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## **Performance Improvements through Implementation of Lean Practices: A Study of the U.K. Red Meat Industry**

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### **Abstract**

'Lean' is an established industrial paradigm with proven track record in various sectors of the industry (Womack & Jones, 1996). World-class Companies such as Toyota (second biggest global car manufacturer), Porsche' (most profitable global OEM), Boeing (largest global aerospace business) and Tesco (third largest global retailer) have adopted Lean at the corporate level. This paper reports on the introduction of 'Lean Thinking' to a new sector – the 'Red Meat Industry' (Food Chain Centre, 2004). This contribution highlights the benefits of lean production techniques in different stages of the red meat value chain and reports 2- 3% potential cost savings at each stage of the chain.

**Keywords:** Lean process, red meat industry, Takt-time, work standardization

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## Introduction

Nearly a hundred years ago Henry Ford drew upon the Chicago slaughterhouses' carcass disassembly (break down) processes to build the world's first assembly flow production line at Highland Park plant, Detroit (Hounshel, 1984: 241). Ford's flow method of production led the global economy into an era of '*production for masses*', away from crafts production techniques (Ibid). The key underpinning characteristics of Ford's system were inter-changeability of assembly parts, inter-changeability of labor, and high degree of vertical integration and control across the supply chain.

The main building block of Ford's system of production for *masses* was the inter-changeability of the assembly parts (a problem which never existed in the disassembly of an animal carcass). In this sense, Ford was indebted to the pioneers of the American System of Production, especially Eli Whitney of Pratt and Whitney Co. (Chandler, 1977). The second most important attribute of *Fordism* was the standardization and fragmentation of all tasks on the shop-floor (Littler, 1985). Jobs at Ford required limited skills and were as interchangeable as the assembly parts. An army of narrowly trained workforce (largely immigrants who barely spoke English and in fact needed not to communicate since tasks were very straightforward) worked in the Ford's plants. Ford incentivised this tightly controlled – unskilled – labor, to vigorously perform these simple repetitive jobs, through higher wages (the famous five dollar day) (Hounshell, 1984: 259). Finally, Henry Ford's dedication for uninterrupted flow of material led him to establish various parts and raw materials supplier plants adjacent to the assembly line. At the River Rouge plant, Ford literally produced everything required to make a car – from oilseed crops to steel mills to power plants (Hounshell, 1984).

Such articulate system of '*production for masses*' well-suited the manufacture of identical Model-T's offering the company the economy of scale which in turn enabled it to constantly lower the prices. Nonetheless, the markets soon became saturated with the monotonous Model-T's and many customers turned to General Motor's automobiles for a perception of individuality, style and quality (Hounshell, 1984: 267). Ironically, the prosperity that '*production for masses*' brought to American society created ever more demanding customers that sought for the customized products of the *flexible mass production* era. Another force that added to Ford's challenge was the emergence of the worker unions, during the 1920's demanding for better life-style in return for their tedious jobs (Hounshell, 1984).

By 1925, GM had yearly model-change policy. At Chevrolet, Khudson – a former chief production engineer at Ford – had devised a relatively flexible production system which – to some extent – accommodated change. Khudson radically departed from Ford Production System by deploying general purpose production machinery as opposed to single purpose machine tools. Although, Khudson stuck with the Ford's idea of sequenced manufacturing line, kept large amounts of

inventory between the work stations to compensate for the changes (Hounshell, 1984: 265). Hence, Chevrolet became the birthplace of what is today known as 'Mass production' and can be characterized with its batch and queue mode and mountains of work-in-progress. Eventually, in 1927, after a significant slump in market shares, Henry Ford, had to succumb to the principles of mass production. GM's marketing creed had triumphed over pure production of Ford (Hounshell, 1984: 267). And so, the smooth flow of identical components evolved into mass production – for many product variants.

Eventually, Toyota resolved this contradiction by developing a flow production system for many product variants and became the birthplace of lean production (Womack *et al*, 1990). According to Mann (2002), powerful business solutions don't accept trade-offs; one Lean philosophy is to eliminate the non-value adding compromise between uninterrupted flow of the process and market-oriented flexible production. Lean production contrasts mass production, by emphasizing the importance of smooth flow, continuous improvement and employee empowerment (Womack & Jones, 1996). This paper explains the various aspects of lean production and reports on introduction of some Lean practices across several Red Meat supply chains. The two basic lean techniques discussed in this paper are Takt-time (Ohno, 1988) which is the basis for smooth continuous production flow, and standardized work (Imai, 1997) which is the basis for continuous improvement.

## Literature Review

### *The UK Red Meat Industry in Context*

Agriculture in Europe and North America is heavily supported by government intervention and protected by trade barriers. In Europe, the Common Agricultural Policy (CAP) supports via import tariffs and subsidy payments. Nonetheless, the market trends are towards eradication of the global trade barriers; and following the 'Agenda 2000 Agreement'<sup>1</sup>, (CAP-reform), the EC's CAP budget is undergoing major reform. The admission of former Eastern Block states, penetration of cheap meat suppliers (e.g. EU full tariff beef imports increased from 26,000 tonnes to 94,000 tonnes between 2000 and 2004<sup>2</sup>), and consumer behavioral changes in favor of convenience and organic products challenge the red meat industry across Europe (Gower, 2004). Over and above that, there have been several issues specifically challenging the UK red meat industry, i.e. the BSE<sup>3</sup> disease epidemic during the 1990's, outbreak of Foot and Mouth disease in 2000/2001, and concentration of

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<sup>1</sup> The Agenda 2000 agreement was agreed upon in Berlin in March 1999. It helps European agriculture to meet the challenges of future trade liberalisation. For more information see: [www.defra.gov.uk/farm](http://www.defra.gov.uk/farm).

