# Implementing BIM to Streamline a Design, Manufacture and Fitting Workflow

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## INTRODUCTION

- Sacks et al. (2010), stated the interactions between Building Information Modelling (BIM) and Lean, arguing that to achieve the full improvements in construction projects both concepts of BIM and Lean should be adopted together.
- BIM implementation demands changes in existing process and procedures for design and construction, representing a technology change, but also a process change. Technology should fit organizational structure and reinforce business process, making the company leaner.
- In the UK, the Government Construction Strategy (2011) mandates the use of BIM in all centrally procured projects by 2016, reinforcing the need of supply chain integration in order to accomplish reliability and better value for money, encouraging the use of offsite fabrication of building and components.
- In addition, there is a vision of the use of Building Information Modelling (BIM) to allow design to feed direct into machines, connecting design and manufacture, and discarding unnecessary intermediaries (Cabinet Office & BIS, 2011).
- BIM adoption and awareness is growing in the UK construction sector. There is an influence of the "push-pull" Government Strategy for BIM, and a 'feeling' of BIM being a new standard for project information, which is transforming the construction industry landscape.

## METHODOLOGY

- The research adopts a case study methodology, including focus groups and interviews, on a BIM Implementation for Design for Manufacture and Assembly (DfMA) at Links , a design, manufacture and fit-out company based in the UK.
- The project is a Knowledge Transfer Partnership (KTP) between the University of Salford and Links. KTP is a program partly funded by Innovate UK, which aim is to support business wanting to increment their performance and competitiveness with innovative solutions by accessing universities knowledge and expertise.
- The project objective is to implement BIM within Links ensuring that the company has the expertise needed to operate in a BIM environment from design to manufacture and installation, integrating these three company areas.
- The project begun in February 2014 and has 30 months duration, divided in 5 stages, as illustrate in Figure 1:
  1. BENCHMARKING: Establish and consolidate best practice knowledge in BIM;
  2. DIAGNOSIS: Detailed review and analysis of the organization's current situation;
  3. ACTION PLANNING: Develop BIM-based collaborative strategy; the current stage on May 2015
  4. TAKING ACTION: Pilot implementation of BIM-based collaborative strategy for DfMA;
  5. EVALUATE: Project review, evaluation, and dissemination.


FIGURE 1: BIM IMPLEMENTATION STAGES, BASED ON ARAYICI, Y., EGBU C. AND COATES P. (2012)

## RESULTS
### CURRENT PROCESS

Figure 2 represents the Design process including interfaces with Customer and Manufacture.

- Design Preparation - ideas for the space sketched by hand.
- Design Concept – 2D layouts and elevations using (dwg), specification sheet (doc), and 3D visualizations (CGIs) on 3DMax.
- Once the client approves design, design outputs are sent to manufacturer sister company.
- The manufacture develop detail furniture drawings (dwg) and send to Links for approval.
- After drawings sign off, 3D models (CAD) with all manufacture information are developed
- 3D models are next input into CNC Machines for production.
- Information is shared in pdf, non-editable files.

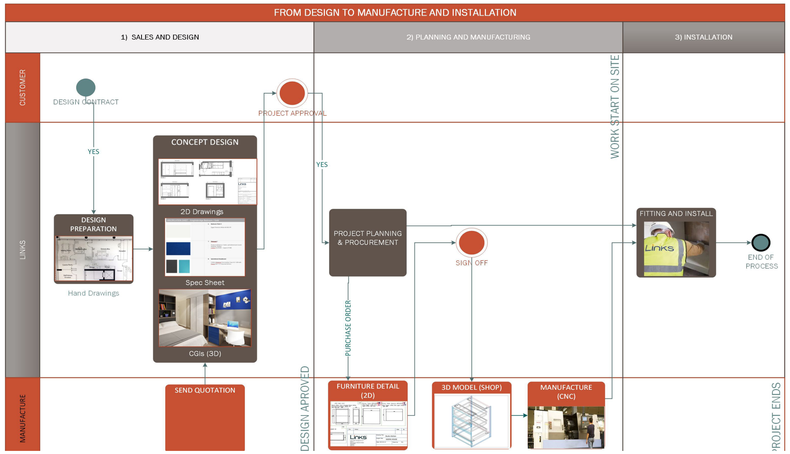


Figure 2

## IMPROVEMENT GAIN ANALYSES

- During a set of interviews and workshops, Links staff shared their vision for improving each process, as well as, details of how to measure their performance.
- Table 1 summarize the issues founded, relating each one with Lean defined wastes, and suggestions for improvement.
- The analyses highlighted the information duplication on design-to-manufacture process: copying the same information in multiple file formats, not interoperable, with a lack of the "single version of the truth" in design projects. Duplication of information is considered a waste; moreover, duplication can cause errors and excess of inventory.

