



**MASSEY UNIVERSITY  
ENGINEERING**

**Sustaining Lean Manufacturing in New Zealand  
Organisations**

**Prepared for**

**New Zealand Trade and Enterprise**

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## **Executive Summary**

New Zealand's manufacturing sector is facing increasing pressure to significantly improve their productivity. The government, through New Zealand Trade and Enterprise (NZTE), has taken steps to help manufacturers' boost productivity growth through a directed campaign to apply lean manufacturing. Several high-growth-potential companies were selected to participate in NZTE's *Aichi* lean program which ran from 2005 through to 2008. Several companies also joined NZTE's *Direct* lean program which kicked-off in 2007.

The training courses and support provided by NZTE was well received by the companies involved and they found the courses to be informative and educational. Companies were mostly satisfied with the level of support and involvement from NZTE. All companies were keen to see a continuation of NZTE financial and/or training support in some capacity however most organisations did not see the continuation of NZTE support as critical to embedding a lean culture. Most organisations felt that any NZTE assistance would relieve some financial stress of implementing lean during the economic downturn.

Overseas experience shows that a majority of organisations attempting lean transformations fail to sustain improvements in the long-term. This study looked at the experiences of a sample of organisations that participated in NZTE's lean program in sustaining their lean transformations. 11 organisations were assessed for lean sustainability using a recognised world class model for sustaining lean improvements. A cross examination of various lean sustainability and continuous improvement (CI) models showed that the Iceberg Model (Hines et al. 2008) was deemed as being the most suitable for studying the experiences of NZ companies in sustaining their lean transformations. The Iceberg Model claims that it is important for a company to address five elements (i.e. strategy and alignment, leadership, behaviour and engagement, technology, tools and techniques and process management) to ensure that it builds a sustainable lean culture.

This project utilised case study research techniques to extract qualitative data from each of the participating companies relating to the five elements for sustaining lean. On the whole the lean initiative had delivered some degree of gain for all organisations that had made an effort to improve their processes. These varied from behavioural changes to financial gains. The findings from this study support the Wilson et al. (2008) study in that organisations experienced good initial gains through the *Aichi* program. However when the companies were assessed against the five Iceberg Model elements results indicated that across the sample of manufacturing organisations investigated, the majority had solely focused on 'above the waterline' elements, i.e. technology, tools and techniques and process management. It is quite evident that the 'below the waterline' elements, i.e. strategy and alignment, leadership and behaviour and engagement, are not specifically targeted and thus pave the way for these organisations to ultimately lose momentum from their initial gains and slide back to their widening productivity gap with their competitors. Evidence from the case studies showed that this lack of focus on 'below the waterline' aspects does inhibit lean sustainability.

The study revealed that eight out of the eleven companies had either not sustained or looked highly unlikely to continue to sustain their lean transformations. Two organisations had gone into receivership during this study and their lean efforts could not be evaluated. The organisation that looked most likely to sustain lean had invested much time and resources into building their 'below the waterline' capabilities. Their most important accomplishment was strong management commitment and good leadership.

All organisations faced some level of difficulty in sustaining their lean efforts. Insufficient leadership was the single biggest problem facing these companies in sustaining improvement as only a small number of leaders are embracing lean and taking appropriate leadership measures to drive

improvements. The ability to formulate organisation-wide strategies was improving within NZ organisations but their ability to deploy these strategies was weak. The ability to implement common lean tools was a strong point for all organisations actively pursuing lean improvements. 5S was the most widespread tool across the organisations. Most organisations' had seen a change in the behaviour and engagement of people towards lean and many companies experienced an unprecedented number of improvement ideas from the shop floor. The application and understanding of process management principles was particularly weak amongst all the organisations studied.

In general organisations are struggling with the 'front-end' aspects of change such as establishing a strategy for change, understanding customer value and getting staff and management commitment to change. There was nothing new about the problems experienced by these organisations in sustaining lean. These problems were comparable and were also consistent with problems experienced overseas by manufacturers attempting to embed and sustain a lean culture.

Greater work needs to be done by NZTE and the companies implementing lean in ensuring the progress is delivered with a long-term strategy in mind. Companies need to put equal time and resources into developing their 'above the waterline' capabilities as well as their 'below the waterline' capabilities if they want to progress past quick-wins to embedding a culture of CI.