<sup>2</sup> Source European Commission

<sup>3</sup> Bovine Spongy Encephalopathy commonly known as Mad Cow disease

market power in the hands of multiple retailers (in the UK the top four retail chains account for nearly two thirds of the retail meat sales) (Fearne, 1998; Simons *et al*, 2003; Hornibrook & Fearne, 2001; Tarrant, 1998). Support payments in the UK have hitherto been on a headage (per head of livestock) basis; but from January 2005, payments cease on a productivity or headage base. Instead, producers will receive a single-farm payment based on historic claims and/or land area. Pre-2005, in order to secure a headage support payment, producers could make a rational decision to produce animals at a loss against the global prices. The decoupling of the support payments increases producers need to minimize supply costs, and may lead to rapid rationalization of the industry. One of the key solutions, proposed in the literature, for smoothing the process of rationalization in the industry is the pursuit of best available practices and creating a learning environment where companies continuously strive on improvement (Pickernell & Hermyt, 1999; Simons & Zokaei, 2005). Clearly, Lean Thinking is one approach that offers insight into potential opportunities for improvements and best available techniques. Against this background, this paper shows the potential benefits which can be realized through implementation of some Lean practices across the supply chain.

### *Lean Thinking*

The term 'Lean' was first coined by James Womack, Daniel Jones and Daniel Roos in "The Machine that Changed the World" (Womack *et al*, 1990). Lean production is rooted in the Toyota's Production System which turned 'Toyota Motor Corporation' from a small domestic producer in 1950's into one of the world's leading automotive companies in the 1980's. The tenet of 'lean' production is elimination of waste both within the firm and across the supply chain (Womack & Jones, 1996). The notion of waste elimination dates back to the '*Scientific Management*' movement (Taylor, 1914; Gilbreth, 1911) in America and has been the cornerstone of all business paradigms which focus on the productive rationality of capital (being human, financial or manufactured capital). Scientific Management (Taylorism) rationalizes the use of labor-power at the individual worker level – through fragmentation of individual jobs into different tasks and optimization of each (Ibid). Fordism, adopts the rational principles of Taylorism and extends the focus of waste elimination to the whole process (Doray, 1988: 69). The Fordist flow assembly line – for the first time – made it possible to control the quantity of effort required at the individual workstations through setting an average line speed (the factory clock speed). Similarly, *Mass Production* has been defined as a '*ruthless war on waste*' (Filene, 1925: 88). Yet, Lean's definition of waste is quite distinctive from Taylorism, Fordism or that of Mass production. Taiichi Ohno (1988), the father of Toyota Production System, defined Waste (Muda<sup>4</sup>) as any human activity, which absorbs resources but creates no value. Performing a wasteful activity adds no value but incurs cost. Ohno (1988) identifies seven types of Muda: waste from overproduction,

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<sup>4</sup> Muda is Japanese for waste, futility and purposelessness.

waste from waiting inventories, waste from unnecessary transport, waste from waiting times, waste from unnecessary motion (movement of people), waste from unnecessary processes, and waste from defected products.

Both Taylorism and mass production have been criticized for causing '*alienation of the labor*' (Doray, 1988: 116). It is true that there is a degree of '*work abstraction*' (Marx, The Capital) in lean – due to standardization of the work methods and sequence, and not allowing for self-regulation of the work speed. Nonetheless, lean avoids total estrangement of the workers through broadening the scope of jobs, offering task variety, eliminating tight supervision, reducing the need for inspections, and encouraging social interactions in workplace (see Womack and Jones, 1996). Contrary to the 'sword of Damocles' approach of the western auto-manufacturers Toyota empowered employees and guaranteed jobs for life, which in turn allowed Toyota to benefit from full-hearted participation of employees.

Womack and Jones (1996) propose a set of principles for achieving a lean enterprise. Companies should embrace these principles and incorporate them into their operations, sequentially. Integrating these principles into operations entails use of certain tools and techniques. Here, the lean principles are briefly explained and then two lean techniques (Takt-time and operations standardization) are discussed in more depth. The first principle of lean is identification of value from the end-consumer's perspective. The second lean principle (value stream) is identification of product families or services that follow common process paths to the consumer. The third principle of lean is '*flow*' – a single product should continuously flow through value-creating processes without interruptions or intervals. The fourth principle is to only let value flow at the pull of the customer. 'Value flowing at the pull of customer' implies that nothing is produced upstream unless someone down stream demands for it. This is opposite of 'batch and queue' thinking which suggests mass production and large inventories in advance and based on forecasted demand. The last principle of lean production is pursuing perfection continuously. This means that firms should always look for waste and find new forms of it and tackle it. (Womack & Jones, 1996)

Nowadays, companies such as Xerox not only apply the lean principles to their own operations but find substantial benefits in implementing Lean Thinking in their customers' processes (Xerox, 2005).

