DonnishJournals 2041-2362

Donnish Journal of Engineering and Manufacturing Technology
Vol 2(1) pp. 001-006 May, 2015
http://www.donnishjournals.org/djemt

Original Research Article

Managing the Change Process Associated with Building Information Modeling (BIM) Implementation by the Public and Private Investors in the Nigerian Building Industry

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Accepted 27th April, 2015.

The non-collaboration and isolation between the stakeholders in the Nigerian construction industry which causes rework as a result of poor communication between the Architects, Mechanical and Electrical (M&E) Engineers, Contractors, and Tier contractors prompted this work. The Building Information Modelling (BIM) and its related technologies for facilitating the design, construction and management of existing buildings in the united Kingdom was reviewed to find out that the implementation of BIM on both high profile large scale and small scale projects achieve a high performance project and save money as a result of reduced rework because of effective and adequate communication, collaboration, and integration between the construction parties. Furthermore, the review of BIM in Nigerian building industryshowed that the clients, design team, contractors and the tier suppliers have not heard of BIM before and have no clue what BIM is all about. The architects, the M&E, and Structural engineers have been using building software such as ArchiCAD, and AutoCAD for the building design which is later printed on a paper for the General contractor to use for the construction on site but there is no software for the co-ordination, scheduling and project planning on site used by the General Contractor. This research recommended seminars and workshops on BIM to enlighten the Nigerian public and private investors about the uses and advantages of adopting and implementingBIM on their construction projects to improve the efficiency and performance of their building projects.

Keywords: BIM, Design team, Rework, Collaboration, Integration, Construction Parties.

INTRODUCTION

The Nigerian construction industry, both the public and the private clients, procure their building projects through the traditional system of procurement (Idoro, Iyagba, and Odusami, 2007). The traditional system of procuring building projects has created room for rework, due to the non-collaboration and the isolation between the construction participants during the process of delivering building projects, which result to not delivering the need of the clients. It is observed in most of the local commercial building projects, the architect does the work of the M&E, structural engineer, and that of the General contractor. More so, in some projects where there is an architect, M&E, Structural Engineer, and a General Contractor, it is also observed that the General contractor is not involved during the building design and neither sees nor contributes to the building design during the design stage. The building design is handed over to the General contractor after the design stage is completed for the start of the construction works on site.

This led to rework on site because in most cases the building design by the architect is not constructible on site. Also, on some occasion due to the non-integration between the architect, M&E, structural engineer, and the general contractor, it is observed that there are clashes between the M&E design and that of the architect such as a sewage pipe hitting or passing through a beam which is only found out on site during the construction exercise.

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Building Information Modelling (BIM) recently, is a dominating tool used for the design, construction, and maintenance of new and existing building projects that promoted collaboration and integration of the design team which involves the architect, M&E, structural engineer, Quantity surveyor, the General contractor, and one or two of the tier suppliers. Detail literature on BIM, its Uses, and its Importance will be discussed in the subsequent section followed by the methodology of the research, the result, and the recommendation.

The Use of BIM and its Importance

BIM is not just the use of computer software for developing, stimulating, and operation of construction projects as stated by AGC (2006). However, Succar et al. (2007) defined BIM as a set policy, process, and technology approach for managing the collaboration and integration of building projects throughout the building's lifecycle. According to Buildoffsite, BIM has been used on projects such as the 48 floor leaden hall building "the cheesgrater" which at 225m will be one of the tallest buildings in the city of London on completion in 2014 and on smaller scale projects such as the modular stairs in the new bus station at slough United Kingdom (2011, cited in Bryde et al., 2013).

BIM is also used in remodelling and renovation of existing buildings such as the remodelling of the Manchester's Central Library that was built in 1934. "The library design was based on the American idea that borrowers don't browse; the librarian gets their desired tome from hidden book stacks. This means 70% of the library is not accessible to the public" (Thomas, L. 2011, p.2). Architect Ryder used BIM to reverse this 70% ratio of the building to be accessible to the public.