We recommend the following actions be taken to enable NZ manufacturing organisations to sustain lean improvements:

- Lean champions need to simultaneously focus on aspects such as strategy, culture and leadership, in conjunction with the tools and techniques of lean to sustain improvements.
- Develop stronger leadership capability within NZ organisations.

The authors strongly believe that ongoing learning is the key foundation stone for developing strong leadership and implementing a CI ethos. We recommend the following to help support ongoing learning in NZ:

i. Create a coordinated and facilitated strategy at all education levels to create an ethos for CI learning in the manufacturing sector.

In relation to education and research it is strongly recommended that current educators should form a Partnership whose aim is to significantly broaden the reach of CI curriculum and provide communication between Tertiary Educators, Industry Training Organisations and Private Training Establishments, as well as linkages to the other key stakeholders.

ii. Government support for industry education

We recommend that bodies, such as NZTE and the Tertiary Education Commission (TEC), look very closely at how they are encouraging industry and tertiary education organisations to align and support NZ's economic development. It is equally important that NZ businesses need to be active and engage with the Tertiary education sector.

iii. Provide focused research to support lean development in NZ

Further research needs to be conducted with the aim of finding solutions to issues such as strengthening organisational leadership in NZ.

## **Section 1: Background to the Study**

### **1.1 New Zealand's Manufacturing Sector**

The manufacturing sector is an important contributor to New Zealand's (NZ) economic productivity growth, a major export earner and a major employer. At the time of writing of this report, the sector comprises of approximately 21,000 companies from ANZSIC06 (section C, which divides into 15 subsectors, labelled C11-C25, including food products, textiles, polymers and rubber products, metal products, machinery and furniture). These organisations together employ around 227,250 people, and the sector contributes around 12% of gross domestic product (GDP) (Statistics NZ, 2011). Weak productivity growth rates of NZ manufacturers over recent years and the fact that in 2009 it was considered that NZ "*still ranks toward the bottom end of the OECD's productivity league*", have meant that "*raising productivity growth [...] remains the greatest medium term challenge*" (OECD 2010). Productivity growth is important because it underpins economic growth (O'Reilly, 2006).

Productivity rates are globally used as a measure of economic performance and standard of living. The Organisation for Economic Co-operation and Development (OECD) has frequently stated that NZ has poor productivity performance compared to other developed nations. NZ's lack of investment in physical capital and over-reliance on boosting production through longer hours and the use of relatively cheap labour means that their capital productivity lags behind many of the OECD countries (BusinessNZ, 2009).

The Government, through New Zealand Trade and Enterprise (NZTE), is using lean manufacturing (Womack et al. 1990) as a model to help manufacturing organisations improve productivity growth rates. Lean manufacturing is a relatively new concept in NZ, especially for Small and Medium Enterprises (SMEs). However the focus on lean has been increasing in recent years with NZTE being the main driver behind this increase. The major NZTE lean initiative to date has been the *Aichi* program. NZTE piloted the *Aichi* lean manufacturing program in 2004 to guide businesses through the lean manufacturing process. The ultimate aim of this project was to improve commercial, cultural and people-to-people links between Japan and NZ (Sutton, 2005). Selected high-growth-potential firms were sponsored through a lean implementation program for a period of 12 months. They were formed into cohorts or clusters to share experiences and learn from each other. NZTE initiated the *Aichi* lean program in four companies in 2005/2006, three companies in 2006/2007 and eight companies in 2007/2008. In addition to the *Aichi* program, NZTE has sponsored eight other firms in 2007/2008 on the lean journey through other programmes such as its Growth Services Fund and industry cluster initiatives. These firms have joined the lean program on their own initiative or through more indirect routes. The non*Aichi* companies are referred to as *Direct* members throughout this report.