## **Lean Transformation in the Agri-business Sector**

### *The Food Value Chain Analysis Approach*

At the heart of any lean transformation lies the reengineering of the value chain (being a single firm or part of the supply chain) to implement the principles of '*flow*' and '*pull*' (Womack and Jones, 1996; Rother and Shook, 1999). This paper reports

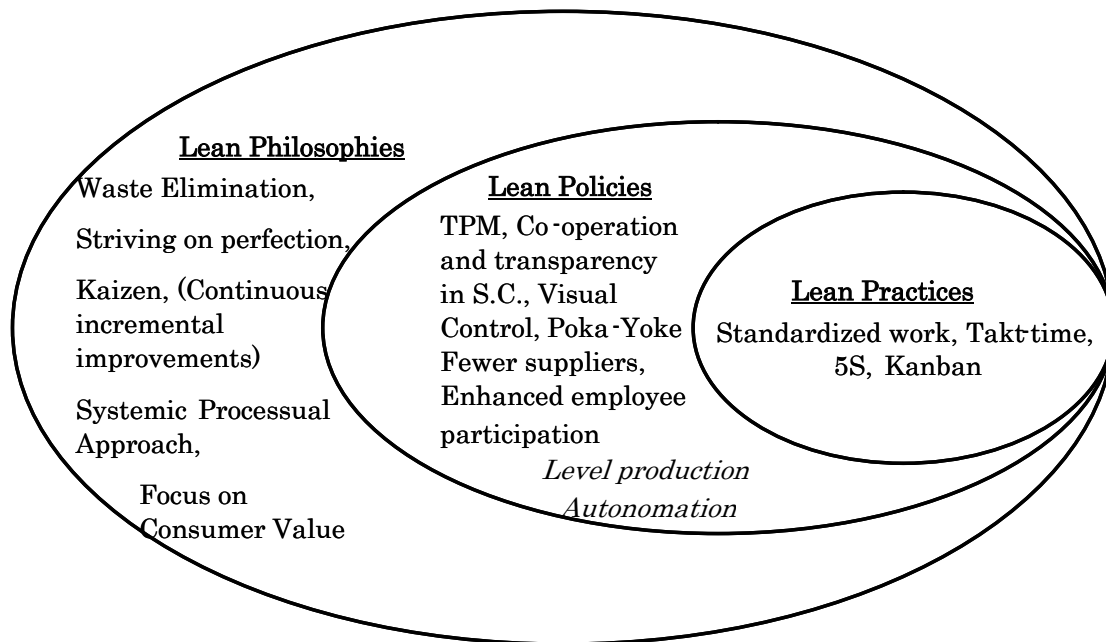
on part of the findings from an extensive research program, which looked into eight red meat value chains in three countries. The research team deployed an agri-business specific Lean implementation methodology – the Food Value Chain Analysis (FVCA). The methodology embraces a number of prominent Operations and Supply Chain Management paradigms, namely Value Stream Mapping (Rother and Shook, 1999; Hines and Rich, 1997), Efficient Consumer Response (Seifert, 2003) and Value Chain Analysis (Porter, 1985; Shank and Govindrajana, 1988). Using the FVCA nine chains in three years were studied and – in excess of – forty middle and senior managers from across the supply chain were trained on Lean thinking tools and techniques to apply them in the participating firms.

The notion that key processes across the supply chain form a Value Chain and the method of analyzing the value chain for competitive advantage was introduced by Professor Porter (1985) of Harvard Business School. Subsequently, Value Chain Analysis was developed in the management accounting literature (Shank, 1989; Shank and Govindarajana, 1993; Coopers and Lybrand, 1996) and more recently in the operations management literature (Rainbird, 2004). The Food Value Chain Analysis is a structured method of analyzing the effects of all the core activities on cost and/or differentiation of the value chain; FVCA analyses where in the supply chain the wastes can be reduced or differentiation can be enhanced (Zokaei and Simons, 2005). The essence of this method is generating a systematic map of the value chain and a systematic method of analyzing each strategic activity in relation to the consumer's value (i.e. the first principle of lean thinking). A key attribute of FVCA is that its analysis and metrics are based on determinant attributes such as quality and time, not on financial attributes. The advantages proposed for this approach are that determinants are leading indicators of financial performance, and from a change management perspective determinant measures are more easily shared across company boundaries (Simons et al, 2003).

## **A Typology of the Lean Elements – Philosophies, Policies and Practices**

Based on some previous research (Macduffie, 1995; Macduffie & Pil, 1996; Pil & Macduffie, 1996; Hines 2001), this paper suggests that the success of lean production stems from a combination of practices, policies, and philosophies. Figure 1 demonstrates a typology of lean elements. Successful lean implementation involves amalgamation of various elements from different levels in Figure 1. For example, Just-in-Time inventory management policy and creation of smooth flow go hand in hand while both depend on the introduction of Takt-time in practice. Furthermore, companies which implement single piece flow need to promote the workers' participation policy and pursue continuous improvement philosophy to sustain the flow production system within the organization.

