

Lean Construction And Surveying

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SUMMARY

The construction industry has come a long way over the years in a bid to try and improve the project delivery process. More recently we have seen the introduction of 'lean and agile' principles adopted from the car manufacturing industry to change the way the construction industry is managed. The environment in which the industry operates today comes with a lot more demands than in the past and the client is more aware now of the value generating process than before. This has resulted in a new principle called 'lean construction'. This basically involves the process of adding value of the finished product by the minimisation of waste. Waste comes from all the different players and aspects on a project of which surveying is one. It is important for the surveyor to realise and understand the whole project delivery process so they can re-align their methods to meet the requirements of lean construction principles.

The advent of the internet and information technology has given rise to a level international playing field by any who care to look beyond their borders and most professionals in the construction industry no longer enjoy the 'territorial advantage'. Technological innovation can occur on two fronts; technology-push or strategy-pull process. The issue of strategy-pull is becoming increasingly complex in process and manufacturing industries generally, and in construction particularly. Over the years surveying has benefited a lot from automated technologies allowing real time production of deliverables and reduced running costs. The problem has been that the initial investment costs are high. The construction industry is clearly moving away from the concepts of using technology solely for automation. The dynamic nature of construction, the volatile economic circumstances the industry faces and the inflow of new ideas of production management that are increasingly divergent from mainstream construction management philosophies, give rise to a climate ripe for innovation and a paradigm shift.

This paper will aim to introduce the main principles upon which lean construction is based, outlining the main advantages of this process and its objectives. It is hoped to create awareness to those involved in any such projects of the whole concept of lean construction as a major aspect of project management.

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1. PRINCIPLES OF LEAN CONSTRUCTION AND SURVEYING

1.1 Key Definitions

Surveying Measurement - The art, science, and technology of gathering and analyzing measurement data related to the land and other land-related surfaces and spaces, to include designing and devising the measurement specifications and standards to accomplish these measurements with the desired precision and accuracy and error control and adjustment, including the use of all instrumentation applicable to such measurements, said measurements typically being, but not limited to distances, heights, angles, directions, positions, areas, volumes, and other measurements associated with these quantities. (Dr. Ben Buckner, Dec'94)

Professional Surveying - The application of knowledge of the science of surveying measurement, the legal principles of boundary location, the laws related to boundaries and land use, the applicable mathematical and computational theories and principles, the natural and other forces which affect positional accuracy, the land planning and development concepts pertinent to subdivision of land and property surveys, land record and land tenure concepts, geodetic and other earth-related sciences to the analysis, design, and execution of surveying and mapping projects and the design of land mapping and information systems. (Dr. Ben Buckner, Dec'94)

Lean production – the new way to manage production in the (construction) industry, with implications for commercial relationships and project delivery mechanisms. Lean construction planning and control techniques reduce waste by improving workflow reliability...Lean construction starts by stabilising the workflowOther lean principles and techniques include coordinating action through pulling and continuous flow, as opposed to the traditional schedule push; decentralising decision-making through system transparency and improvement; practising concurrent engineering, involving installers in the design process, and simultaneously designing product and process. (Howel, G. Lean Construction Institute, 1998)

A process – defined as 'the logical organisation of people, materials, energy, equipment and procedures into work activities designed to produce a specific result.' Davenport and Short, 2001)

The Process Protocol – a common set of definitions, documentation and procedures that provide the basis to allow a wide range of organisations involved in a construction project to work together seamlessly. (Kagioglou et al, 2000)

The Supply Chain – the network of organisations that are involved, through upstream and downstream linkages, in the different process and activities that produce value in the form of products and services in the hands of the ultimate customer. (Christopher 1992)

1.2 Introduction

The construction industry the world over faces fluctuating demand cycles, project/client specific product demands, uncertain production conditions and the need to combine a diverse range of specialist skills. There has been great pressure on the industry to adopt production methods and business attitudes that have made a lot of success in other industries – more specifically ‘lean production’ as applied in the car manufacturing industry. The publication of the Egan Report in the United Kingdom – Rethinking Construction, in 1998 is often seen there as the point at which lean production principles were first formally suggested to the UK construction industry. The report made a lot of interesting recommendations some of which are;

- Use of Lean and Agile production principles in construction, hence lean construction.
- Process mapping as part of defining the value stream in construction
- Partnering the supply chain

These three points form the basis upon which this report is based and will be reviewed in greater detail in the sections below.