### **1.2 Lean and Continuous Improvement**

The birth of the '*Toyota Production System (TPS)*' or '*Lean Manufacturing*' can be traced back to Toyota's desire to become a learning organisation. This desire to learn and the strong external pressure Toyota faced in surviving and growing as an organisation after the events of World War II led to the development of a disciplined process-focused production system now known as the TPS or lean. It is important to note that Toyota's focus on learning gave birth to lean and it wasn't lean that made Toyota a learning organisation. Lean manufacturing is a set of management principles and techniques geared towards eliminating waste in the manufacturing process and increasing the flow of activities that, from the customers' perspective, add value to the product (Womack and Jones, 1996). The essence of lean manufacturing is the elimination of waste wherever it exists within the firm and along the whole supply chain (Kippenberger, 1997). It is also important to state that lean is a never-

ending journey where continuous improvement through learning is embedded throughout the organisation. Womack and Jones (1996) succinctly describe this journey as striving for 'perfection'.

The adoption of lean manufacturing in NZ is in line with what has been happening globally. As organisations have struggled to remain profitable during periods of economic slowdown, many have embraced lean to improve competitiveness (Worley, 2006). Like many improvement programmes, lean implementations have not succeeded universally in their application with many different variables impacting the failure or success of a lean transformation. Sustaining the gains from lean transformations has become a challenge for many companies that have started the journey (Woods, 2008). Companies generally experience good initial gains to productivity, quality, staff morale, etc, but the majority fail to sustain these improvements in the long-term (Shin et al 1998). Emiliani (2005) states that while thousands of companies worldwide have been engaged in lean transformations for five to ten years or more, most achieve only modest levels of improvements.

It has been suggested that at least 50% of improvement programmes are deemed by firms to be failures over the longer term and up to 70% fail to achieve all of their intended benefits (Found, 2006). Venkateswarlu and Nilakant (2005) mention that 75% of American and British firms have introduced some form of improvement initiatives and two out of three of these programmes simply grind to a halt. Their study of five organisations attempting TQM in NZ since the early 1990's showed that only two out of the five organisations had persisted with their initiatives. Redman and Grieves (1999) and Shin et al. (1998) quote failure rates between 60-90% for TQM initiatives. Soltani et al. (2005) mention that only 20% of British companies surveyed believe their TQM program had achieved tangible results. Bhasin et al. (2006) state that only 10% of lean implementations are successful. A recent survey by the lean Enterprise Institute on 999 respondents reported that only 4% characterised their progress as 'advanced' while 46% characterised their lean implementation efforts as 'early'. The survey found that most companies have great difficulty implementing and sustaining lean principles and practices.

As lean is a never-ending journey aspiring to 'perfection' the importance of creating a lean culture shouldn't be underestimated, especially when faced with the difficulties described previously. This lean culture can be described as is a problem solving culture and is based on the concepts of continuous improvement and learning (Czabke et al. 2008). Many of the leading lean advocates and scholars (Emiliani 1998; Hines et al. 2008; Liker 2004; Womack and Jones 1996) insist that the true measure of lean sustainability is when an organisation has embedded a culture of CI. For the purpose of this study, lean is defined as a CI methodology and lean is sustained when an organisation has embedded a culture of CI focused on removing non-value adding operations.

Liker (2004) spent over 20 years studying Toyota and he states that there is no 'one way' to do any of the lean processes. He mentions that the one reality of the 'Toyota Way' is that there is always more than one way to achieve the desired result. After 30 years of studying Toyota and practicing lean, Koenigsaecker (2009) defines lean as 'whatever Toyota does'. Liker (2004) and Koenigsaecker (2009) agree that the important thing is to learn, to think about what you have learned and to apply it, and to reflect on the process and continuously improve to strengthen your organisation in the long-term i.e. embed a new organisational culture. In fact a company is never 'lean', since there is no end to CI and related learning (Koenigsaecker 2009). Toyota's culture can be summarized through the two pillars that support it: '*Continuous Improvement*' and '*Respect for People*' (Emiliani 1998a). CI, often called *Kaizen*, defines Toyota's basic approach to doing business. The CI principle embodies the tools and methods used to improve productivity. The '*Respect for People*' principle embodies leadership behaviours and business practices that must be consistent with efforts to eliminate waste and create value for end-use customers.

