APPLYING LEAN THINKING PRINCIPLES IN THE UK ROOFING AND CLADDING INDUSTRY

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ABSTRACT

Through the description of a case study, which comprises a number of lean transformation projects, this paper discusses an approach to the implementation of lean thinking principles and techniques within the roofing and cladding tributary of a construction value stream – from inquiry through estimation, contract, design, fabrication, materials delivery and site management to installation.

KEY WORDS

Lean Thinking, value stream analysis, current and future state maps, lean transformation policy deployment

INTRODUCTION

Introducing lean thinking principles and techniques into any industry is not easy, and the construction industry poses special problems in terms of implementation. Construction activities are unlike the majority of manufacturing and service operations in that they usually work from a one-off design, use a predominantly temporary supply chain and temporary layouts, and are often executed under difficult environmental conditions. However, the Hathaway Roofing case study demonstrates that the application of lean thinking to construction projects and their supply base can result in reducing costs, increasing productivity and delivering higher value products to clients.

In order to move from a comprehension of lean principles to the implementation of a lean transformation, a number of lean techniques need to be understood and used. In this paper, using the Hathaway case study as an illustration, we will focus on a discussion of three of these techniques: ***value stream analysis, current & future state mapping*** and ***lean policy deployment***.

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VALUE STREAM ANALYSIS

In Jones and Womack's book *Lean Thinking*, they identify and elaborate five fundamental principles: value, value streams, flow, pull and perfection. After establishing the real value of a product or service, as determined by the final customer of an economic process, a lean transformation process will then seek to eliminate all wasted effort, materials, time, space, etc., from the set of all activities and operations – the value stream – which are executed to bring that product or service to market. In order to identify the operations and structure of a value stream, a technique known as value stream analysis is used.

Value stream analysis tools incorporate various elements of the process flow-charting which has been used for some time now in industry. The essential aspect of a value stream analysis chart is that activities are recorded in sequences, and/or attached to symbols, that identify which, and how, each activity charted adds value or not. Such a chart is called a value stream map. The following case study presents a type of value stream mapping tool called *transformation analysis.* In constructing a transformation analysis chart, the activities within a work process are profiled according to five categories of transformation: storage, transport, ancillary, supplementary and basic. Of these, only supplementary and basic transformations are value adding. A basic, fundamental transformation (like the actual baking of the bread) is an activity where the maximum value is added. In supplementary transformations, (like the kneading of the bread dough) where there is significant but not fundamental change, some value is added. Usually, however, storage, transport and ancillary operations add no value at all to a product or service and, where possible, should be removed from the process via improvement projects.

When a value stream map has been designed, it is good practice to then track, in real time, the coming into being of a product or service – from raw material to the delivery of the finished goods to a customer. Not only can this tracking lead to many modifications of the original, and usually idealised, map, but tracking will facilitate recording the real times taken and distances travelled in each activity by materials, equipment, people and information.

It is important to note that, in order to be most effective, value stream analysis should map *all* the activities that an organisation undertakes to bring their goods to market. This means mapping not only all the operations concerned with physical transformations, but also all information transformations. This pertains to areas such as marketing, sales, accounts, administration, new product development, etc., as well as the standard production and service activities.

CURRENT & FUTURE STATE MAPPING

Value stream mapping defines the time flow of operations at what is called the *task level* – the level where actual transformation tasks are performed by both physical and information operators. Current and future state maps are higher level mapping. They use symbols to represent whole functions and other organisations within a value stream.

Once an organisation has determined in detail, through the use of task level value stream mapping and tracking, where waste is to be found in its operations, it needs to use some kind of technique for representing what the value stream will look like when it is able to remove all the waste. In other words, it needs to picture where the lean transformation process is going, where it wants to get to. Current and future state mapping is used for this purpose.

Based on the experience of detailed mapping, a higher level *current state* map is constructed. (See diagram 1). This gives an overall picture of the configuration of the present state of the value stream which is the focus for a lean transformation. Then, on the basis of the criteria for value, as defined by the customer, and the knowledge of the techniques of flow and pull production (kanban, takt time, line balancing, etc., cf. *Learning To See*), a *future state* map is designed which presents the higher level value stream structure which will result if all the waste could be removed from the current system. (See diagram 2).

