



Lean Manufacturing Review

**A review of the historic
impact of Lean on UK
manufacturing and how it
may be made more
effective in the future.**

An Amnis White Paper

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1.0 Overview of Amnis

Amnis are specialists in supporting transformation, Lean and operational excellence programmes in manufacturing, healthcare and local government, with a client base across the UK and around the world.

Our work is focused on helping clients to understand not only how to use the tools of improvement concepts such as Lean but how to turn these tools into successful improvement programmes.

Manufacturing companies in the UK face many challenges, including a high cost base when compared to many international markets and problems with the availability of people with the right skills. For many, the only way forward is to continuously improve the way they do things.

Amnis help manufacturers reduce lead-times in development and operations, as well as helping them to cut the costs of production and leverage more from their existing assets, whether that is from their people, their machinery or their technology.

For more information about our work with manufacturing organisations please contact us on 0870-446-1002 or email info@amnis.uk.com.

2.0 Introduction

In an increasingly competitive global market, manufacturers in the United Kingdom must develop the most efficient and productive manufacturing processes to enable them to remain viable.

Almost two decades after the rise of Lean in the UK, it is clear that there are still many opportunities for manufacturers to benefit from the application of Lean. It is also clear that despite the opportunities, many manufacturers are hesitant to invest in improvement activities as they are unsure if Lean is the answer to their many operational and engineering problems. Much of this is related to uncertainty about the most effective way to introduce Lean without risking more than the benefits will deliver. Whilst Lean is not a panacea to any business, it is an effective way of rapidly improving processes if used effectively.

In this report we will review the history of Lean in UK manufacturing and will then review the expected future of Lean based on the available evidence. Finally, we will end with a series of recommendations for those organisations considering implementing Lean about how they can get the most from their investment.

3.0 The Importance of Manufacturing to the UK Economy

There has been a resurgence in manufacturing in the UK over the last few years as production levels in many of our most prominent sectors have started to increase. Manufacturing output is predicted to continue growing in many UK regions, with only occasional ‘troughs’ expected.¹ Research undertaken during mid-2011 shows that 30% of companies report seeing an increase in new orders, with this change particularly prominent in the North West.²

As a whole, UK manufacturing comprises 18% of national GDP and 62% of exports,³ employing some 2.6 million people directly, or 1 in every 10 jobs.⁴ The impact of manufacturing goes further, with three service sector jobs dependent on every manufacturing position, meaning that 40% of all UK jobs are directly or indirectly dependent on manufactured goods.

As mentioned, 62% of UK exports consist of manufactured goods, with the majority going to the United States, Germany, France and the Netherlands.⁵ Between 2010 and 2011 there has been a 2.7% annual increase in

manufacturing output, a trend set to continue for the foreseeable future.⁶

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The recovery will most likely be spurred by increased levels of exports in the renewable energy and high-technology sectors,⁷ but with so many jobs in the UK dependent on manufactured goods, and the negative impact on our balance of trade from any reduction in manufacturing output, there are few sectors that do not need to consider the application of Lean as part of their drive for operational excellence.

4.0 How has Lean Affected UK Manufacturing so Far?

Although the concepts that underpin Lean such as flow, small batch sizes and flexible processes go back a long way, what we now perceive as a ‘Lean approach’ was first introduced to the UK by Japanese car companies entering the UK automotive market in the 1980s and 90s.⁸

The first recognisable publicly funded Lean programme in the UK was the Industry Forum (IF), established in 1996 by the Society of Motor Manufacturers and Traders and the Department of Trade and Industry. Members of IF included Honda, Nissan, Toyota, General Motors and Volkswagen, who then provided engineers who

specialised in manufacturing process improvement to train other UK engineers in Lean. The IF created programmes so that trained UK engineers could share their new knowledge and skills with other companies, with the engineers then returning to their own businesses to apply the concepts.

Lean techniques improved the automotive industry so greatly that it spurred the idea of applying the idea to non-automotive manufacturing companies: "This is based upon the premise that manufacturing problems and solutions are universal."⁹

During the mid to late 90s, Lean expanded from the automotive sector into general manufacturing such as aerospace, consumer electronics, construction, health technologies and medical devices, and later into food manufacturing and food processing.¹⁰

The impact of Lean on UK manufacturing has created more streamlined production processes, with long-term advantages for many companies such as less waste, decreased environmental impact and more consistent product quality.