A savings of 5% have been recorded by a working group as a result of implementing BIM. According to Thomas (2011), the savings comes from sharing the design information between the project design team members, which saves them the time and cost of drawing up the design and development from scratch. Also, the savings comes from eliminating the extra cost of paper base design (2D- design), and eliminating the expensive clashes before the project gets to site. Holding the design information data in common signifies that the design information is co-ordinated and consistent. Anticipating the benefits from BIM Implementation in delivering building construction on schedule with less possibility of error to be made, rework and availability of the building detail design model information for the maintenance of the buildings, "the UK government tends to require the use of 3D BIM on all its projects by 2016" (industrial structure, 2011, p.28). Adopting and managing the change process of implementing BIM at the organisational level, process level, and product level has some challenges which will be discussed in the subsequent sections below.

BIM at the Organisational level and its Challenges

Managing the change process of implementing BIM at the organisational level in Nigerian building industry starts with moving away from the traditional design-bid-build system of procurement to an integrated system of procurement. The traditional design-bid-build system of procurement has a lot of limitations when compared to the integrated system of procurement in delivering a quality project to the satisfaction of the client. The traditional design-bid-build system of procurement lacks interoperability, integration and effective sharing of information during project delivery which results in cost overrun, delay in project delivery, blames and claims between the client and the contractor. Traditional system of procurement is usually used in a one-off project construction. However, the importance for the use of BIM cannot be achieved in a construction project with the traditional architect or designer working with 2D or 3D CAD tool that produces drawings that are hand-off to the contractor when the design is completed. In such project, much of the value that BIM brings to the project is not properly utilized.

BIM at this level involve the federal Government of Nigeria, agencies such as the Nigerian Building and Road Research Institute (NBRRI) and some other related building industry association, and researchers to enforce policies, principles, and research frameworks to generate standard and best practices in order to protect the benefits between stakeholders in a BIM environment, to promote collaboration between stakeholders and discourage stakeholders from working in silo. In other words, there must be integration of the quantity surveyor, general Contractor, and tier supplier with the design team (architect, M&E, and structural engineer) at the early design stage, and the effective share of information and collaboration among them. Furthermore, the integration of the stakeholder continues from the project design stage to the commissioning stage.

Challenges that can be encountered at the organisational stage is ignorance and no knowledge of BIM, which will result to rigid attitude towards the change process of adopting BIM and negative attitude of some building owners, designers, engineers, and contractors towards the change process.

BIM at the Process level and its Challenges

Managing the change process of implementing BIM at the process level can be emphasized onintegrated project delivery, design intent validation, and lean design management. The stakeholders involve at this level are the project owners, designers, Engineers, contractors and the operators (Succar et. al 2007). Implementing BIM at the process level starts with listening to the voice of the client by the consultant from the Design and build construction firm employed by the client in order to clearly define the need of the client. The design and build firm will align the goals and the objectives of the client for embarking on the project with the BIM goals and objective and pull solution to the client goal and objective from the BIM technology.

The consultant can be an architect, a design engineer, or a project manager from the design and build firm. After the need of the client has been clearly defined and stated, the design team from the design and build firm, which involves the architect, M&E, structural engineer, quantity surveyor, General contractor, and any tier supplier, provides the detail design and design development of the building project together using the required BIM technology. This encourages the effective share of information between the stakeholders and the integration of the General contractor at the early design stage. In other words, the stakeholders collaborate together, and pull from each other to eliminate waste from the project delivery process, reduce rework and cost overrun, and eliminate claims and blames between the client and the contractor company.

The architect provides the building plan using any of the BIM software. The building plan from the architect is sent to the M&E for the design of the HVAC systems, piping, and other electrical and mechanical systems. The structural engineer uses the model from the architect and M&E to analyse and design the structural loads, bending moments and shear forces of the building structures. The presence of one or two tier-1 supplier among the design team makes the project feasible.