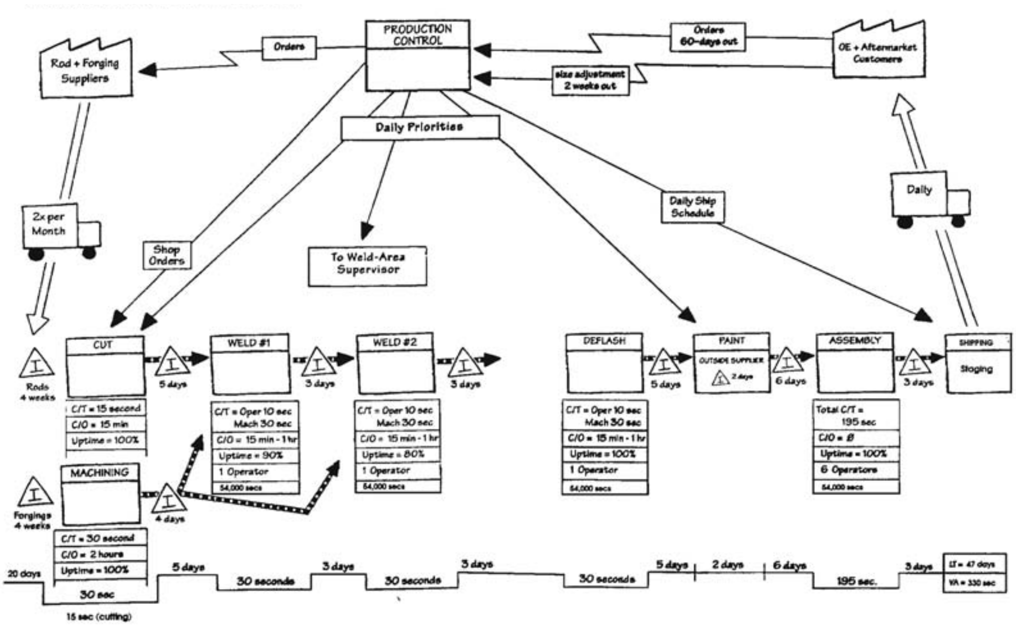

Diagram 1 **- Current State Map**

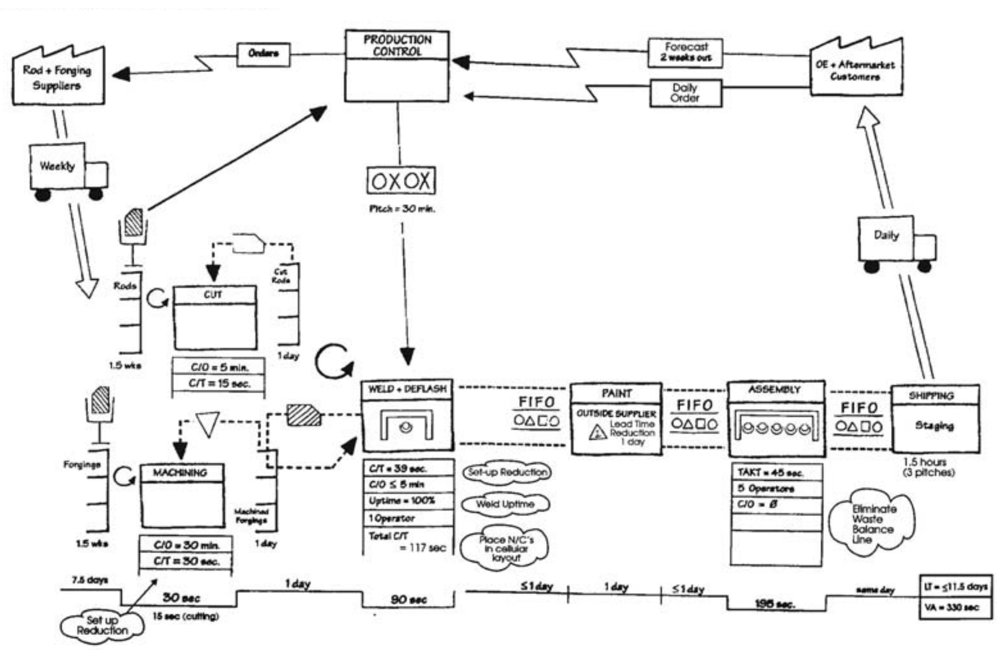

Diagram 2 **- Future State Map**

LEAN POLICY DEPLOYMENT

The next step in the planning and design of a lean transformation is for an organisation to determine how and where it will apply its resources to eliminate waste. It needs to create a strategy for the step by step elimination of waste which will take it from its current state map to its desired future state reality. Just as the coming into being of a product or service follows logical sequences, the elimination of waste from these processes also needs to follow a logical and strategic sequence. An exercise where priorities, methods, resources, change agents (people) and time frames are identified and agreed upon, is called lean *policy deployment*. Such a technique usually results in the formalisation of objectives, targets and projects in some form of a policy deployment chart and its clarifying documents. (See diagram 3).