'The Lean Survey' undertaken by *The Manufacturer* magazine in 2011 indicated that 70% of responding companies utilised Lean

programming. An additional 11% responded with plans to implement Lean programming within the next year. Of the companies that have already established Lean programmes, 25% have had programmes running for five or more years, and 70% cited their programmes as being successful.¹¹

This cannot be taken as a general indication of the prevalence of Lean in UK manufacturing, given the likelihood that many of those manufacturers not using Lean would fail to respond to such a survey, but it is a useful reference survey that shows that amongst those who are proactively implementing Lean, success is possible. In the next few examples we will provide some tangible case studies about how Lean has been used to drive improved performance.

Autoglym Ltd¹²

Autoglym Ltd produces vehicle care products. In order to cut costs and improve productivity, the company has put into practice Lean manufacturing techniques and has reformed its product assembly area. After becoming interested in the benefits of Lean manufacturing, Autoglym began a series of workshops for senior managers in order to learn more about the process. Improvements were made to the organisation, production processes

and material planning systems. As the company grew, the team found they had to refine their Lean approach to suit their specific manufacturing processes.

Autoglym's Manufacturing Manager, Mark Evans, explained, "It was important that the people actually doing the job understood the benefits. We focused on our key product, Life Shine, which is a vehicle care kit comprising 24 components."¹³

Through Lean a flexible production line was established for the Life Shine kits, which are now assembled in half the time using the same number of people, saving over £100,000 as well as ensuring the team can deliver On Time, In Full (OTIF) more consistently.¹⁴

A key finding from Autoglym's experience is summed up by Evans, who says, "Although we've communicated the new approach throughout the company, we should have involved the whole workforce earlier. At the time, it seemed impossible because we couldn't shut down production, but in retrospect we could have found other ways to get them involved."¹⁵

Portakabin¹⁶

Portakabin is an international company that specialises in creating modular, stand-alone

buildings. Its Lean manufacturing process focuses on waste reduction in all steps of production, with a particular focus on eliminating wastage and scrap that has reduced its material sent to landfill by 60% (with a corresponding reduction in costs). This has been achieved through cutting materials to precise lengths, redesigning the materials used to reduce the amount per product and re-using materials, such as using door and window shapes cut from insulation as floor insulation.

Portakabin believes that "Lean production can be seen as providing a win/win/win situation: financial benefits for Portakabin and its customers; environmental benefits to nature and the population; social benefits to people and communities".

Now, 99.6% of Portakabin's products are delivered on time and on budget (compared to 63% on time and 49% on budget on average previously), and building times are 50% faster due to the rigorous application of Lean techniques that have been applied throughout every stage of production.

Corus¹⁷

The Restoring Success Programme was a Lean-based initiative designed to make Corus, an international metals company, more competitive by cutting waste and unnecessary activities as well as making processes more efficient and consistent.

Within a year, 50% of the target savings were realised. Corus claims that “the best people to identify ‘Lean’ processes are those who are most involved in production activities”.

In order to initiate change, “Corus saw that training was the underlying imperative which would drive the improvement process”. Across the company, 250 improvement coaches were implemented, who then trained the workforce from the top down.

An example of success from within the Corus group can be seen at its Port Talbot plant, where implementing a pilot programme yielded savings valued at £350,000 as well as improving safety and the physical environment in which people were working.

Kellogg’s¹⁸

Although the Kellogg’s company originally began in the United States, manufacturing plants have been running in the UK since 1938.

Kellogg’s is highly concerned about its Corporate Social Responsibility and the sustainability of its supply chain. One of Kellogg’s primary goals is to reduce energy and emissions throughout the manufacturing and distribution processes and has used Lean to streamline its production processes and reduce transport delays.

The Lean manufacturing system adopted by Kellogg’s in the UK has ensured its plants remain profitable.

“Cultural issues dominate Lean implementation in all sectors. In manufacturing, whilst application may be good in the manufacturing area itself, it’s usually poor or non-existent in the rest of the company. Lean is a highly focused approach that delivers a lot, not just in cost savings, but in reductions in bureaucracy and improvements in customer focus and timeliness.”