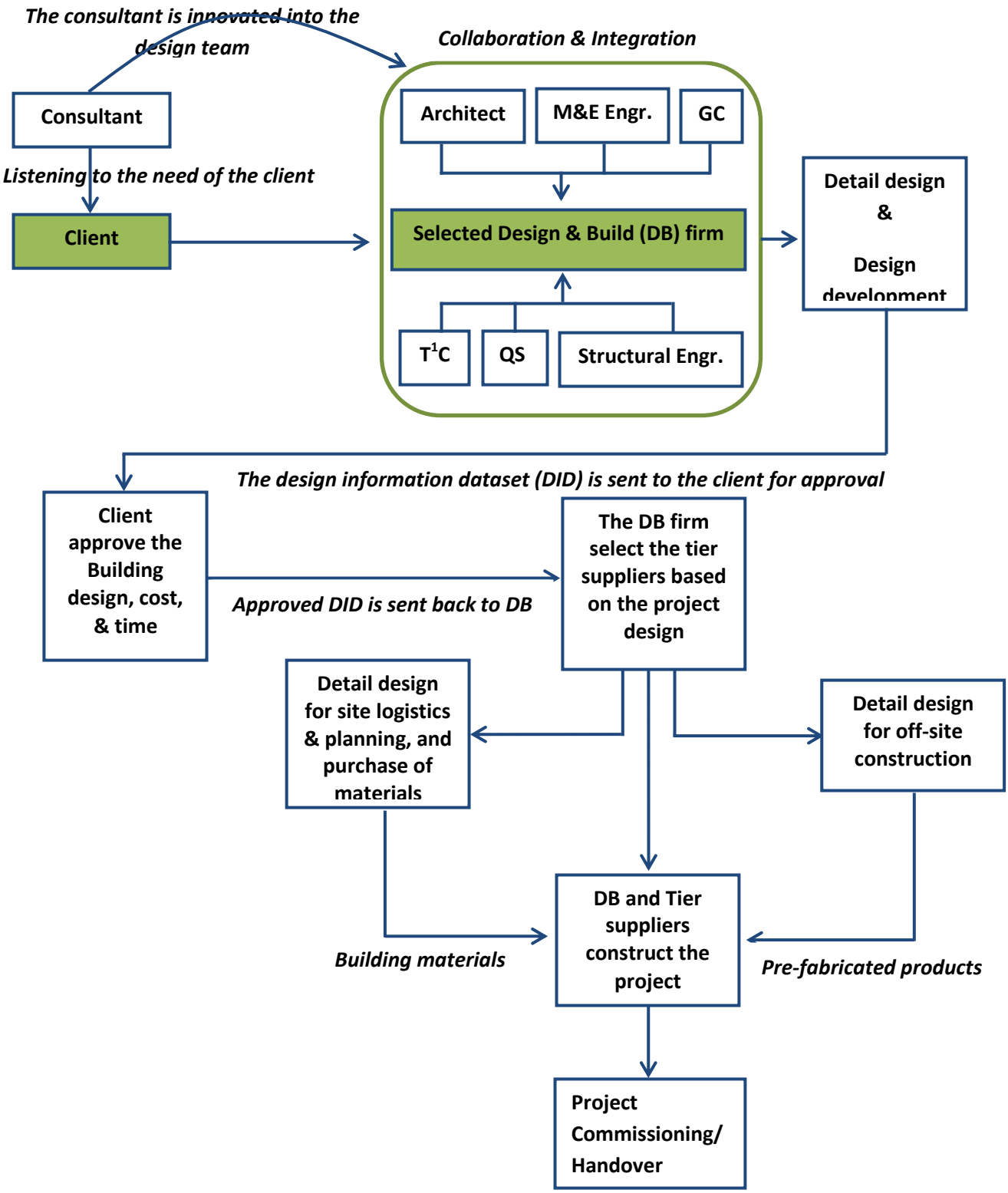

Figure 1: Information & Workflow process

Table 1: BIM design tools and its personnels

Design Team Members	BIM 3D design software
Architect	Quality Function Deployment (QFD), ArchiCAD, AutoCAD, Revit etc.
M&E Engineer	AutoCAD, CADDUCT, Revit, FireCAD etc.
Structural Engineer	Revit, Bentley, AutoCAD, etc.
Quantity Surveyor	Quantity take-off (AutoDesk), QS Plus, etc.
Contractor	NavisWorks, MS Project, etc.