The following will describe how the above techniques were used to implement a lean transformation at an industrial roofing and cladding company in the North of England, and will outline some of the results that this transformation has achieved to date and is pursuing at present.

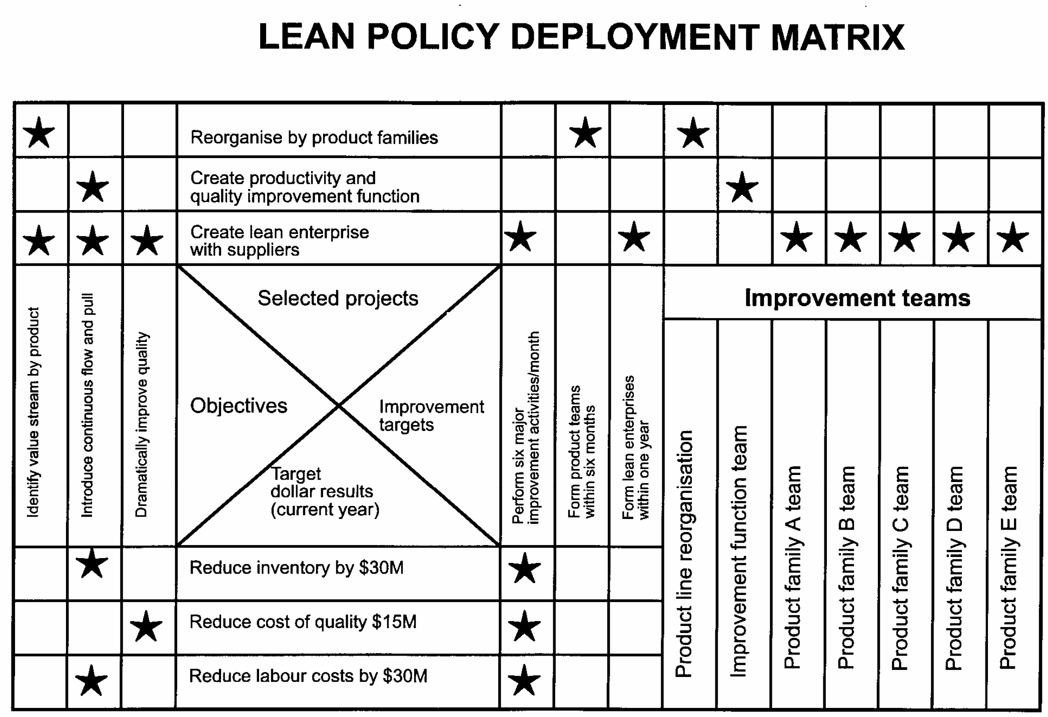

Diagram 3 - Lean Policy Deployment

THE HATHAWAY ROOFING CASE STUDY

Hathaway Roofing Limited is one of the largest metal roofing and cladding companies operating throughout the UK. They provide their customers with a wide range of products and services which include; estimation, design, materials purchasing, manufacture of site-specific accessories, aluminium windows, doors and curtain walls, site management and qualified sub-contractors for installation. In short, they offer a complete service for their products from concept through installation and have long-term relationships with major contractors, clients and suppliers.

In 1998 Hathaway Roofing undertook a company-wide transformation process guided by the principles of Lean Thinking. After developing a strategy which was discussed, studied, designed and agreed by managers at all levels of the company, Hathaway launched a change process based on a detailed analysis of the various value streams within which the company's operations are embedded.

Value stream maps were constructed which analysed the company's task level activities within Accounts, Estimation, Design, Procurement, Fabrication Plant, Contracts Management, and Site Crew Construction & Installation. An example is given below (see diagram 4) of the windows production line within the Fabrication Plant.

On the basis of this comprehensive analysis, current and future state maps were designed. It was then determined by the company's senior management that the overriding objective of the organisation was to transform its operations so that their project managers on sites would be able to *pull* from the company's other functions – in terms of labour, materials, equipment and information – exactly what they needed, and when they needed it, in order to complete their agreed, weekly roofing and/or cladding assignments.

In further lean deployment workshops it was agreed that this transformation would be implemented through seven major improvement projects. It was established that the first project in time, and priority, would be a complete transformation of their fabrication plant.