Figure 1 underlines the fact that lean production goes beyond the operational level and links into the overall business philosophy of the organization. That is, lean



**Figure 1:** Typology of Lean Elements – Philosophies, Policies and Practices  
Adapted from (Simons and Zokaei, 2005)

production is more than just a set of tools and techniques. ‘Lean Thinking’ restores the organizational focus on the real ‘value’ (i.e. value from the customer’s point of view) and aligns all the processes to that end. Nonetheless, the existing paper only focuses on application of lean practices to different stages of the red meat supply chain. The objective of this paper is to appraise the benefits of two lean practices (standardized operations, Takt-time) along the chain, and quantify the potential benefit to all stakeholders.

## Takt-Time

The German word ‘Takt’ means precise cycle of time, rhythm or interval; it, also, refers to the conductor’s baton and beat of music. The term ‘Takt’ was first introduced in the German aircraft industry, and subsequently was taken to Japan by the German engineers training Japanese aircraft producers pre-World War II, and later became an integrated element of lean production (Wada, 1995). Takt-time is used to synchronize the rate of the production process with the customer demand in order to prevent the waste of overproduction (Rother and Shook, 1999). Takt is the time elapsed between units of output, when the production rate is synchronized to customer demand. According to Ohno (1988) calculating Takt-time shows when items are needed so that they are produced as required, one-by-one.

The most significant source of Muda (waste) is overproduction, i.e. producing more, sooner or faster than is required by the next process downstream (Rother and Shook, 1999). Overproduction means that resources are tied up in stock rather than being directly devoted to production. Buffer inventories are often costly to store and handle, hinder move from one product design to another and hide production errors. Thus, by avoiding overproduction, Takt is central to lean production.

Takt-time is calculated by dividing the customer demand into available working time per shift. The calculation for Takt-time is as follows:

$$\text{Takt-time} = \frac{\text{Production Time Available}^*}{\text{Customer Demand}^{**}}$$

\* Total production time minus breaks, downtime, etc. It includes changeover time. Sometimes regarded as Operational Availability

\*\* Average customer demand over a certain period

When the Takt-time for a process is 30 minutes, it means that the process should produce only one part per 30 minutes. This is totally different from producing 2 parts per hour or 16 parts in an eight-hour shift. This links into one-piece flow production – the third principle of lean production (Miltenberg, 2001). In order to achieve one piece per 30 minutes, each processing step along the production line should precisely perform its task within 30 minutes and pass the work-piece down the process.

The simplicity of the Takt-time concept belies its astonishing effects. Here are some main features of a Takt system.

#### *Increased Productivity through Stabilized Production Flow*

Flow production was first introduced in 1913, when Ford Motor Company setup the first flow assembly line for the Magneto assembly process (Hounshell, 1984). This was a major breakthrough in the static mode of assembly and increased productivity by 50% (from twenty man-minutes down to thirteen man-minutes). However, a problem soon occurred: the rate of the work flow was not constant.

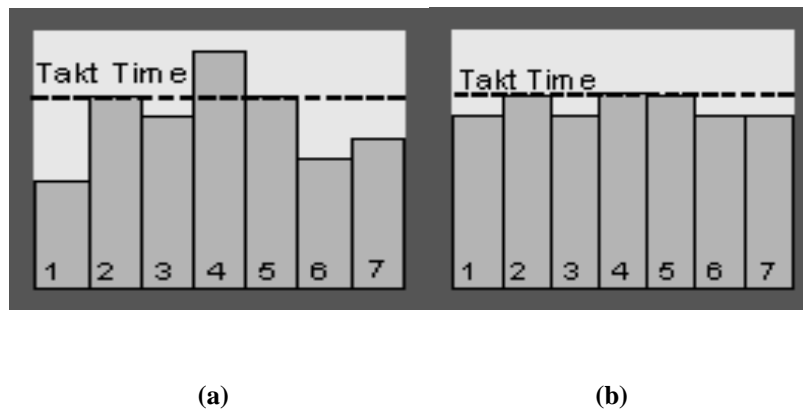
Shortly, Ford engineers found that by moving magnetos at a set rate by means of a motorized chain, they could set the pace of work. This resulted in a four fold increase of productivity: five man-minutes compared to the original twenty (Hounshell, 1984). Clearly, the concept of Takt or stabilized flow logically follows from the concept of 'flow'. It has been understood that smoothness and harmony in flow are fundamental to productivity and efficiency (also see the case of aircraft industry and one hour bomber Kidder 1995). The Takt system describes a constant rate of flow.



The production flow, theoretically, can have a constant or a variable rate. A flow line with variable flow rate, for example between 0.75 and 1.25 units per minute on different occasions; but averages 60 units per hour. On the contrary, a constant rate line runs at 1 unit per minute throughout the hour. Operating to a Takt-time means all workstations operate at a constant rate synchronized to the customer demand. By eliminating variability at each step, Takt-time prevents build-ups of inventory between workstations and the stops and starts that occur at a variable flow rate.

### Work Balance

Work Balance refers to a situation where all the operators along the production line require the same length of time to perform their tasks. Operating a line to Takt-time is a prerequisite to effective work balance. In an ideal situation, the work content is distributed evenly between workstations in a way to meet the Takt-time (Tapping & Fabrizio, 2001). Figure 2(a) is an illustration of an unbalanced line where cycle-times vary significantly from one process step to another (cycle-time for a work station is the time required from completion of one unit to completion of the next<sup>5</sup>). Operator 4 is pressurized to cut corners in order to finish the job within the



**Figure 2(a):** In the first illustration (left) the production line cannot make the necessary quantity because operation number 4 exceeds the Takt-time. In the second chart (right), the work has been balanced at Takt-time or slightly below. (Source: Strategos, 2004)

**Figure 2(b):** This figure illustrates improved balance of the line; work content is nearly balanced and the cycle-times are just below the Takt-time. Line balance creates a situation where individual and team performance can be monitored. This has potential benefits and drawbacks for operators (Babson, 1995). Benefits included good ergonomics and increases morale since everyone works equally hard.