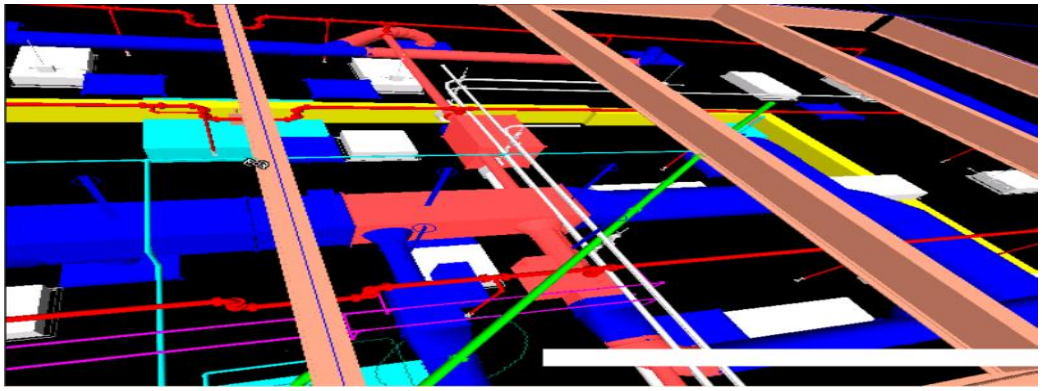

Figure 2: Hard conflict between the Fire Sprinkler Pipe and the Supply Duct that was automatically identified in Navisworks Clash Detective on the Camino Project (Staub-french and Khanzode, 2007, p.13).

In other words, the tier supply will make sure that the project materials to be used according to the design specifications must be available in the market. The quantity surveyors with the co-operation of the architect will take the more accurate quantity take–off and project costing. The contractor will therefore combine all the model designs from the architect, M&E, structural engineer, and the quantity surveyor and check for error on the design information dataset, and check for any clash dictation on the design information dataset. The contractor will also use the dataset for the project and site logistics planning, and scheduling. Meanwhile, each of the design team during his modelling is free to review the design and reveal any error that is found from the designs of his colleague and send it back for correction.

Challenges that can be encountered during BIM implementation at the process level are as follows: the cost of implementing this change process, for a design and build firm, which involves the cost of training the staffs. Also, the competition between the architect and the design team members of who owns the building models can critically affect the implementation of BIM at the process level. However, each member of the design team has ownership of their individual model design and uses others as an external reference (Thomas, L. 2011). Therefore, every member of the design team is responsible for any design error from his or her own design.

The nature of the integration on BIM provides a huge development on the sharing of information among the shareholders. The respective design model of each design team member are joined together to form a complete design information dataset (DID) that will be used for the building project. The BIM information is handled in such a way that building design cannot be altered once the design stage is completed and each construction activity can only have access to the model information that will only be used to perform the needed task.

BIM at the Product level and its Challenges

At the product level of BIM implementation, various BIM related technologies are discussed. This includes 3D model software, computer systems, laser scanners, quality function deployment (QFD) tool and other BIM tools and technologies. Details of these BIM technologies will be discussed as we proceed. The 3D model software is discussed in a table 1 above.

The Quality Function Deployment (QFD) is a tool used by a consultant, who can be an architect, an engineer, or a quantity surveyor, to effectively listen to the voice and need of a client and clearly documents the project requirements. The ArchiCAD, AutoCAD, and Revit are 3D BIM softwares that are used for the design and modelling of the architectural project plan, M&E, and structural design and analysis. The contractor uses the NavisWorks to view and simulate the detail project design and performance analysis. It is also used to detect clashes within the project structures such as the beams, pipes, concrete walls and columns, etc. Furthermore, the NavisWorks software has the capacity of combining all the model design from the various design team members on different software platforms into one platform. The contractor uses the Microsoft Project software tool (MS Project) for project planning, scheduling, monitoring, and controlling of the project construction processes.