Professor Tony Bendell, International Expert, Consultant & Trainer in Quality, Excellence, Six Sigma and Lean, Nottingham, United Kingdom

5.0 The Future of Lean

Between 2009 and 2017 the UK will require an additional 587,000 engineers at all levels and all disciplines to support the long-term recovery of manufacturing. However, only 20,000 engineers are being trained annually, and this lack of talented engineering expertise entering the manufacturing sector could stifle the resurgence in manufacturing that we are currently experiencing.¹⁹

By increasing investment in Lean manufacturing techniques, manufacturers may be able to go some way towards compensating for the impending deficit of skilled engineers and workers by streamlining processes and reducing the number of steps involved as well as reducing the ambiguity in many technically complex design and production activities.

In addition, the size of the import market in the UK provides an opportunity for companies that are looking to implement Lean practices to capture more of the domestic market. Conversely, by using Lean to increase dependency, it will also reduce the need for companies to outsource activities, with a potentially significant reduction in both costs and business risk.

In a speech at the CBI Manufacturing Dinner in November 2010, Minister of State for Business and Enterprise Mark Prisk introduced a new set of tax cuts that will ensure the UK has one of the lowest corporation tax rates of any major Western economy. After introducing the tax breaks, Prisk announced that the cuts will help companies “increase their productivity and address new opportunities in a number of areas”. One of three areas Prisk encouraged organisations to invest in for the future was Lean manufacturing.²¹

Reducing lead-times to cope with demand variability and to reduce overall stock holding will continue to be a key driver of improvement. For example, the expanded application of Lean in the construction, marine, aerospace and automotive sectors will result in more accurate predictions of future installation times, reduce project durations, avoid design redundancy and reduce excess inventory.²²

In addition, the government wants to drastically decrease carbon emission by 80% by 2050, a problem that affects many sectors but that is particularly an issue in the construction sector, which accounts for 47% of all UK emissions.

In order to reduce energy consumption and waste products, the construction industry as a whole is looking to implement Lean manufacturing into its processes to achieve its goals.²³

“Sustainability is becoming increasingly important as a business issue for construction companies. Whether it is government commitments to reduce emissions and employ local labour, compliance with regulations or efficiency savings through better waste management, sustainable construction will continue to develop.”²⁴

In following the call for UK construction to be more environmentally sustainable, Ancon, a construction supply company, has implemented Lean manufacturing in order to reduce waste. Ancon produces steel components for masonry and concrete construction and supplies an international customer base. Three of its manufacturing facilities, including the headquarters, are based outside of the UK. Ancon’s Managing Director, Stuart Maxwell, claims that with sustainability being the core of the company, “all of our facilities employ strict energy management and waste-minimisation procedures, following the principles of Lean manufacturing”.²⁵

Paul Davies, the Institute of Engineering and Technology’s Head of Policy, expressed hopeful sentiments at a top-level summit to discuss the future of UK manufacturing: “As we have seen from recent economic data, the manufacturing sector is keeping the UK economy afloat; the economy is therefore at risk if we do not work to encourage these green shoots to grow.”²⁶

New manufacturing opportunities are also arising from emerging energy supply industries that focus on ways to avoid using fossil fuels. Additionally, the aerospace industry is looking towards growth in the future with research in the new high-technology industry sector that seems to be developing quickly within the UK.²⁷ Growth sectors benefit from Lean by reducing the time to market for new products and increased capacity, enabling them to capture more market share.

Sectors that are expected to decline in the future are those related to mining and the quarrying industry as well as the oil and gas extraction industry, as the nation becomes more focused on possible new energy supplies.²⁸ Declining sectors benefit from Lean through reducing costs and stock levels, enabling them to remain viable for longer whilst at the same time helping to find new market

opportunities for existing technologies and capabilities within the business.

Lean manufacturing is finding its way into these new high-technology sectors, and greatly improving the production rates of some companies such as Dawson Precision Components (DPC).

DPC is a production engineering company that produces small parts for Formula 1 cars, mass spectrometers and fighter jets. Lean has had an impact on both front-end communications with customers and faster production lead-times, both significant in the fast moving markets DPC operates within.²⁹

6.0 Key Success Factors

Widely differing pressures on different manufacturing sectors creates widely differing improvement needs. For some, the focus of Lean needs to be long-term and strategic, whilst for others having a 'quick fix' is the order of the day. However, there are a number of common themes that will drive the future success of Lean across all manufacturing sectors in the UK, and in this section we have attempted to summarise the most important of these factors.