1.3 Lean And Agile Production

The underlying principle of lean production is;

‘remove waste form a process in order that a product can be manufactured and delivered to order and of sufficient quality to the customer without maintaining any intermediate stock or inventory’

Some of the main features of lean construction are that it provides clear delivery process objectives, it maximises performance at the project level, it allows product and process to be designed concurrently, it maintains production control throughout project lifecycle.

There are five key principles of lean; value, value stream, flow, pull and pursuit.

Specify Value

- Value is the critical starting point of lean thinking.
- Value can only be defined by the ultimate customer but it is created by the producer.
- Lean thinking must start with a conscious attempt to precisely define value in terms of specific products with specific capabilities offered at specific prices through a dialogue with specific customers, Womack and Jones (2003).

Identify the Value Stream

- Value stream is the set of all specific actions required to bring a specific product through the critical management tasks of any business.
- This is a step in lean thinking that exposes large amounts of *muda* or waste.
- Lean thinking must go beyond the firm (producer of value) to look at the whole; the entire set of activities entailed in creating and producing a specific product from concept through to detailed design to availability.
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Make the Product Process Flow

- ‘We are all born into a mental world of “functions” and “departments (divisions)”, a commonsense conviction that activities ought to be grouped by type so they can be performed more efficiently and managed more easily.’ Womack and Jones (2003)
- Batches, departments or divisions always mean long waits as the product sit awaiting the next processing stage or action by a different division.
- Business process reengineers have not gone far enough conceptually. Allegedly they are still dealing with disconnected and aggregated process rather than the entire flow of value-creating activities for specific products.
- Lean principles mean redefining the work of functions, departments, and firms so they can make positive contributions to the value creating activities and address the concerns of employees at every point along the stream so it is actually in their interest to make value flow.

At the Pull of the Customer

- A change from departments and batches to product teams and flow dramatically reduces the time required to go from concept to launch, sale to delivery, and raw material to the customer and makes delivery time more predictable.
- This in turn reduces inventory, storage or product waiting time.
- The ability to design, schedule, and make exactly what the customer wants means sales forecast can be dealt away with and simply make what customers actually tell you they need.
- By so doing you let the customer pull the product from you as opposed to pushing the product to the customer.

Pursuit/Perfection

- With *value* specified, the *value stream* identified and *flowing* continuously at the *pull* of the customer, *pursuit* to *perfect* the product will no longer be a far fetched idea anymore.
- The first four stages in lean operations always result in the elimination of *muda*.
- Dedicated product teams in direct liaison with the clients always find ways to specify value more accurately and often learn of new ways to enhance flow and pull as well.
- With a clear and transparent value stream available to all key stakeholders it is easy to discover better ways to create value.

1.4 Lean Principles and Construction

The Construction Task Force, lead by Sir John Egan, noted the following in their report Rethinking Construction (now famously known as the Egan Report);

- The UK construction industry is a very competitive one and is capable of delivering the most difficult and innovative projects matching world class standards.
- The general feeling is that the industry is underachieving with low profitability and too little capital investment. Clients are generally dissatisfied.
- The Task Force’s aim was to initiate radical change based on experience in other industries.

- 5 key drivers for change were identified; committed leadership, a focus on the customer, integrated processes and project teams, and a quality driven agenda and commitment to people.
- Experience shows that ambitious targets and effective measurement of performance are essential to deliver improvement.
- Proposals of a series of targets for annual improvement. These targets are based on experience from project within the UK and abroad.
- Targets include an annual reduction of 10% in construction cost and time and defects to be reduced by 20%.
- The construction industry requires radical changes to the processes through which projects are delivered - a clearly specified value stream, and that these processes are transparent to the industry and its clients.
- Integrated project process created around the four key elements of product development, project implementation, partnering the supply chain and production components. Lean principles should then be used for sustained improvement.
- Substantial changes in the business culture and structure are needed for the construction industry to achieve full potential.
- Competitive tendering must be replaced by long term relationships based on clear measurement of performance and sustained improvements in quality and efficiency.
- The housing sector is of particular interest because of the number of stakeholders involved. They need to work closely together to improve processes and technologies and develop products.
- Major clients of the construction industry must give leadership by implementing the principles of this Egan Report (basically lean and agile production) in projects.