The computers that are used for BIM implementation is high definition systems with high random access memory (RAM), high storage system and a strong processors with high processing frequency. Such BIM hardware are as follows; Autodesk Architectural Desktop (ADT), projectors, electronic board, plastic white board, laser scanners (for scanning an existing building in order to obtain the building plan in the case of a lost building plan) etc.

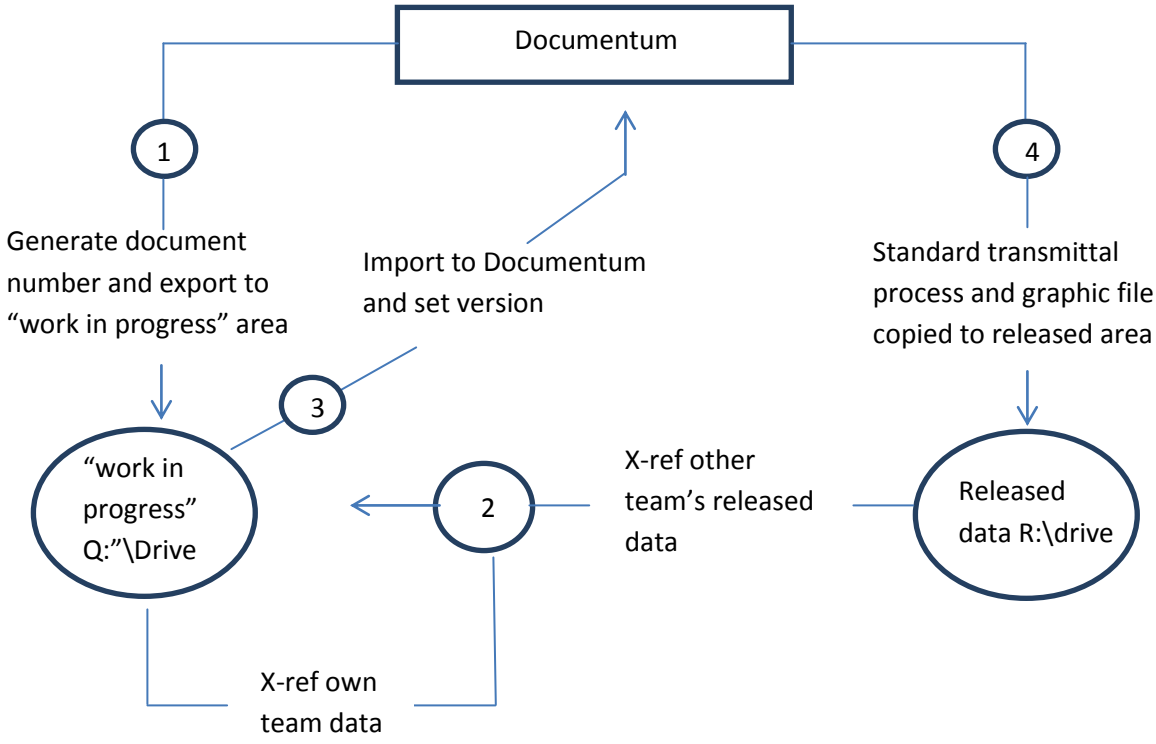

Figure 3: Window Explorer Environment (Graham, B. et al, 2006).

Reviewing the Case study of CAMINO MEDICAL GROUP PROJECT UK- A project scope of 250,000 Square foot with three-storeymedical office building and two-storey 1,400 space parking garage, the architect used the ADT software to design the 3D model for the architectural and structural scope of work. The structural engineer from the architect's model designed the building structural steel, concrete foundation and shear walls using the ADT software. The mechanical & Electrical Engineer used the AutoCAD to model the mechanical and Electrical systems in 2D. The subcontractors used the 3D pipe designer, and CADDUCT to design the building plumbing system, piping and ductwork, Conduct and cable trays in 3D. The Fire protection subcontractor used the FireACAD to design the building fire protection system in 3D, and the general contractor used the NavisWorks to coordinate the overall design and MEP in 3D, identifying the clashes between the design models with the NavisWorks Clash Detective program and tracking the resolution of any outstanding issues.