<sup>5</sup> Cycle time is a measured quantity and takt time is a calculated value.

Takt-time, while operators 1, 6 and 7 drag their heels. Line imbalance potentially impairs the quality, leads to underutilized machinery and people, builds up inventory levels, causes individual frustration, and triggers team dissension.

On the other hand, the rigidity of Takt-time means that operators cannot take informal unscheduled breaks (Delbridge, 1998).

### *Enhanced Awareness on Performance*

Takt-time is displayed on the shop floor, sometimes using electronic devices, which count back from the Takt-time to zero in every cycle. So, production team tracks time and “*everyone can see where production stands at each moment*” (Womack & Jones, 1996). This provides frequent and cyclic feedback on productivity, machine reliability and quality problems, which increases the level of awareness in both workers and management. Such heightened awareness brings great motivation to the team and leads to higher productivity and quality.

## **Standardized Work Practices**

Operations standardization began with the ‘*Scientific Management*’ movement (Taylor, 1914; Gilbreth, 1911) as the first step towards the modern industrial era and as a method of reducing dependency on the skilled workers of the craft production age. According to Imai (1997), work standardization is critical for any improvement and key to success in the Toyota Production System (the same as lean). Standards can be defined as the best way of doing a job (Imai, 1997). Work standardization refers to operational procedures on the shop floor that ensure customer satisfaction i.e. work standards show what, where, when, who and how tasks should be carried out to ensure best results. Standards must be clearly documented and circulated to everyone. A critical differentiation from early work standardization that relied on industrial engineers to set the standard is that – in lean – people on the shop floor must establish work standards and they are responsible for improving those (Tapping & Fabrizio, 2001; Imai, 1997).

Work standards should be maintained in the first place and continuously improved. In fact, standards create the basis for subsequent improvements. Some of the features of standardized work systems are as follows (Imai, 1997):

- Standards represent the best, easiest and safest way to do the job
- Standardized operations provides the basis for continuous improvement
- Performances are measured against the standards
- Standardization is a necessity for training the workforce
- Standardization is key to preservation of organizations’ knowledge base

## Methodology

As part of the Red Meat Industry Forum's Value Chain Analysis Initiative (Simons *et al*, 2003), nine red meat chains were studied using the FVCA method – which involved ten-days of data collection as explained in Figure 3. Multiple – qualitative and quantitative – sources of information are used and results triangulated with data from outside the scope of the nine case studies (Stake, 2000; Yin, 2003). A case study research method (Yin, 2003) is adopted to investigate the implications of lean production within the context of red meat industry. Yin (2003) challenges the traditional concerns over the lack of rigor of case study method, e.g. limitedness and bias. Yin (2003a) argues that the case study method, when systematically designed, is a legitimate method for research.

Day	Event	Methodology
1	Initial Workshop	Lean Concepts and VCA. Principles for benefit sharing. Supply Chain Structure Map. Organization and Communication Map.
2	Workshop Current State	Select Product Current State Map Chain Consider whole carcass
3,4,5	On-site mapping	Farm; abattoir; meat processing plant; sausage manufacturer; distribution centers, retail store Identification of internal operational improvement opportunities at each facility
6	Workshop: Full Chain Future State Map	Future State Map Consumer Value Ideal State Identify Key Performance Indicators
7	Off-site	Consultation framework on strategic opportunities
8	Workshop: Future State	Rationalize Ideal to Future State Link Consumer Value and Key Performance Indicators Identify key projects
9	Prepare Presentation	Firm proposal with project owners, benefit allocations and milestones. Involve Senior Managers pre-presentation
10	Presentation	Joint presentation of recommendation to senior management of all companies Decisions taken as to which improvement projects to progress.

(Adapted from Taylor and Simons 2004)

**Figure 3:** Development of the Ten-Day Activity Plan

The research question is “*how and why adopting lean practices (i.e. Takt-time and Work Standardization) improve operational performance of red meat supply chains and what are the potential monetary benefits.*”

## **Operational Data**

To establish the operational data the FVCA case study approach was used applying a ten-day program of collaborative data collection (Figure 3) involving senior managers from each of the companies in the chain (Simons et al 2003, Francis, 2004, Taylor and Simons 2004, Simons et al, 2005b). A variety of data collection techniques are used including process activity, demand amplification, quality filter, physical structure, decision point, supply chain response matrix and production variety funnel (Hines and Rich, 1997) and value stream maps (Rother and Shook, 1998).

## **Monetary Benefits**

Performance indicators can be categorized into leading real time indicators (mainly operational) and lagging performance indicators (mainly financial) (Fitzgerald *et al*, 1991). The FVCA methodology focuses on lean operational evaluation but does not include cost/benefit analysis (Zokaei and Simons, 2005). The authors recognize that to analyze the changes, cost/benefit analysis should encompass all economic, societal and environmental impacts and trade-offs (Mishan, 1967, Pearce 1976).