2. THE CONSTRUCTION PROCESS

Davenport and Short (2001) define a process as the ‘logical organisation of people, materials, energy, equipment and procedures into work activities designed to produce a specified result’. More specifically, the construction process is one in which a client commissions a professional representative to facilitate the project process. By refining the client’s needs and incorporating certain requirements, the representative comes up with a brief setting out the main objectives of the project. This then goes through design by other professionals to produce documents relating to the technicalities of carrying out the work and eventually to produce the desired product. A schematic representation of this process is what is called a ‘process map’. In general, process mapping is a technique for creating a common vision and shared language for improving results. The following factors and practices tend to yield powerful results in process mapping;

- foreground goals in organising the process map
- determine how to create value for the customer throughout the process
- map tools, skills and performance metrics along with the process
- engage widely in process mapping to define problems and solutions

2.1 The Process Protocol

The Process Protocol provides ‘a common set of definitions, documentation and procedures that provides the basis to allow a wide range of organisations involved in a construction project to work together seamlessly.’ (Kagioglou et al 2000). It is based on experiences from the manufacturing sector as a reference point to map the entire project process from the client’s view of a new or emerging need, through to operations and maintenance. The project is mapped by breaking it down into eight teams called activity zones, namely Development, Project, Resource, Design, Production, Facilities, Health & Safety and Legal, and Process Management.