More important than the actual improvements that individuals contribute, the true value of CI is in creating an atmosphere of continuous learning and an environment that not only accepts, but embraces change (Liker 2004). Such an environment can only be created where there is respect for people. When Toyota talks about respect for people, the phrase encompasses many things, including designing a system that motivates people to want to improve, teaches them the tools of improvement, and encourages them to apply those tools every day. So at one level, all that Toyota does is simply continuous improvement through people. Hence lean can be regarded as a people-driven improvement system that can improve any work process with the ultimate goal of building a learning culture that solves customer problems forever (Koenigsaecker 2009). Many of the leading scholars of lean (Womack and Jones 1996; Emiliani 1998a; Hines and Taylor 2000; Liker 2004; Shingoprize 2008) state that it takes three to five years to embed a true lean culture.

### **1.3 Lean/Continuous Improvement Implementation Models**

Several lean implementation models have been developed by lean scholars and consultants to guide organisations through lean transformations. The five implementation models evaluated for this study were:

- The 20 Keys, Kobayashi (1995)
- The Lean Implementation Plan, Womack and Jones (1996)
- Going Lean, Hines and Taylor (2000)
- Toyota Production System House, Liker (2004)
- Shingo Prize Model, Shingoprize (2008)

Although the implementation approaches vary slightly from each other, the models have a common theme that clearly states that lean should be approached as a holistic organisation-wide methodology for embedding a culture of CI and not merely as a set of tools. The models advocate embedding a culture focused on identifying and meeting customer demands through CI. The importance of having an organisational change strategy and full commitment to change is also emphasised within the models.

There has been significant work done in the last five years in sustaining CI initiatives. Several models and frameworks have been developed to guide companies in achieving sustainability. Five of the key publications in the area of CI sustainability are discussed next and summarised chronologically in Table 1. Four of these models focus on lean manufacturing with the fifth focusing on process improvement initiatives. Process improvement activities have generally been conducted using process improvement techniques pioneered by Japanese automobile manufacturers, i.e. lean manufacturing (Found et al. 2006).

The models evaluated in this study:

- The 4P Model, Liker (2004)
- Lean Management System, Mann (2005)
- Theoretical Framework, Found et al. (2006)
- House of Sustainability, Hines et al. (2006)
- The Sustainable Lean Iceberg Model, Hines et al. (2008)

The models discussed in this section have been analysed in Table 1 to determine the commonalities and dissimilarities between them. A comparison of these models shows that there are numerous



commonalities between the models. Three (House of Sustainability, Theoretical Framework and Iceberg Model) of the five models have been developed by the same set of researchers. This is because the bulk of the current research in the area of lean sustainability has been undertaken by these researchers. The principles discussed in each model were grouped under the five categories of management, culture, tools and technologies, strategy and business process as shown in Table 1. These five categories appeared to be the common dimensions covered in the models. Breaking the models down into these five categories helped pinpoint the key themes within each model and made it easier to compare and contrast the commonalities and differences between them. The models were also listed chronologically to determine if there were any major changes occurring with time.