However, various industry observers in the UK expressed interest in understanding the potential internal economic value of improvements to the groups of actors in the whole sector. Lean performance improvements primarily lead to better quality and reduced inventory levels which quickly release resources in terms of people and cash; but only translate into bottom-line benefits in long-term. A common strategy for lean adopters is to grow their businesses and to build on the improvements that aren't immediately reflected on the balance sheet (e.g. strong brand and released human resources that should not be laid off) rather than just focusing on monetary savings. Moreover, precise conversion of operational measures to economic benefits to the actors is limited by:

- The unpredictability of the interaction of operational improvements – for example reduction in variance on the farm might have a calculable benefit to the producer, but will also lead to simplification of processor tasks.
- The limitation of the applicability of case study data to the performance of the wider industry – i.e. no value chain will have average operational performance.
- The variation in accounting methods and book value of assets – for example the benefit may depend on the current depreciated value of an asset.

This paper presents some preliminary work to estimate the order of magnitude of direct economic savings to the actors at each point in the chain. This is based on converting leading operational measures to savings through the use of actual costs identified in the chain and industry estimates (MLC Market Values Analysis <sup>6</sup>).

Table 1 shows a series of steps to convert operational savings to actor economic savings. The Current Performance is based on actual figures collected in the case chains, and the Achievable Performance is based on targets or actual improvements made by chain participants through implementation of lean thinking, i.e. practices, policies and philosophies. This leads to an estimate of Total Potential Operational Saving, which is then converted to a monetary saving by taking account of the proportion of the actor's variable costs that have occurred at the process where the opportunity occurs. Based on the action plans created by the case study participants, an estimate of the proportion of the saving achievable through lean practices (i.e. Takt-time or work standardization only) is applied to reach a potential cost saving for the actor.

**Table 1: Converting Operational Improvements to Actor Economic Saving (Illustrative figures to demonstrate calculation method)**

<b>Step</b>	<b>Mortality</b>
Operational Measure	Effectiveness
Current Performance	60%
Achievable Performance with lean practices, policies and philosophies	80%
Total Potential Lean Saving (80%-60%) / 80%	25%
Variable costs incurred in this process stage when loss occurs as percentage of total cost. (Actual costs or estimates are made)	40%
Potential saving to selling actor at stage in chain 25% x 40%	10%
Contribution of Lean Practices only (without policies or philosophies)	50%
Potential cost saving to selling actor for Lean Practices 10% x 50%	5%

## Limitations and Supporting Evidence

The cases include most players in the UK supermarket oligopoly and several major foodservice channels. Similarly, in the processing sector many larger UK plants have participated. Although, the authors would not claim statistical significance for

<sup>6</sup> The Meat and Livestock Commission publish annual reports on the value of meat production and sales in the UK.

the findings, they tentatively suggest that the cases have credibility as they covered approximately 50% of retail channels and 30% of processing capacity. However at producer level, a handful of farmers were involved selected by the retailer/producer as likely collaborators. The producer findings are therefore limited because of this selection method, and as they are species specific. To counter these limitations at the producer end, other data has been used in triangulation; producers outside the chains were engaged in semi-structured interviews, industry body statistics accessed and secondary literature used.

## **Results<sup>7</sup>**

This section summarizes the potential estimate savings identified along the chain associated with Lean Practices. The potential savings to actors in the chain is summarized, and then the detail behind how lean practices of takt-time and standard operations contributed to these potential operational improvements is discussed for each part of the chain.

Table 2 presents the potential savings to the actors, which total 14.5% along the chain. These are currently expressed as variable costs at the stage in the chain, and would need to be unified as a percentage of retail price to give a total chain saving – for example 2% at farm cost has a different value to 2% at distribution centre cost. The value chain potential saving could be considerably lower. However, of the 14.5% available to actors, our tentative estimate is that 8.6% total savings are available through implementation of lean practices. To the farmer this is estimated to be 3.4%, the processor/packer 2.9% and the retailer 2.2%. Further analysis is underway to weight these findings by species, livestock route and distribution channel to provide a range of values for different chains. The next section discusses the operational data behind these estimated savings through description of the major areas of improvement.

## **Mortality**

In the pork sector, PMWS (Post-weaning multi-systemic wasting syndrome) was a major concern e.g. estimated to affect over 80% of Scottish herds in 2004, with mortality rates of up to 25% (Strachan, 2004). The pork FVCA took place on farms that were disease free and had been restocked in the recent past. Birth to farmgate mortality averages 10.6%, and can reach 19% with poor process. Disease free units with top stockmen and investment achieved 5%, giving a 5.6% reduction in cost available in the farm growth stage. A pig producer commented that “the best stockmen reduce mortality from 19% to 5%.”

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<sup>7</sup> The authors acknowledge the data collection contribution in the results section of [information withheld for the purpose of the review process].