Create the right environment for Lean

The tools of Lean are amazingly simple to understand in most cases. The complexity comes with the practical implementation where prejudices, relationships between teams and varying levels of understanding about the need for change create a multitude of problems. Creating the right environment for Lean to succeed through an effective communications programme, training, changes to the way senior leaders behave and involving the front line in improvements creates, over time, an organisation that is ready to 'go Lean'.³⁰

Create a Lean strategy

Companies should be clear from the outset what the desired changes are, and how quickly they need to be attained. The objectives need to be specific, clearly defined and available to every member of the company.³¹

Don't just implement, follow up

The most exciting element of a Lean programme is the implementation phase. However, without an effective 'follow up' programme to deal with operational problems that arise with new processes and that ensures old practices do not creep back in, the likelihood is that improvement activities will simply slip away.³²

Be consistent in your message about Lean

Ensure that there are no mixed messages by following through on words with the appropriate actions. New behaviours and ways of working don't just apply at the front line, and it is very easy to undermine a Lean programme by executives and managers not having to follow the same rules and Lean principles as everyone else.³³

Don't starve the process of resources

Manufacturers, quite rightly, want to see a return on their investment in Lean, but sometimes there is a perception that this return can be realised without investing resources to make things happen. Allocating time for people to participate and having an improvement budget are keys to turning the dream of Lean into real improvements.³⁴

Build your Lean capability

Don't rely on external consultants to deliver your improvements in the long term, instead focus on rapidly building up your own ability to 'go Lean'. The art here is not too much training that you simply tire people out, and not too little that they don't know what to do.³⁵

Ensure your leaders are onsite

Leaders play a pivotal role in the implementation of Lean and have the power to

motivate staff, ensure people are engaged in the process and that the process of Lean is delivering results, and vice versa, to demotivate, starve resources and block progress.³⁶

For every project, be clear about the problem

Every Lean project needs to be focused on tackling a problem and that problem needs to be defined clearly and planned before implementation starts.³⁷

Celebrate every success

Although benefits can be realised from almost day 1, Lean is a medium to long-term investment. It is important that people are told about successes so that they see progress is being made, and at the same time telling people about what has been achieved both educates them and spreads the message about what things are going to be recognised as important in the future.³⁸

Don't lock up the ownership in your Lean Team

Your internal change agents are there to facilitate Lean projects and train others. Your Lean projects are owned by the managers and staff in each area. Mix up these roles at your peril.³⁹

7.0 Final Words

The modern use of Lean is a relatively new concept to UK manufacturing, and thus it is still evolving and still being tested daily in thousands of companies. Lean will find its place in the UK manufacturing industry's future by providing production boosts for new sectors as well as filling in the gaps for industries that are struggling. The real final words to this report need to be said by a Lean practitioner:

"A challenge for Lean practitioners everywhere is to encourage all employees to bring their experience to work. When I meet with production operators and other individual contributors I ask, 'How many of you are managers?' They smile and reply that they are not managers. Then I tell them that they all are. They look surprised. In their private lives they control their own finances, so they are finance managers. They plan what they need to buy at the grocery and at the shops, so they are materials managers. They raise and educate their children, so they are HR managers. They move house sometimes, so they are logistics and project managers. They plan meals and holiday festivities, so they are planning and production managers. They plan for and make repairs at home, so they are facilities and maintenance managers. These kinds of practical

experiences are very relevant to effectively managing processes that occur in operations.

I encourage all levels of employees to bring their home experience to work. If they do, I explain, they will grow their careers faster, which is a win for employees and is also a win for the company."

Ward Chartier, General Manager at Branson Ultrasonics

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About Amnis

Change is one of the few constants in today's economy. For manufacturers looking to develop competitive advantage through the successful application of Lean, Amnis is an effective organisation to partner with.

Practical, pragmatic and hands-on in our approach to training, consultancy and implementation, we have an enviable track record.

Contact us to discuss how we can:

- Help you plan and deliver an organisation-wide Lean programme, or simply focus on improving one or more key business processes.
- Build your internal capability to enable you to plan and undertake Lean programmes.