| Process | Common Issue | Waste | Vision | Related Action | KPI |
|---|---|---|---|---|---|
| **General** | • Design need to freeze in a certain point to avoid defects | | | Management | |
| | • Lack of knowledge of fabrication process and fitting process to be able to develop new products | Skills | Integration of company departments knowledge though workshops | DfMA Training | X |
| | • Lack of training on software | Skills | | BIM Training | X |
| **Concept Design** | • Areas of improvement: Information about the products better organized to speed up design and specification process | Over processing | BIM: Design Software, Component Library with Links products, Researchable database of suppliers | BIM Software | X |
| | • Cost of Design is calculated at the end of the design concept process, by other department | Motion<br>Re-work | Implement a BIM 5D tool to have the capability of cost in early design stages | BIM Software | X |
| | • Small amendments asked by the client after the amendment period make the project finish difficult to be establish | Unclear communication | Clarify on contract the kind of amendments that are included or not in the proposal. | Management | |
| | • Duplication of information in multiple formats<br>• Lack of a "single version of the truth" | Overproduction<br>Duplication | BIM: Design Software interoperable with CNC | BIM Software | X |
| **Design Handover** | • No formal handover to project management teams, lack of information for manufacture | Unclear communication | BIM: Common Data Environment for a better Information Management | BIM Software<br>Process change | X |

Table 1

## MEASUREMENTS

- On the BIM Strategy Plan, a set of KPIs are proposed applying the Balanced Score Card methodology, that covers 4 areas of every organization: Customer, Internal Process, Financial and Learning and Growth (Kaplan & Norton, 1996). More than measuring the processes these are KPIs to control that the company is moving towards its strategic objectives. Furthermore, systematic measurements could stimulates a continuous improvement process.
- To get a comparison of the results of BIM Implementation, a baseline project is going to be measured. Next, KPIs are going to be captured on a BIM Pilot Project.
- Table 2 describe KPIs, its objectives and the proposed metrics.

| | Objectives | KPI | Measures | Targets |
|---|---|---|---|---|
| **Satisfy Shareholders** | Increase Customers numbers | | Number of Customers | % increase |
| | Increase Design Turnover | | Average Sale | % increase |
| | Increase Conversion rate | Percentage calculated by Projects proposal/ projects | | |
| **Delight Customers** | Increase Customer Satisfaction | Questionnaire for Client Satisfaction Overall including service, specification, timely and accurate provision of information and personnel | Customer Satisfaction | % increase |
| **Effective Processes** | Reduce Cycle or Lead Time | Compare before and after BIM<br>Capture time from baseline project and measure against pilot BIM Project | Cycle Time | % reduction |
| | Reduce Changes | Requirements captured (EIR)<br>Capture Number of changes to measure how accurate EIR are | Number of Changes | % reduction |
| | Reduce changes after amendment period | Changes out of amendments period to be measured in separate | Number of changes | % reduction |
| | Increase Quality of information on internal handover | Provisional of Information Overall<br>How satisfied the internal client was with the timely and accurate provision of information by design team | Internal client satisfaction | % increase |
| **Motivated & Prepared** | Increase Core Skills | Measure employee satisfaction before and after training | Training | % increase |

Table 2

## RESULTS
### TARGET PROCESS

- The BIM Strategy for DfMA, supported by appropriate software and considering interoperability of different software utilized from design into manufacture will eliminate the information duplication.
- Part of the project is to develop standard component libraries with parametric models that are going to be used in concept design, and send direct to manufacture after design approval.
- The use of Component based design would speed up design process, reduce errors and increase manufacture efficiency.
- Figure 3 illustrates the input of component library on concept design process, which output is the 3D BIM model. From the 3D BIM Model, it is possible to generate 2D Drawings for Layouts and Elevations automatically, and the 3D Model is a base model for rendering (CGI).
- Table 3 compares the current process with the target process, estimating the time savings.

