft Word, Excel, AutoCAD etc.)?
- 7) Can your company provide full product information/data at quotation stage, prior to manufacture and delivery?
- 8) Are you currently providing information/data for entry into BIM's?

Please feel free to include any further information, together with any questions that you may have.

Appendix C1: Internal Design Training 2009

		INTERNAL DESIGN TRAINING															
Presentation Subject	Presented By	Technician 1		Technician 2		Technician 3		Technician 4		Technician 5		Technician 6		Technician 7		Technician 12	
		Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date
CDM – Designers Responsibilities	Melvin Henaughan (MH Safety Services)			✓	14-Jan-09			✓	14-Jan-09	✓	14-Jan-09	✓	14-Jan-09	✓	14-Jan-09	✓	14-Jan-09
Design Handbook (Ver 3)	Lynne Cowan (Quality in a Box)			✓	27-Feb-09			✓	27-Feb-09	✓	27-Feb-09			✓	27-Feb-09	✓	27-Feb-09
Guide to Fixings (Ver 1)	Paul Johnson (Bennett Architectural)			✓	19-Mar-09			✓	19-Mar-09	✓	19-Mar-09			✓	19-Mar-09	✓	19-Mar-09
Guide to Site Dimensions (Ver 1)	Paul Johnson (Bennett Architectural)			✓	23-Apr-09			✓	23-Apr-09	✓	23-Apr-09			✓	23-Apr-09	✓	23-Apr-09
Fire Stops & Acoustics	James Barrow & Mike Carrick (SideRise)			✓	14-May-09			✓	14-May-09	✓	14-May-09			✓	14-May-09	✓	14-May-09
Kawneer AA3110 & AA3610 Sliding Window Awareness	Dave Tanner (Kawneer UK)	✓	14-Sep-09	✓	14-Sep-09	✓	14-Sep-09	✓	14-Sep-09	✓	14-Sep-09	✓	14-Sep-09	✓	14-Sep-09		
Kawneer AA3110HW, AA3610LS & AA600TE	Jayne Kemp (Kawneer UK)	✓	13-Oct-09	✓	13-Oct-09	✓	13-Oct-09	✓	13-Oct-09	✓	13-Oct-09	✓	13-Oct-09	✓	13-Oct-09		
Smoke Vents, Teleflex and Actuators	Stephen Newell, Kirsty Newell & Phil Griffiths (Dyers)	✓	6-Nov-09	✓	6-Nov-09			✓	6-Nov-09	✓	6-Nov-09			✓	6-Nov-09	✓	6-Nov-09
EPDM and Window Foils	Steve Wild (Tremco Ilbruck)	✓	18-Nov-09	✓	18-Nov-09			✓	18-Nov-09	✓	18-Nov-09	✓	18-Nov-09	✓	18-Nov-09	✓	18-Nov-09
Fire Stops	Steve Roberts & Paul Tsalolikhin (Hilti)	✓	1-Dec-09	✓	1-Dec-09					✓	1-Dec-09	✓	1-Dec-09	✓	1-Dec-09	✓	1-Dec-09
Glass Re-make Schedules & Condensation	Paul Johnson (Bennett Architectural)	✓	10-Dec-09	✓	10-Dec-09			✓	10-Dec-09	✓	10-Dec-09	✓	10-Dec-09	✓	10-Dec-09	✓	10-Dec-09