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Appendix 1

Lean by the Dozen Article

This article is adapted from its original that was first published in *Control*, the journal of the Institute of Operations Management (Vol 3, 2009)

Abstract

This article provides an overview of some of the key historical events that have helped shape Lean today, as well as a review of the state of Lean in the UK today in the public, service and manufacturing sectors.

Introduction to Lean

Most of the goals and principles of Lean are common sense. Benjamin Franklin in his *Poor Richard's Almanac* (published from 1732 to 1758) says of wasted time, "He that idly loses five shilling's worth of time, loses five shillings and might as prudently throw five shillings into the river." Franklin further added that avoiding unnecessary costs could be as (or more) profitable as increasing sales, stating "A penny saved is two pence clear".

In this article we will take a look back at the history and some of the key milestones that have led to the development of Lean as it

stands today and then provide a look at the state of Lean today in the public and private sector.

We will end with a short discussion about the possible future for Lean in the UK, given where the economy may go in the next few years.

The Origins of Lean

Because Lean contains many elements that are intuitive (such as the desire to maximise productivity and ensure that waste is minimised), the history of Lean can be difficult to trace as much of what went before 1996 when the term 'Lean' was coined would have appeared as 'good practice' at the time and not necessarily have been seen as part of the development of a structured approach to transformation. Like much in the history of human development, it is the bringing together of many factors that has led to the development of Lean, including the availability of tested methods, expertise to turn those methods into actions and the need for the methods (in the form of improved efficiency) that has driven its development.

Lean's Place Today

In this section we will examine the current state of Lean in three main areas, namely the public sector, service industries and in its traditional home of manufacturing. What is clear is that in times of economic uncertainty such as we are currently experiencing, Lean has an even bigger role to play in helping drive out wastes in organisations, but also that these very same organisations are just as likely not to invest in Lean at this time due to the economic pressures, what can be termed a 'no win situation'.

Lean in the Public Sector

Following the publication in 2004 of the Gershon Review (titled 'Releasing resources to the front line') the public sector has been driven by the need both to demonstrate that the services they are buying and providing can be considered 'value for money' and to demonstrate that they are continuing to improve the effectiveness of the services they provide.

Like many manufacturing companies, a large number of public sector organisations have used Lean to deliver short-term improvements in performance to meet their obligations under the 'efficiency agenda', and whilst this has generated some significant gains (such as the

reduction in the time taken to process high demand housing adaptations for disabled people in one area from 200 days to 12 days), fewer of them are realising the longer-term organisational benefits that can accrue through the associated cultural change that Lean can bring (most notably in creating an environment that supports continuous improvement) rather than just the short-term cash and resource-releasing benefits that can be achieved.

The available evidence suggests that at a local level (such as local councils or individual NHS organisations) there are islands of excellence, but the uptake of Lean is both patchy and in many organisations has been started and then stopped. Some of the factors that seem to underpin this patchwork approach to Lean are the creation of a reliance on an external consultancy that is not transferred to an internal team (and becomes uneconomical to support), a change of management focus (or even a change of management) or simply that Lean was adopted to tackle a short-term strategic issue and was not seen as a long-term concept for organisation-wide change.

However, there are still some very inspiring stories of the use of Lean in the public sector in areas such as HM Revenue & Customs and the NHS, with the latter using Lean to both improve

safety and the experience of patients as well as the more traditional use in reducing costs and increasing capacity in places such as theatres and outpatient departments.

With 1 in 5 workers in the UK employed in the public sector, there is obviously a great scope for Lean to be used to improve efficiency in vital areas such as health and local services, but the reduction in revenues that can be expected due to the current economic conditions will significantly reduce the revenues available to fund the external support that has marked out the growth of Lean in public services, and this will place an increasing need on public sector organisations to 'grow their own' Lean capability.

Lean in the Service Industries

With far more people employed in the service sector than in the traditional industrial sector (with common estimates stating that there are 4–6 service sector jobs for every manufacturing position), there is obviously a large market for Lean, but until recently the 'uptake' of Lean in the service sector has not been as prolific as that seen in the manufacturing sector. Some of this was to do with difficulties in the translation of concepts such as continuous flow and standardised work from an industrial to a service context, but it was also the absence of

established success stories that initially prevented service companies from investing in Lean.

