An eFast Teo White paper

“Measuring Lean benefits using Radio Frequency Identification (RFID) technology.”

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Introduction

Many manufacturing companies in Ireland are turning towards Lean Manufacturing to cut costs and increase sales. In implementing this philosophy, it is essential that Lean benefits are measured in order to benchmark savings. Conventionally time and method study approaches are used to measure day-to-day outputs. Although these studies are time consuming, they provide an accurate snapshot of line performance.

RFID is suggested as a means to speed up this measurement process. The application of the technology is widened into the process improvement field through its innovative implementation.

This application provides real time data for management and technical teams to continually improve their processes. It is best suited to multiple work step manufacturing processes.

This paper introduces the concept of Lean Manufacturing and benefits which result in its implementation. RFID is then introduced and its application to improve processes is described. Amalgamation of both these concepts is proposed in the concluding comments.

Lean Manufacturing

The term ‘Lean’ was originally coined by John Krafick, a research assistant at the Massachusetts Institute of Technology (MIT) with the International Motor Vehicle Programme in the late 1980’s (LEI, 2004). Lean Manufacturing, sometimes referred to as Lean Production, was brought to the western world by the dissemination of this research (Womack et al, 1990). It can be described the best practice application of Just In Time (JIT) manufacturing and the Toyota Production System, work systems that originate back as far as post-World War 2 Japan.

Womack and Jones (1996) later published ‘Lean Thinking’, describing concepts of converting a mass production firm into a Lean organisation. According to Womack and Jones (2003), Lean “provides a way to do more and more with less and less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customers exactly what they want” (p14). Taiichi Ohno, the founder of the Toyota Production System, describes Lean more succinctly: “All we are doing is looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value-added wastes” (Ohno, 1988;
In other words, it is an adaptation of mass production in which workers and work cells are made more flexible and efficient by adopting methods that reduces waste in all forms (Groover, 2001). It revolves around, firstly, the identification and removal of waste (described as ‘Muda’ in the Japanese system) and secondly the establishment of flow (using Just In Time Principles). Waste exists within 26% of manufacturing practices, so the opportunity to eliminate it through Lean implementation is there. (Tweedie, 2004).

Womack & Jones (2003) describes five steps to implement a Lean initiative:

1. Specify value in the eyes of the customer. Production activities are classified into value-added and non-value added activities, depending on their impact to the customer. I.e. the customer will not see (or care) about activities that have no effect on the end item. The implementing organisation should aim to eliminate these non-value or ‘wasteful’ activities.

2. Identify the value stream: once all non-value activities are removed, a value stream map is drawn up. This exercise is similar to a flow chart, but contains more information including inventory levels, lead-times, breakdown times and yield levels. This map helps organise all activities per product family into one sheet and generate overall metrics for the line.

3. Make value flow without interruption: activities are reorganised to allow the product or service to flow without interruption. In shop floor activities, this would mean aligning manufacturing activities as close together as possible. Batch sizes and inventory levels should be reduced, and problems associated with reduced inventories are eliminated.

4. Allow the customer to pull value: this step requires the organisation to become flexible and responsive to customers needs. The notion of ‘pulling’ value goes against traditional ‘pushing’ of product. Rather than the organisation building to forecasts, they are in a position to build for the customer as they demand it. The order starts with the customer rather than at the start of the line.

5. Pursue perfection / Kaizen: Kaizen is Japanese for continuous improvement (LEI, 2004). Once flow is in place, and all wastes are eliminated, the organisation should aim to continuously improve. This involves re-specifying value and drawing up a
new value stream map, continuously aiming to reduce waste and improving flow in the process.