## CONCLUSION

- So far, the project demonstrates that the combination of Lean for Process Improvement and BIM can bring efficiencies for the company.
- In the next steps, the chosen software, KPIs and target process are going to be tested on a pilot project, followed by an evaluation and review stage.

| Title: Design to Manufacture Process | | | Date: | | | | | Title: Design to Manufacture Process - Re-engineered | | | Date: 06/05/15 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Chart Symbol | | | | | | | | Chart Symbol | | | | |
| | Step | Flow | Time (min) | Operation | Move | Delay | Store | Inspect | Step | Flow | Time (min) | Operation | Move | Delay | Store | Inspect |
| 1 | Request Suppliers Quotation and Samples | | 2 days | | | | | | Request Suppliers Quotation and Samples | | 2 days | | | | | |
| 2 | Spec Sheet Development | | 1 day | | | | | | Spec Sheet Development | | 1 day | | | | | |
| 3 | Send information to CAD/3D Visualizers | | 0,5 days | | | | | | Using BIM Libraries, design model in 3D | | 3 days | | | | | |
| 4 | Wait until CAD/3D Visualizers can allocate design | | up to 7 days | | | | | | Export and format Layout and Elevations | | 1 day | | | | | |
| 5 | Prepare Layout and Elevations | | 2 days | | | | | | Export and include light and finishes to final CGIs | | 3 days | | | | | |
| 6 | Prepare CGIs | | 5 days | | | | | | Prepare Mood Boards | | 2 days | | | | | |
| 7 | Prepare Mood Boards | | 2 days | | | | | | Review CGIs and 2D Drawings | | 0,5 days | | | | | |
| 8 | Recieve and Review CGIs and 2D Drawings | | 0,5 days | | | | | | Finalize Spec Sheet (paralel to CGI developement) | | 0,5 days | | | | | |
| 9 | Finalize Spec Sheet | | 0,5 days | | | | | | Handover to estimators with quantities | | 1 days | | | | | |
| 10 | Amend CGI | | 1 day | | | | | | Wait until estimators allocate design | | up to 3 days | | | | | |
| 11 | Handover to estimators | | 2 days | | | | | | Send drawings for quotation | | 1 hour | | | | | |
| 12 | Wait until estimators allocate design | | up to 3 days | | | | | | Wait until Nordic can allocate quotation request | | up to 4 days | | | | | |
| 13 | Send drawings for quotation | | 1 hour | | | | | | Receive and review Cost plan | | 1 hour | | | | | |
| 14 | Wait until Nordic can allocate quotation request | | up to 4 days | | | | | | Prepare final presentation | | 0,5 days | | | | | |
| 15 | Receive and review Cost plan | | 1 hour | | | | | | | | | | | | | |
| 16 | Prepare final presentation | | 0,5 days | | | | | | | | | | | | | |
| | **Total** | | **17 days 2 h** | **14d** | **2.5d 1 h** | **14d** | | **0.5 d 1 h** | **Total** | | **14.5 days 2 h** | **13d** | **1d 1h** | **7d** | | **0.5d 1h** |
| | Process at Nordic (manufacture) | | | | | | | | Process at Nordic (manufacture) | | | | | | | |
| 17 | Send Quotation | | 1 day | | | | | | Send Quotation | | 1 day | | | | | |
| 18 | Receive Purchase orders | | 1 hour | | | | | | Receive Purchase orders | | 1 hour | | | | | |
| 19 | Produce furniture drawings for approval | | 2 days | | | | | | Receive and Review Design for manufacture | | 2 days | | | | | |
| 20 | Send drawings for approval | | 1 hour | | | | | | Send drawings for approval (*Links) | | 1 hour | | | | | |
| 21 | Review and sign Drawings (*Links) | | 0,5 day | | | | | | Review and sign Furniture Detail Drawings | | 0,5 day | | | | | |
| 22 | Wait for drawings sign off | | up to 7 days | | | | | | Wait for drawings sign off | | up to 7 days | | | | | |
| 23 | Design for manufacture | | 3 days | | | | | | | | | | | | | |
| | **Total** | | **6 days 1 h** | **6d 1h** | **1h** | **7d** | | **0,5d** | **Total** | | **3.5 days 1 h** | **3d 1h** | **1h** | **7d** | | **0.5d** |

Key:
As-Is Process
To-Be Process
Process changes

Table 3

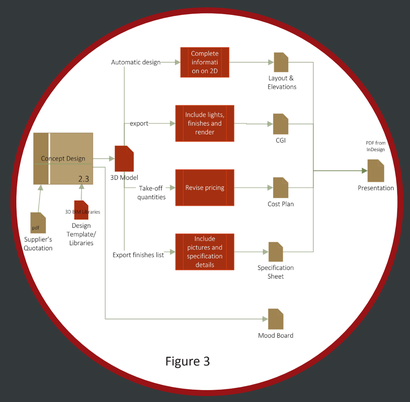


Figure 3

## ACKNOWLEDGEMENTS

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