Like the history of Lean generally, the history of Lean in the service sector is mixed up with examples of good practice that go back many years. A good stake in the ground for the start of the efficiency drive in the service sector can be traced to the book *Relevance Lost* by Johnson & Kaplan (1991), which ultimately led to the Lean movement in the accountancy sector.

Attempts to introduce Lean (although it was not called such at the time, being mostly done under the banner of Business Process Reengineering) into the service sector in the early to mid 1990s tended to fall over because the approaches either did not 'fit' (being too industrial in nature), were too disruptive, for example trying to transform the entire organisation simultaneously, or proponents misused the concepts to dehumanise workplaces.

Over the last 10 years, and with the development of Lean since 1996, there has been an increasing number of case studies of Lean being used in such places as call centres to improve capacity, the energy sector to reduce

administrative overheads and the financial services sector (although I am sure the adoption of Lean was not at the centre of the current banking crisis).

There have even been tentative steps taken by various government agencies to promote Lean in the service sector (or Lean Office as it is sometimes also termed to allow it to include the administrative functions of manufacturing companies as well as purely service sector organisations), and there does seem to be a correlation between the availability of case studies, the production of available information and the uptake of Lean in the service sector since 2000, with an increase in any one of these three areas driving an increase in the other two, for example more case studies triggers more published materials and this in turn has an impact on the uptake.

From discussions with organisations actively involved in delivering Lean in the service sector, the message is broadly consistent in that those organisations who have seen the benefits of Lean are continuing to invest in reducing costs and improving effectiveness (albeit a number have scaled back the size of their investment), whilst most of those who were toying with Lean prior to the current economic conditions have

parked their investment plans for the current time.

The benefits of Lean in the service sector are clear from the many case studies that exist, from reducing the time taken to answer calls to a call centre by 90% through to reducing the costs of processing claims in the insurance sector by 75%, but like the public sector the focus has to be on developing internal capability rather than creating or continuing the dependence on external consultants, and there are an increasing number of workshops with titles such as 'Lean in the Office', 'Lean Accounting' and 'Lean in Service' that underpin the drive to raise the Lean skills of people in the service sector.

Lean in Manufacturing

Manufacturing is the traditional home of Lean and certainly the one with the greatest number of case studies. In addition, the government has invested heavily in promoting Lean in manufacturing through schemes aimed at raising the number of people with Lean skills (including the promotion of the Lean-based Business Improvement Techniques NVQ) and also providing discounted consulting advice to SMEs, but even given the length of time people have had to invest in Lean and get it right, there are still a large percentage of manufacturing

companies paying lip service to Lean or using it purely as a tactical vehicle for short-term improvements.

The real issues that underpin why manufacturers have had a love/hate relationship with Lean have revolved around their ability to both turn great plans into great benefits and then sustaining the change against forces that want to return to the 'old ways'. Productivity in manufacturing has gone up over the last 15 years, although it would be impossible to state how much of this has been due to Lean and how much has been brought about by the changing mix of manufacturing in the UK (away from low cost/low margin producers to higher value add manufacturing), but Lean and similar approaches have certainly played a part in the improvements in many companies.

The application of Lean in manufacturing was initially focused on reducing lead-times and the overall amount of work required to produce each item, but latterly has focused on the whole enterprise including the sales and finance functions, stock management, distribution and service. In essence, the focus of Lean for many manufacturing companies is now taking what Professor Michael Porter describes as a 'Value

Chain' approach from initial concept through to after-sales service.

The results for those manufacturing companies investing in the cultural as well as the process changes that can be achieved by Lean are seeing a year on year reduction in operating costs, increased flexibility, better customer service and reduced defects, but with the current economic conditions pressing hard on the manufacturing sector generally, many organisations who were previously investing in Lean have either scaled back or stopped their investment completely. The long-term effects of these decisions will be difficult to estimate, but it will certainly introduce an amount of inertia that, when things start to pick up, the organisations will need to overcome again to get their Lean programme back on track.

Lean – Alive & Kicking

What can be seen is that Lean is alive and kicking across most of the UK, and even though the current economic conditions have created a 'slow down' in the progress to Lean, it still has a role to play. If the economy continues to be uncertain over the next few years, then Lean will be an essential tool for enabling organisations to reduce costs and create flexible and responsive processes.