Proper application of Lean can lead to the following positive improvements in the manufacturing environment:

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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Productivity</td>
<td>Increased between 10-100%</td>
</tr>
<tr>
<td>Throughput times</td>
<td>Decreased between 40-90%</td>
</tr>
<tr>
<td>Inventories</td>
<td>Decreased between 40-90%</td>
</tr>
<tr>
<td>Scrap</td>
<td>Reduced between 10-50%</td>
</tr>
<tr>
<td>Space savings</td>
<td>Between 30-60%</td>
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<tr>
<td>Overtime</td>
<td>Decreased up to 90%</td>
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<tr>
<td>Safety-related injuries</td>
<td>Decreased up to 50%</td>
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<tr>
<td>Product development time</td>
<td>Decreased up to 30%</td>
</tr>
</tbody>
</table>

**Table 1: Lean Savings (Sources: Liker, 1998; Berger, 2002)**

Although Lean offers savings described in the above table, authors are quick to point out that based on the last two decades of Lean application in companies, only a few cases have been truly successful with real changes (Bicheno, 2000).

A critical element in implementing Lean Manufacturing is being able to measure the area of improvement. Conventionally Time studies, Motion Time Measurement and Value Stream Mapping are common techniques used to benchmark line improvements, pre and post Lean (Currie, 1968; Womack et al., 2003). The innovative implementation of RFID may be a faster way to measure the area of improvement.
Lean and RFID

RFID is a generic term for technologies that use radio waves to automatically identify people or objects. This technology involves tags that emit radio signals; and devices called readers that pick up the signal. The RFID tag consists of a microchip which is attached to an antenna. This tag is also known as a transponder. There are various ways in which a RFID tag can be used, but the most frequent is to store a serial number that identifies the person or object on the microchip attached to the antenna. Additional information may also be stored on the microchip. The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can be read by computers. The figure below outlines the sequence of events which take place in order for RFID to work.

![Figure 1: How RFID works (Source: Dunlop, 2006)](image)

One very important factor to consider is that RFID does not require a line of sight between the devices. RFID tags can be read through packaging, shipping containers, and most materials. Exceptions would be conductive substances such as water and metal. Objects with these elements are modified so RFID tags are positioned to minimise interference. The transmission speed and range is determined by the frequency used, antenna size, power, and...
interference. Interrogators or readers can read between 10 and 800 tags per second, depending on the equipment and the environment. Even under poor conditions, RFID interrogators surpass a manual process in both speed and accuracy. If security is a concern, then the communication can be encrypted to protect the integrity of data between tag and reader.

Similarly to Lean, RFID can be traced as far back as World War 2 and the development of radar. RFID itself was first developed at the end of the 1940’s, but industrial applications did not appear until the 1970’s. At this point many different bodies were involved in the development of RFID. Large companies were developing RFID technology (e.g. Raytheon’s “Raytag” in 1973). Potential applications of RFID at that time were animal tracking, vehicle tracking and factory automation. The use of RFID grew considerably in the 1980’s, when the technology went mainstream.

For example, electronic toll collection became widespread in the United States in the 1990’s. The world’s first open highway electronic tolling system opened in Oklahoma in 1991. Vehicles could pass toll collection points at highway speeds, without the impediment of a toll plaza or barriers. The only measure was by video camera. Toll collection became a very popular RFID application in the 1990s, with various countries adopting this method.

Concurrently, new technological advancements were increasing the functionality of RFID. There was growing interest in the potential of the technology with regards to item management and coexistence with the bar-code. Whereas bar-coding provides adequate identification in many circumstances; RFID technology has many superior features. For instance, it can offer the Supply Chain better traceability, security and inventory management provided the business processes are geared to enable this technology to function optimally. As a means of auto-identification, RFID can be used to communicate seamlessly with components, products and assets in the supply chain. Whilst it may not be a replacement for bar-coding yet, RFID is likely to have a significant impact on how global supply chains operate. Particular areas of interest likely to be impacted would be inventory management, and logistics. For example, a company called Peerless, a heavy-haul trailer manufacturer, is utilising RFID to determine the pace of production needed to meet customer demand and identify delays (Bacheldor, 2007).

This technology is capable of networking physical objects without any human intervention. Originally RFID was a bulky expensive option, it has since progressed however, to a far less costly arrangement, with many more options for its implementation and deployment.
Normally RFID is used to track specific products travelling through the value chain. This paper explores the concept of using RFID in an innovative way to track flow. By tagging products and work stations, RFID would be a means to track bottlenecks and build-ups on the entire line. The next section describes an implementation approach to this “Lean RFID” system.