Appendix C2: Internal Design Training 2010

		INTERNAL DESIGN TRAINING															
Presentation Subject	Presented By	Technician 1		Technician 2		Technician 3		Technician 4		Technician 5		Technician 6		Technician 7		Technician 12	
		Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date
KaluCAD Handover Training (Ver 5)	Lynne Cowan (Quality in a Box)	✓	11-Mar-10	✓	15-Mar-10	✓	11-Mar-10	✓	11-Mar-10	✓	11-Mar-10	✓	11-Mar-10	✓	11-Mar-10	✓	11-Mar-10
NCR Review Session (Ver 7)	Lynne Cowan (Quality in a Box)	✓	8-Apr-10			✓	8-Apr-10	✓	8-Apr-10	✓	8-Apr-10	✓	8-Apr-10	✓	8-Apr-10	✓	8-Apr-10
Automatic Doors	Craig Lakin & Will Brotherhood (GEZE)	✓	27-Apr-10					✓	20-Apr-10	✓	20-Apr-10	✓	27-Apr-10	✓	27-Apr-10	✓	27-Apr-10
Guide to Scheduling Glass, Solid Panels, Louvres and Bonded Glass (Ver 1)	Lynne Cowan (Quality in a Box)	✓	19-May-10					✓	19-May-10	✓	19-May-10	✓	19-May-10	✓	19-May-10	✓	19-May-10
Glass Seminar	Geoff Hancock (Dual Seal)	✓	9-Jun-10					✓	9-Jun-10	✓	9-Jun-10	✓	9-Jun-10	✓	9-Jun-10	✓	9-Jun-10
Doc L Update	Paul Johnson (BAASL) delivering the Craig O'Connell (Kawneer) Presentation	✓	30-Jun-10					✓	30-Jun-10	✓	30-Jun-10	✓	30-Jun-10	✓	30-Jun-10	✓	30-Jun-10
Site Dimension Session	Paul Johnson & Steve Callow (Bennett Architectural)	✓	8-Jul-10					✓	8-Jul-10	✓	8-Jul-10	✓	8-Jul-10	✓	8-Jul-10	✓	8-Jul-10
Ironmongery Seminar	Andy Stolworthy & Russell Richards (Adam Rite)	✓	28-Jul-10					✓	28-Jul-10	✓	28-Jul-10	✓	28-Jul-10	✓	28-Jul-10	✓	28-Jul-10
AA542 Product Launch	Stephen Newell (Kawneer)	✓	8-Nov-10			✓	8-Nov-10	✓	8-Nov-10	✓	8-Nov-10	✓	8-Nov-10	✓	8-Nov-10		

Appendix C3: Internal Design Training 2011

		INTERNAL DESIGN TRAINING																							
Presentation Subject	Presented By	Technician 1		Technician 3		Technician 4		Technician 5		Technician 6		Technician 7		Technician 8		Technician 9		Technician 10		Technician 11		Technician 12			
		Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date		
NACO CPD Metal Louvres	Kevan Barrett (NACO)	✓	27-Jan-11	✓	27-Jan-11	✓	27-Jan-11	✓	27-Jan-11	✓	27-Jan-11	✓	27-Jan-11	✓	27-Jan-11							✓	27-Jan-11		
Design Handbook Refresher (Ver 6)	Lynne Cowan (Quality in a Box)	✓	3-Feb-11	✓	3-Feb-11	✓	3-Feb-11	✓	3-Feb-11	✓	3-Feb-11	✓	3-Feb-11	✓	3-Feb-11							✓	3-Feb-11		
CPD - Window Films	Micky Calcott (The Window Film Company CPD)							✓	23-Mar-11	✓	23-Mar-11	✓	23-Mar-11	✓	23-Mar-11										
Horton Automatics	Laura (Horton Automatics)	✓	1-Nov-11					✓	1-Nov-11			✓	1-Nov-11			✓	1-Nov-11								
Windload Seminar	Paul Johnson (Bennett Architectural)	✓	13-Oct-11					✓	13-Oct-11			✓	13-Oct-11			✓	13-Oct-11	✓	13-Oct-11			✓	13-Oct-11		
AA543 Product Launch	Stephen Newell & +1 (Kawneer)	✓	29-Nov-11	✓	29-Nov-11			✓	29-Nov-11			✓	29-Nov-11			✓	29-Nov-11	✓	29-Nov-11	✓	29-Nov-11	✓	29-Nov-11		

Appendix C4: Internal Design Training 2012

		INTERNAL DESIGN TRAINING															
Presentation Subject	Presented By	Technician 1		Technician 3		Technician 5		Technician 7		Technician 9		Technician 10		Technician 11		Technician 12	
		Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date	Attended	Date
Dyer Environmental CPD Training	Matt (Dyers)	✓	22-Feb-12			✓	22-Feb-12	✓	22-Feb-12			✓	22-Feb-12			✓	22-Feb-12
AA720 Product Launch	Stephen Newell (Kawneer)	✓	27-Feb-12	✓	27-Feb-12	✓	27-Feb-12	✓	27-Feb-12	✓	27-Feb-12	✓	27-Feb-12	✓	27-Feb-12	✓	27-Feb-12
Pilkington Planar Awareness	Tony Brundred/Chris Barr (Pilkington)									✓	15-Mar-12						
Fischer CPD	Ryan Haddock (Fischer)	✓	12-Jun-12	✓	12-Jun-12	✓	12-Jun-12			✓	12-Jun-12	✓	12-Jun-12	✓	12-Jun-12	✓	12-Jun-12