Since the ability of the Hathaway fabrication factory to deliver the fittings and parts that form the distinctive design elements of each 'outer shell' the company constructs is so essential, and in fact sets the construction pace for each job, it was decided that a lean factory – which could build and deliver just in time, just what is needed – would drive the lean transformation through the rest of the company's functions.

Following the factory transformation, the majority of which was completed in 1999, six other projects were designed, and are now being implemented. The rest of this paper will briefly describe the factory transformation and then outline the aims of the other six projects.

Project 1) FACTORY TRANSFORMATION

The factory is situated in one building covering 3321 square meters. It employs around 50 people (about 10% of which are managers and supervisors) and has a yearly turnover of about £3 million. It produces four basic kinds of products: flashings, gutters, glazing items (windows/doors) and custom fabrications (such as louvers, vents, etc.).

Before the factory began its transformation, in the Spring of 1998, it looked like many of the inefficient, functionally organised, small to medium sized fabrication sites which one can find throughout the UK. The big pressing, punching, bending and cutting machines were all in a row against a wall at one end of the factory. A number of workbenches were

		Hathaway Factory Transformation Analysis					
WINDOWS		Transformation Levels				Quantities	
Change Process	*Storage*	*Transport*	*Ancillary*	*Supplem.*	*Basic*	*Time(min*	*Distance*
extrusions in yard						5	(yards)
to quarantine						1	10
in quarantine						(2 weeks)	
to paint stillage						30	1
to painters						(1 day)	(25 miles)
at painters						(1 week)	
in canopy						60	
on trolley						10	
to isomat area						2	35
to bench						1	1
attach isolator						10	
feed in machine						2	2
to rack						2	12
on rack						60	
to saw area						5	25
in saw area						1	
to saw						2	3
saw						2	
to rack						5	4
on rack						60	
to router area						1	13
in router area						10	
to router						1	2
rout						5	
to rack						1	18
in rack						*60*	
to multi-punch area						1	2
in multi-punch area						1	
to punch						1	
punch						1	
to rack						1	2
in rack						60	
to crimper area						2	26
in crimper area						10	
to bench						1	2
glue						>	
cleat corners						>	
crimped						10	
to rack						1	3
in rack						60	
to beading area						1	4
in beading area						30	
to bench						1	1
bead						>	
attach gasket						>	
tape						30	
to pallet						2	10
on pallet						(1 day)	
to wagon						10	4
on wagon						(1 day)	
to site						(2 days)	
Totals	17	23	2	4	5	559	180

Diagram 4 **-Transformation Analysis of Hathaway Windows Production Line**

in front of them so that whatever had just been cut, pressed, bent and punched could be assembled. Stretching off to the other end of the factory were storage racks. They were full of work-in-progress kits and an enormous array of materials that were waiting for jobs or had been left over from jobs (or were just there because they were a good buy at one time or other). Smaller pieces of equipment were scattered around the site.

Because the factory's machines — great and small — were all used at various times by many different people for every kind of job, there was no overall logic to their placement. To facilitate the movements of materials from machine to machine, to workbenches, to welding booths and back again, wide passageways were cut between and around these work stations so that fork trucks could make their way. Yet the aisles were invariably full to overflowing with work-in-progress due to the many physical process bottlenecks — and to the start-stop dynamics caused by juggling orders competing for the same resources — so common to this type of custom-build job shop.

Outside the factory, it was just as congested. Because the same large door and holding bay were used for goods inwards, goods outwards and quality control, the area was a mixed sea of pallets stacked with raw materials, sub-contracted parts and finished goods. In front of all this was usually a queue of lorries (blocking a large part of the employee car park) waiting to be loaded or unloaded. Fork trucks would whiz around and everyone was always busily engrossed in work. To many people, it must have appeared to be a healthy factory full to brimming with jobs to be done. In fact it was wasteful, chaotic and inefficient.

Coached and guided by Rubicon Associates, a group of organisational development consultants, and hand in hand with their operators, the factory's managers have changed the factory's layout and implemented lean operating procedures, delivering the following outcomes:

NEW FACTORY LAYOUT:

- dedicated goods-inwards-only doors
- a one-way delivery system
- new raw materials stores area
- four main east-west oriented manufacturing cells
- dedicated entrance and exit area
- dedicated and movable equipment
- Bits & Pieces fifth cell
- new production office, maintenance shop and improvement centre

INNOVATIONS IN PROCEDURES AND METHODS:

- Just-in-time deliveries and pick-ups
- Reduction of consumable suppliers
- Cell teams trained in change-overs, set-ups and routine machine maintenance
- Packing crews integrated into each cell
- Innovation of packing boxes and stillages
- Specially designed push trolleys and roller lines
- First-in-first-out (FIFO) production control system

- New job ticketing system
- Continuous improvement system
- New bonus system

BOTTOM LINE RESULTS TO DATE:

- Inventory reduction = from £300K to £100K
- Lead time reduction = 30%
- Machine set-up reduction = from 3 hours to 30 minutes
- Productivity increase = 35%

The factory, with its greatly increased capabilities, now provides the key to delivery throughout the Hathaway supply chain. Without the factory developing in the way it has, the effectiveness of other developments would have been greatly constricted. As it stands, the factory is now able to meet the expanding needs of the sites by delivering, just in time, just what is needed.

Since the factory transformation, the following projects have been launched and are expected to run through the year 2000.

PROJECT 2) INFORMATION FLOW

Aims:

With clients;

- Resolve outstanding specification issues and options before the launch. If this is not possible, make sure the client is aware of the implications of late decisions.
- Determine a strategy for informing the client at tender or appointment stage of our requirements in respect of critical information and implications of this not being available.
- Ensure that the client is aware of any key approval dates for drawings, RFTs or samples, and implications of not achieving these dates.
- Determine a strategy for informing a client at tender or appointment stage of our requirements in respect of site logistics i.e. access, storage, site accommodation, build sequences, etc. and the implications of any of these not being available on site.

With suppliers;

- Review current information flow with suppliers
- Determine the required lines of communications
- Develop and implement a strategy to achieve a high level of quality and timeliness of information flow

PROJECT 3) DRAWING OFFICE

Aims:

- Review the current level of drawing production in respect of the following;
  - Quality
  - Quantity
  - Relevance to the end user

- Establish the minimum level of drawing production necessary to enable all involved parties to complete the project.
- Review the number of workstations in the office and make recommendations on any additional requirements.

PROJECT 4) MATERIAL DELIVERIES TO SITE

Aims:

To review all aspect of the current system of material procurement i.e.;

- Material phasing – *is it detailed enough?*
- Stock – *enough for emergencies?*
- Storage and distribution of materials on site – *do we need central storage? – are our crews waiting for the same forklift?*
- Deliveries to site – *lateness or lack of co-ordination?*
- The call-off system – *is it adequate or antiquated?*
- Packaging – *is it adequate, wasteful or necessary?*

PROJECT 5) QUALITY AND CONSISTENCY OF SHEETING CREWS

Aims:

- Grade the sheeting crews
- Pick the top ten
- Study their methods for examples of best practice
- Develop a set of standard operating procedures (SOPs)
- Train all crews in SOPs

PROJECT 6) SITE MANAGERS PROBLEM SOLVING

Aims:

To establish how much of a site manager’s time is taken up sorting out problems on site through recording their activities over a period of weeks. The record will include;

- The source of the problem
- How it affect materials and costs
- How the problem was resolved
- How much of the manager’s time was taken
- Delay to the works and to what extent

PROJECT 7) ESTIMATING BILLS

Aims:

To assess whether the estimating bill is user friendly, or necessary, in the current sectional format.

The Hathaway lean policy deployment team has chosen a lean transformation manager to oversee the implementation, integration and completion of these projects.

CONCLUSIONS

The logic of lean thinking moves from: 1) stripping a production process of its waste — i.e. its non-value adding activities; to 2) bringing about the possibility for a seamless *flow* of transformations through physical and procedural alignments and integrations; to 3) realising this steady flow of value creation by establishing the dynamic of *pull*. Pull must originate with customer requirements which are communicated upstream by physical or symbolic kan-ban systems. These tell the next operation upstream in a value stream that *just so much* of what they provide is now needed downstream — and no more. In a lean operation a pull system replaces the traditional production scheduling approach, or *push* system. This reduces work-in-process and inventory build up within the flow of an operation and renders it transparent and highly flexible.

At Hathaway Roofing, pull will be achieved when its installation sites can communicate to its upstream operations just what they have as an actual need for a short time into the future, and when these communications then pull the labour, materials, equipment and information required. The lean transformation projects that are now being deployed in the company and integrated with the transformations already achieved by its fabrications plant, will, hopefully, bring the whole organisation into the flexible and transparent state where pull is not only possible but practical on an ongoing and stable basis.

The above represents a picture of the lean construction future into which the Hathaway Roofing organisation is heading. If it can achieve it soon, it will be an outstanding leader in the country's construction industry.

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