**Table 2: Economic Savings across Red Meat Chains**

	<b>Mortality</b>	<b>Clean Animals</b>	<b>Farm Giveaway</b>	<b>Cutting Room</b>	<b>Packing Lines</b>	<b>In Store Waste</b>	<b>On Shelf Availability</b>	<b>Total</b>
<i>Operational Measure</i>	<i>Survival: Lamb and Pork Only</i>	<i>Clean Animals Entering Processor</i>	<i>Weight Paid For by Processor (lamb only)</i>	<i>Operator Value Add Time</i>	<i>Overall Equipment Effectiveness</i>	<i>Product Paid For</i>	<i>Time % Available</i>	
Current Performance	90.00%	95%	99%	60%	40%	95%	90.00%	
Achievable Performance with lean practices, policies and philosophies	95.00%	100%	100%	80%	60%	98.50%	97.00%	
Total Potential Lean Saving	5.26%	5.00%	1.16%	25.00%	33.33%	3.81%	7.22%	
Variable costs incurred in this process stage when loss occurs as percentage of total cost.	45.00%	0.50%	90.00%	8.77%	10.96%	90.00%	25.00%	
Potential saving to selling actor at stage in chain	2.37%	0.03%	1.04%	2.19%	3.65%	3.43%	1.80%	<b>14.51%</b>
Contribution of Lean Practices only (without policies or philosophies)	100.00%	100.00%	100.00%	50.00%	50.00%	25.00%	75.00%	
Potential saving to selling actor at stage in chain for Lean Practices	2.37%	0.03%	1.04%	1.10%	1.83%	0.86%	1.35%	<b>8.57%</b>

In the lamb sector, Meat and Livestock Commission data for 164 farms from birth to farm gate showed mortality in the range 4-5%<sup>8</sup>. However, two large scale leading producers who participated in FVCA and measured mortality had a total scan to farmgate mortality of 11 to 15%, of which birth to farmgate accounted for 8% to 12%. At first sight, this would indicate these farms are twice the national average. However, the mapping team and researchers concur that the higher figures for these producers is counterintuitive as the producers involved are in the top flight of the industry, which indicates that their measurement may be different from the MLC's participants. The research team have also interviewed a group of nine farmers outside this chain and the indications were that they did not measure mortality in a systematic way, and estimated mortality to be 10-15%. In a nine-year study in the US with a different methodology 10-14% (Berger, 2005) was reported from birth to farmgate. Although the study method is different, they found

<sup>8</sup> Meat and Livestock Commission data collated by [information withheld for the purpose of the review process].

significant improvement opportunity “3/4 of all mortality had its cause in faulty or inadequate management” and “4 to 5% should be the number one priority of any sheep producer” (Berger, 2005, 41).

In the beef sector, mortality levels were lower, and no evidence on significant opportunities for reduction observed. Our analysis argued that pork and lamb, which represent 57% of slaughtered production value, could be improved by 5.6% and 5%. Firstly, the pork sector was observed to have standard measures to assess mortality levels, which were influenced by the skill or craft of the stockman. The opportunity is to convert the craft process (Womack et al, 1990) to a standard process that is repeatable and transferable to less skilled personnel. Secondly, the lamb sector shows little evidence to support the presence of widespread standard measures evident in the pork industry. The US study showed that improvement was possible, and the tentative finding is that similar gains should be possible in the UK with standard measurement and operations.

## **Giveaway**

Lamb processors to major retailers required lambs at approximately 18.75kg and allowed a variation of +/- 15% or 30% range in total. Over 30 deliveries (Appendix 1) of lambs to processor consisting of 1794 animals had an average 14.55% above the top weight. Meat in excess of the top weight is not paid for, leading to 1.16% of all meat delivered being ‘giveaway’ by the producers. 19% of producer batches had ‘giveaway’ in excess of 3%. Interview data indicated that the main reason that animals were overweight related to the producer holding back product in anticipation of a better price at a later date. This relates to a disconnection between the takt-time of the market and the cycle time of production. In the sample of farmers within the chain, and groups outside, no producer cited ‘giveaway’ as a measure.

## **Cutting Room**

Simons and Zokaei (2005) analyze five cutting rooms – by means of activity sampling and observation – and categorized them as traditional and advanced with significant differences in productivity. The traditional cutting rooms had no concept of Takt-time or standardized work, and exhibited the waste of ‘overproduction’ (Ohno, 1988). By contrast, the advanced lines all ran at a pace that workers could apply standard operations and cut to the correct quality, and in two cases (4 & 5) were also paced to a Takt-time. The paper tentatively (due to the activity sampling method) concluded on operator activity, that traditional lines run at 60% and advanced lines run at 80%; and therefore advanced lines can operate with 25% less labor cost due to improved line balance. With the introduction of Takt-time and standardized operations, the red meat cutting rooms react in the way predicted by



**Table 3: Cutting Line Results Summary**

Case	Species	Channel	Processor	Activity Sample	Standardized Operations	Takt -time
1	Beef	Foodservice	Small UK	60%	-	-
2	Pork	Supermarket	Medium UK	60%	-	-
3	Beef	Foodservice	Medium UK	70%	✓	-
4	Beef	Foodservice	Large Overseas	80%	✓	✓
5	Pork	Supermarket	Small	90%	✓	✓
6	Lamb	Supermarket	Medium	70%	✓	-
7	Beef	Foodservice	Small UK	65%	✓	-

\*Amended from (Simons and Zokaei, 2005)

Figure 3(b). Two further cases are added for this paper, which underpin the original findings.