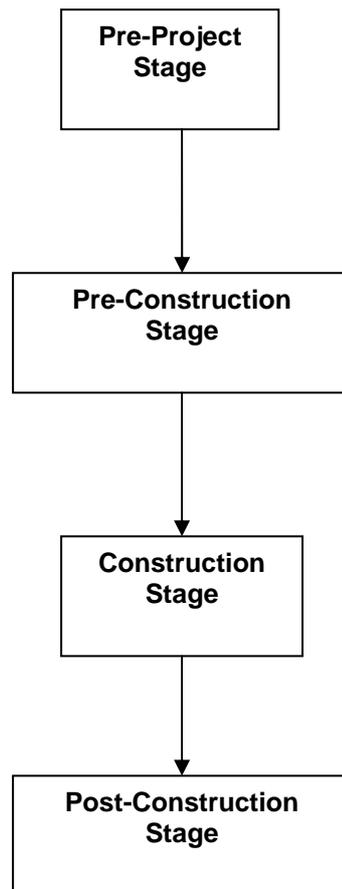


Fig 1 stages in a construction project

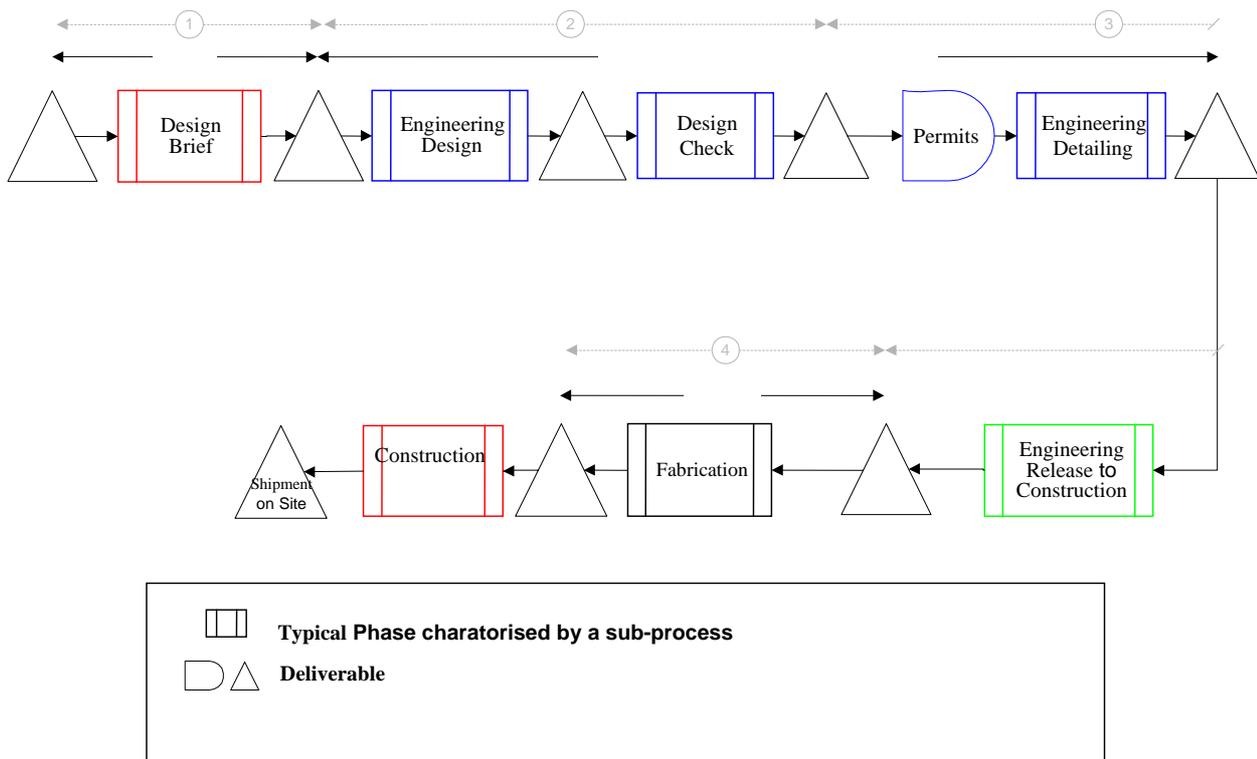
In construction projects, construction itself is often considered synonymous with the project process. Right from the start of the project the tendency is to accelerate the whole process to the construction stage. Ideally the Process Protocol aims to

- Integrate the various participants of a project into multi-functional teams
- Make sure these teams operate in a stage-gate based project environment
- Increase transparency in the production environment
- Enables design fixity

- Reduces downtime caused by late deliveries of certain project activities by clearly mapping the deliverables
(Kagioglou *et al* 2000)

2.2 Construction Supply Chains and Partnering

The supply chain has been defined as ‘the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer.’ (Christopher,1992) The following is a typical configuration of a supply chain in manufacturing (adapted from Ruben Vrijhoef and Lauri Koskela, 1999)



Dainty *et al.* (2001) identified the following barriers in the supply chain;

- Financial/cost related issues to the competitive tendering based on price, which develop adversarial relationships that result in serious problems with regard to payments.
- Planning/time related issues, such as false expectations on the part of the main contractor and unrealistic schedules.
- Quality of information and related issues such as wrong drawing revisions, inaccurate survey data or inadequate information from the main contractor.
- Attitude related issues such as arrogant conducts, exclusion of subcontractors from early involvement phases, lack of praise of good work, poor site management practices and a general lack of understanding for subcontractor problems. The attitude

is normally that the subcontractor has got to deliver to a specific program that was set out without any input from them.

Sir John Egan's report recognized partnering as an effective method for achieving ambitious program targets. Partnering is defined as 'a contractual arrangement between two parties for either a specific length of time or an infinite period., (Latham, 1994) The parties agree to work together, in a relationship of trust, to achieve specific primary objectives by maximizing the effectiveness of each participant's resources and expertise. Dainty et al (2001) define partnering as 'the use of integrated production teams and continued monitoring of the effect of performance improvement measures.'

Project partnering is where partnering is based on a single project. This is often the case in huge projects often costing millions of pounds and spanning over long periods of time. Strategic partnering is where a long term commitment spans several years and several small to medium scale projects often of the same nature. The underlying principle is that the experience gained on one project is carried over to the next maintaining the same project teams thereby continuously improving the delivery process.