Also, the review of another Case Study of TERMINAL 5, LONDON HEATHROW UK showed that AutoCAD MAP was used during the design concepts as a CAD Platform and DOCUMENTUM ™ as a document management platform. However, AutoCAD MAP was not producing the appropriate 3-D data needed and was not suited to X-refs which are essential for sharing data between the teams. DOCUMENTUM ™ would neither allow X-refs nor would it allow different teams to share information from a single source, so the user requirement became demanding as the project proceed and the system has to be upgraded by replacing the AutoCAD MAP with AutoCAD 2002 which enabled all the members of the team to use X-refs. A T5 WINDOWS EXPLORER ENVIRONMENT was introduced with dedicated drives to give a complete freedom to work with CAD data within the design team members so that users can take full benefit of X-refs.

Additional BIM software are CSC 3D+ used for 3D steel work and concrete design, Rhino used for Steel casting, CADD RC used for 2D reinforce Concrete detailing, VILLA used for 3D Baggage system, MX used for ground Modelling and highway design, etc.

Challenges that can be encountered at the product level are the cost of purchasing these softwares and other BIM technologies, and the cost and duration of training experts to operate and handle those design model software and its related technologies.

CONCLUSION AND RECOMMENDATION

This work concluded that BIM Implementation cannot be achieved successfully without teamwork, Collaboration and interoperability and proper sharing of information among the stakeholders. This work recommends that the Federal Government of Nigeria, and other building and construction institutes and agencies to enforce the use of BIM, by organising workshops and seminars to educate owners, engineers, operators, contractors and tier suppliers on the uses and advantages of BIM of public and private construction projects, in order to reduce the blames and claims between the contractors and the project owners which results to contractors and owner going to court.

REFERENCES

AGC (2006). The Contractors' Guild to BIM, *Associated General Contractors (AGC) of America.* Available at www.agc.org.

Aranda-mena, G., Crawford, J., Chevez, A., and Froese, T. (2009). Building Information Modelling demystified : does it make business sense to adopt BIM ?. *International Journal of Managing Projects in Business.* 2(3), 419-434.

Bryde, D., Broquetas, M. &Volm, J.M .(2013). The Project Benefits of Building Information Modeling (BIM). *International Journal of Project Management*, 31(7), pp.971-980. doi: http://dx.doi.org/10.1016/j.ijproman.2012.12.001

Computer Integrated Construction Research Program. (2013). BIM Planning Guild for Facility Owner. Version 2.0, June. The Pennsylvania State University. Uinversity Park. PA, USA. Retrieved from http://bim.psu.edu.

Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2008). BIM Handbook: A Guild to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors. Hoboken, NJ.: John Willey

Graham, B., Tom, H., Tarsem, K., Steve, R. (2006, January). Terminal 5, London Heathrow: 3D and 4D design in a Single Model Environment. *The Arup Journal*. Retrived from http://blackboard.salford.ac.uk/bbcswebdav/pid-1143682-dt-content-rid-2411631_1/xid-2411631_1

Idoro, G. I., Iyagba, R. O. A., and Odusami, K. T. (2007).Evaluation of the use of design-bid-build procurement system in the Nigerian Construction Industry.*Construction Research Journal,* 1(1), 15-25.

Industry Structure: Building Information Modelling. (2011, September).2(3), Pp.28-30. Retrieved from http://www.cri.org.uk

Sheryl Staub – French, AtulKhanzode. (2007, July). 3D and 4D Modelling for Design and Construction Coordination: Issues and lessons Learned. Pp. 1-27. Retrieved from http://itcon.org/2007/26/

Succar, B., Sher, W., Aranda-mena, G., and Williams, T. (July, 2007). A proposed framework to investigate Building Information Modelling through knowledge elicitation and visual models. *In conference proceedings of the Australian University Building Education Association,* Melbourne, National Institute of Standard and Technology.

Thomas, L. (2011, 30th September). BIM – The inside story.The Building. Retrieved from http://www.building.co.uk