**Implementation approach**

The implementation of the Lean RFID solution is summarised with the following diagram:

![Implementation approach diagram](image)

**Figure 2: Implementation approach**

This approach consists of a number of elements.

Offline development would involve researching and developing a best-fit Lean RFID system. This includes assembling an implementation team, developing end-user specifications for the system, sourcing and purchasing necessary RFID technologies, and Pilot preparation.

The next logical step would be to troubleshoot the system. Before implementing the Pilot Project, all problems must be ironed out. Problems can include technology interfacing, sustaining project goals, etc. It is essential that these problems are addressed before Piloting, or production may potentially be affected.

Once ready, a Pilot Project would be implemented to demonstrate applicability in the company. RFID tags are attached to the product or containers holding the product from sub assembly stages. Each work step has sensors to pick up RFID signals. Appropriate barriers ensure the product is located at the correct work step. Information is sent back to a back-end programme.
Company-wide implementation follows successful piloting of the technology, once the Lean RFID system demonstrates measurable success. Measures may include return on investment, cost of time study programmes, or response time to line issues.

Post implementation, options for the company include developing the functionality of the system, integrating it into the company’s ERP systems or keeping it as a stand-alone system. As well as measurable outcomes, a Lean RFID system provides other benefits, discussed in the next section.

**Benefits**

Lean implementation can provide positive results outlined in Table 1. However, a Lean system amalgamated with RFID technology can also have a positive impact for the following reasons:

1. This is potentially a stand-alone application of RFID

2. Real time strategic measurable data is constantly coming from the line

3. Measuring a line utilising Lean RFID technology is quicker than carrying out line and time studies

4. Management and technical teams can plan work, and track changes and improvements in real time.

5. Problems and line interruptions are highlighted in real time.

6. One investment in the technology, as tags are potentially reusable.

7. It is a less complex system to implement than conventional RFID systems Each tag sends out the same information, so there is no need to reprogramme tags.

8. There is a potential to build on the system and include conventional RFID features. Examples could include the integration of asset tracking and security features.
Conclusions

The implementation of Lean through innovative application of Radio Frequency Identification is novel in its approach. This paper demonstrates the diverse applicability of RFID, for example, in process improvement. It must be stressed however that the application of RFID on the shop floor is only a small element of overall RFID implementation – appropriate attention must be directed to collaboration and integration, the aftercare and subsequent maintenance at all stages. Not every organisation is in a position to implement this technology. Lean manufacturing provides many benefits, including cost reduction and sales increases, but implementing it with RFID can truly lead to more innovative, responsive bottom line measurable improvements.
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Company Profile

eFast Teo. provides "on demand" Fixed Asset Management solutions which resolve Sarbanes Oxley (SOX) legislation issues.
Utilising ‘user-friendly’ software in conjunction with RFID technologies, our highly scalable and robust solutions, reduce Operational and Administration Costs by providing up-to-date monitoring information of Fixed Assets. They significantly improve Return-on-Investment (ROI), Asset Visibility and Utilisation for all stakeholders throughout the organisation and the Supply Chain.
For further information visit www.efast.ie.

Author Biographies

Gillian J. Dunlop is a RFID Consultant with eFast Teo. She is also a Business Logistics Consultant for other organisations. She graduated with a M.Sc. in Supply Chain Management (SCM) in 2006. Her thesis entitled “RFID and its potential application to the Medical Device Industry”, involved extensive research in the RFID area. She was awarded with a scholarship from DHL for this course in 2004, based on an assignment which addressed the role of SCM in Ireland’s economic development. Her industrial experience is predominantly in the area of medical device logistics with Boston Scientific Ireland Ltd and Abbott Ireland Vascular Devices.

Kevin Fitzgerald is a Researcher in Galway-Mayo Institute of Technology. He completed his M.Eng in the area of workplace innovation and Lean Six Sigma improvements. His industrial experience is in the area of implementation of Lean Manufacturing in the medical technology industry.