Another plant visited in Australia which appeared to have a good rate of value added was visited but not activity sampled. The interesting thing with this line was the way in which takt-time was achieved. In previous examples, takt-time was achieved through a motorized belt or line indexing forward at a constant rate. However, in this instance, a light illuminated at regular intervals to signal an operator to launch another carcass at an exact takt-time.

## Retail Packaging

FVCA measurement in one lamb packer applied an established standard measure to packing lines, Overall Equipment Effectiveness (Nakajima, 1984). The average value measured was in a detailed study in one plant was 26%. Observation indicates that average OEE in the eight chains was in the order of 40%. This is substantiated by improvement work that achieved rapid improvements of 60% reduction in changeover times. An average of 40% OEE with a target of 60% OEE seems achievable against a backdrop of World class manufacturing at 85%. Moving from 40% to 60% leads to packing lines being scheduled for 33% less time, requiring less labour, less space and less reworked product. Lean practices around standard operations were key to the improvement work on changeovers, reducing labour, energy input and wasted /reworked product.

## Retail Store

Retail store back room processes are important to converting product available at the end of a supply chain into customer needs. All retailers agreed that availability was a key measure. One retailer through continuous real time shelf inspection measured on-shelf availability, whilst others assessed what was in store by calculating the time from the last sale of a product until the shelf was replenished. This data indicated that On-Shelf Availability is approximately 90%. A major step

forward on availability during this project was the ECR UK/IGD<sup>9</sup> work on 200 key lines. For the key red meat lines, this has helped raise availability from 93% to almost 99% in just nine months. The challenge is to repeat this for the whole assortment of products on a regular basis. Back room processes were observed to be inconsistent across store networks, and a key opportunity to improve availability by moving product more quickly and efficiently to the shelf. The realizable gains from improving availability in terms of reduced lost sales is dependent on the interaction with other chains (gaining customers) and products (in store substitution). A worldwide study of on shelf availability showed similar availability for ambient goods, with sales losses due to out of stocks of 2.1% to 4.5% dependent on category (Corsten and Gruen, 2005). Taking the lower figure this equates to 0.25% increase in sales per 1% of availability. If typical red meat chain data (90%) could be brought up close to IGD top 200 lines (say 97%), then there is a 1.75% improvement in sales. In the five retail cases in this study, suppliers were to depot availability was 97% to 99% with 7% to 9% loss between depot and shelf. The team tentatively estimates 50% of this availability loss due to backroom processes and that the workplace organization is a key factor in this. This contrasts markedly with supplier and retailer warehouse/depot housekeeping. This issue was general across all retailers. The use of plastic trays and reduction of cardboard waste negated the issue to a small degree. There were however some isolated examples where local management had implemented excellent housekeeping and visibility benefited.

## **Conclusion**

The detailed analysis of eight major value chains by the a collaboratively by the chain participants is a step forward in understanding how the UK red meat industry may become more competitive. These chains represent a significant proportion of leading UK red meat channels to the consumer, and so the case studies provide a reliable insight to the current value chain of "UK Red Meat PLC". Hundreds of days of industry effort has been contributed to understanding the current state of the value chain. Full analysis is underway to understand the benefits of lean philosophies, policies and practices to industry and the wider community. This paper is a first report of this process, limited to the immediate economic benefits of lean practices to the industry actors. Lean practices (principally takt-time and standard operations) are demonstrated to have significant potential improvement to determinant operational measures in all parts of the chain. These lead to an estimate 2 to 3% cost savings for each actor in the chain at their selling price in implementing lean practices. The significance of this cannot be understated when several actors struggle to achieve profit margins of this magnitude.

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<sup>9</sup> <http://www.igd.com/cir.asp?cirid=1602&search=1>

Further work is planned to understand the economic cost savings expressed as a percentage of retail price. Follow on work to report and quantify long-term collaborative chain work on lean philosophies and policies in certain chains that have a high level of adoption is also forthcoming. There will then be an opportunity to assess the benefit outside the actors in the chain to the wider industry and society.

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## Appendix 1: Lamb Giveaway Analysis

Batch size	Batch Weight	Number overweight	Giveaway kg	Giveaway %
15	266	0	0	0.0%
20	437	10	17	3.9%
22	463	6	12	2.5%
25	465	2	2	0.4%
25	485	1	1	0.1%
25	450	0	0	0.0%
28	621	17	25	3.9%
30	538	0	0	0.0%
30	554	0	0	0.0%
30	608	2	2	0.3%
30	639	10	16	2.5%
36	687	0	0	0.0%
40	822	13	22	2.6%
44	794	1	1	0.1%
45	951	15	32	3.3%
46	833	0	0	0.0%
46	900	7	8	0.8%
50	1016	7	8	0.7%
50	1009	7	9	0.8%
60	1317	31	49	3.7%
60	1258	21	31	2.5%
74	1291	3	5	0.4%
75	1348	3	3	0.2%
83	1736	29	45	2.6%
86	1635	10	17	1.0%
87	1878	39	59	3.1%
94	1893	6	10	0.5%
80	1599	12	25	1.6%
100	1950	0	0	0.0%
100	1705	0	0	0.0%
112	2193	6	6	0.3%
146	2535	3	6	0.2%
<b>1794</b>	<b>34866</b>	<b>261</b>	<b>406</b>	
<b>Overweight %</b>	<b>14.55%</b>			
<b>Giveaway %</b>	<b>1.16%</b>			