With an economy in recovery, Lean can help organisations to achieve ‘first mover’ advantage as new opportunities appear, and it also plays a role in the development of effective new products and services that will meet the growing demand that will signal the start of the recovery.

When the economy is back to full strength, Lean has a role to play in creating a culture of continuous improvement that will prepare your organisation not just for the recovery but for any future ups or downs that your market may experience.

Appendix 2

A Brief History of Lean

From 1473 – The Venice Arsenal develop a ‘continuous flow’ process based on mass produced and standardised items that ultimately enables them to produce an entire ship in around one day.

1776 – Lieutenant General Jean-Baptist de Gribeauval becomes Inspector of Artillery in France and starts to introduce reforms to reduce the diversity of artillery in use, replacing it with a more standardised range of weapons

that also used a form of interchangeable parts and manufacture.

1799 – Eli Whitney, inventor of the Cotton Gin, takes on the contract to produce 10,000 muskets for the US Army at a low cost of \$13.40 each. To enable him to do this he had perfected the process of designing interchangeable parts between the muskets, which enabled the process to be divided up and standardised.

1894–1912 – Frederick W Taylor publishes a series of articles on improving efficiency, with his key work *Principles of Scientific Management* being published in 1911 containing details of how to eliminate many of the inefficient practices existing in industry at the time and strongly advocating standardised work and the division of labour to improve efficiency. Collectively this approach is later termed ‘Taylorism’.

1905–1921 – Frank & Lillian Gilbreth (made famous by the film *Cheaper by the Dozen* in 1950 and indirectly the reason for the name of this article) publish a series of articles and books on improving efficiency through Time & Motion Study, culminating in 1921 with their book *Time & Motion Study As Fundamental Factors in Planning & Control*.

1910 – Henry Ford along with Charles E Sorensen create a comprehensive manufacturing strategy and move to the Highland Park Plant, Michigan, which was the world’s first automobile plant that used an assembly line. In 1914 they create the first moving assembly line, reducing production times by a further 75%.

1924–1939 – Walter Shewhart advocates statistical control of processes and later his work is adapted by W Edwards Deming to form the ‘Plan-Do-Check-Act’ cycle and to form the basis of Six Sigma, although many of the concepts are also adopted within a ‘Lean’ approach to effectiveness.

1943 – Taiichi Ohno joins Toyota Motor Corporation and later (1947 onwards) starts the development of what is now known as the ‘Toyota Production System’ (TPS) incorporating cellular working, waste reduction, reduction of Work in Process (WIP), in-process inspection by workers and many of the other concepts, including (in 2001) the ‘respect for people’ principle.

1983 – Robert Hall publishes *Zero Inventories*, which is seen as the first broad description of the Toyota Production System by an American author.

1990–1996 – Jim Womack & Dan Jones produce *The machine that changed the world* (1990) and *Lean Thinking* (1996), coining the term Lean and defining the five principles of Lean.

Appendix 3

UK Manufacturing

Highlights

The UK's largest manufacturing sub-sectors are as follows (percentage indicates portion of industry each sub-sector accounts for; larger percentage equates to a larger impact on the industry in its entirety):

1. Food, drink and tobacco (14.7%)
2. Textiles and clothing (2.6%)
 - 2a. Leather and leather products (0.3%)
3. Wood and wood products (1.8%)
4. Paper, printing and publishing (12.9%)
5. Coke, refined petroleum and nuclear fuels (1.7%)
6. Chemicals and man-made fibres (12%)
7. Rubber and plastic products (4.7%)
8. Non-metallic mineral products (3.4%)
9. Basic metals and metal products (11%)

10. Machinery and equipment (8.5%)
11. Electrical and optical equipment (11.1%)
12. Transport equipment (10.7%)
13. Other manufacturing (4.6%)

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The top 10 UK export markets by value are as follows:

1. Motor cars (£1,870m)
2. Oils (£1,665m)
3. Petroleum oils (£1,534m)
4. Medicines (£1,392m)
5. Engines and motors (£963m)
6. Aircraft (£845m)
7. Pearls, precious/semi-precious stones (£464m)
8. Tele-com equipment (£533m)
9. Measuring/analysing instruments (£512m)
10. Alcoholic beverages (£508m)