3. CONSTRUCTION/ENGINEERING SURVEYING

CONSTRUCTION SURVEYS are conducted to obtain data essential for planning, estimating, locating, and layout for the various phases of construction activities or projects. This type of survey includes reconnaissance, preliminary, location, and layout surveys. They are primarily the means by which designs are defined in the real world. In other words, they are the way in which value is defined to the end user. The objectives of engineering or construction surveying include the following:

- the obtaining of reconnaissance information and preliminary data required by engineers for selecting suitable routes and sites and for preparing structural designs
- the defining of selected locations by establishing a system of reference points
- the guidance of construction forces by setting stakes or otherwise marking lines, grades, and principal points and by giving technical assistance
- the measuring of construction items in place for the purpose of preparing progress reports
- the dimensioning of structures for preparation of as-built plans

Engineering and/or construction surveys, then, form part of a series of activities leading to the construction of a building or structure. Looking back at the construction process it is clear that surveying principles are applicable at all the stages of construction. It is imperative, therefore that surveyors play a major part in the supply chain and hence are affected by the general shift to lean construction.

3.1 Making Surveying Lean

As stated before, lean construction basically involves the process of adding value to the finished product by the minimisation or elimination of waste. It is no doubt that advances in technology have made the process of surveying much more efficient and waste has been eliminated along the process of this technological innovation. Recent advances in surveying has seen the use of such techniques as GPS, Remote Sensing, Laser Scanning, Robotic Total Stations, Smart Rovers and Smart Stations that are integrated GPS Total Stations. These technologies yield very accurate results at incredibly fast speeds enabling results to be produced in real time. The need to have two operatives on site at any given time, the requirement to go back to the office for post processing of field results and the numerous calculations often associated with certain types of surveys has been eliminated by combining all the functions into one small gismo. Not surprisingly, the fact that survey information can be obtained at the touch of a button has led some project managers into believing that surveyors should not be engaged in the planning phases of a project as their services should be available on demand. The result of such an assumption is that quite often surveyors have been called at a stage when the process is suddenly going wrong and they are put under too much pressure to salvage a project whose process they do not have control. The following are some of the sources of waste inherent in the process of surveying;

- presentation of wrong or inaccurate survey information
- delays in production and issuing of data
- the use of old survey technologies that are labour intensive to perform a simple survey
- inappropriate and unnecessary use of sophisticated technology to perform a simple survey
- lack of involvement of surveyors at sufficiently early stage of the project often caused by a lack of understanding of their role by fellow players on projects

It is clear from the above list that certain aspects of making the process of surveying lean can clash. How does one balance between the use of the appropriate technology for a particular task and the cost of investment of the different paraphernalia? This is not so much a problem for the bigger companies that specialise in different types of surveys at different scale but it is a nightmare for the smaller survey companies or individuals because the initial cost of investment in modern ‘state of the art’ technology is quite high. It is important to take note of the following principles in economics when considering investing in new technology.

- a break-even point defines when an investment will generate a positive return
- fixed costs are not directly related to the level of production
- variable costs change in direct relation to volume of output
- total fixed costs do not change as the level of production increases

Contracts in the construction industry are still being awarded on a lowest price basis and this will be the case for a while. Certain contracts are awarded using a different criteria, for example most companies are adopting concepts of partnering the supply chain, but price competitiveness remains the single most important guiding factor. This basically means therefore that even with a significant investment in equipment, the cost of investment cannot simply be transferred to the client on a project by project basis.

4. CONCLUSION

The process of lean construction involves to some extent the minimization of cost input, the elimination of waste and mapping the value stream to generate value for the client. Surveying in itself is one of the single most important tool of turning design into reality on construction projects. It is involved at any stage of the process and it is important that surveyors are engaged throughout the cycle of the project. Modern technologies, the use of the internet and globalization in general have made any part of the world accessible by anyone who so wishes. Projects are being managed and monitored from thousands of miles away and at a much lower cost. The territorial advantage that surveyors used to enjoy is a thing of the past because the client is getting more sophisticated and is more aware of what they want and how they want it. The choice of resources for the client is now limitless and the main focus of the construction industry is 'lean and agile' construction as used in the manufacturing industry. As key players on the project delivery process, surveyors must be aware of the latest developments in the field of project management. If projects demand lean then surveyors should deliver lean lest they lose to their competitors. Lean construction may not come cheap to the surveyor but the ultimate result is what is best for the client. There is need for careful consideration when investing into new technologies.

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