**Table 1. Analysis of the five CI sustainability models.**

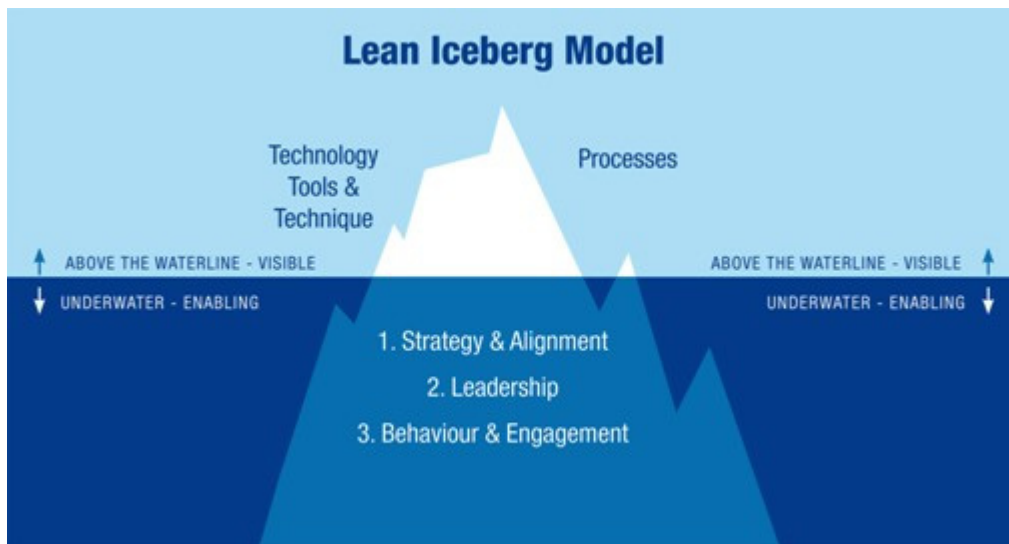
Categories	4P model (Liker, 2004)	Lean Management System (Mann, 2005)	House of Sustainability (Hines et al. 2006)	Theoretical Framework (Found et al. 2006)	Iceberg Model (Hines et al. 2008)
<b>Management</b>	People and Partners	Leader standard work	Leadership	Make choices regarding process, technology options Make choices regarding HR policies, employee structure, incentive schemes etc Embed Future Knowledge transfer and training	Leadership
<b>Strategy</b>	Philosophy	Daily accountability process	Strategy & Alignment	Recognize the need for change Understand the customer requirements and develop strategy for change Clearly communicate the need and strategy for change	Strategy & Alignment
<b>Culture</b>	Problem Solving People and Partners	Discipline	Behaviour	Monitor employee perceptions and understanding Understand current culture and employee behaviours	Behaviour and Engagement
<b>Business Processes</b>	Process	Visual controls	Processes	Understand current process capability and identify waste Develop a model of current organisational climate and capability Match to customer requirement Develop Future State	Process Management
<b>Tools &amp; Technologies</b>	Process		Technology	Remove the waste from in current system to create early wins and visible results that increases motivation and involvement	Technology, tools and techniques

Our analysis showed that the categories covered in the five models were quite similar however the depth of coverage within each of the categories was generally greater with later models. All models

cover management, strategy, culture and business processes. Besides Mann (2005) all models also discuss process improvement tools and technologies. Mann's (2005) lack of focus on improvement tools is the only gap between these models. Overall the five models proved to be quite similar in their recommendations and the gap that existed between them was considered minor and therefore not investigated further. A closer look at the sustainability models reveals that the scope of each of these five key themes has been expanded with each new model, with the Iceberg Model providing the most comprehensive guide to achieving sustainability. In addition, the Iceberg Model focuses exclusively on lean and is the latest body of work on sustaining lean. Based on its comprehensibility, exclusive focus on lean and its recent publication the Iceberg Model was deemed as being the most suitable for developing the framework to study the experiences of NZ companies in sustaining their lean manufacturing initiatives. The key recommendations of the Iceberg Model were used to measure the lean sustainability progress of several NZ organisations.

#### 1.4 The Iceberg Model – Five Key Themes

This section presents a summary of the five key themes from the Iceberg Model. Hines et al. (2008) have argued that applying lean is best explained by an analogy with an iceberg (Figure 1). They contend that it is generally not what you see 'above the waterline' (i.e. tools, technologies and techniques and process management) but what you do not see 'below the waterline' (i.e. strategy and alignment, leadership, and behaviour and engagement) that is more important to sustaining lean. A sustainable lean thinker needs to learn to see and act 'below the waterline' as well as above it. Establishing a sustainable lean organisation involves addressing the five elements at all levels of the organisation and not just on the shop floor (Hines et al. 2008). The model also advocates that a sustainable lean organisation has all employees fully engaged and immersed in the change initiative from the outset.



**Figure 1: The Lean Iceberg Model (Hines et al. 2008)**

In addition to the themes discussed in the Iceberg Model, this study analysed recently published work in the areas of leadership, behaviour and engagement, strategy and alignment, process management and tools, technologies and techniques. For example, in addition to lean leadership recommendations from the Iceberg Model, recent work in the area of good leadership was also investigated.

Recommendations on what companies should be doing in each of these five areas are presented below.

### 1.4.1 Leadership

Buckler (1996) states that success with embedding a CI culture will depend on management's ability to create a learning environment where individual, team, and thereby organisational learning is facilitated. The leaders need to have a clear and deep understanding of organisational culture and be engaged with capability requirements to change their organisational culture. Emiliani (2003) argues that it is essential that managers understand the learning process and know how to facilitate its application throughout their areas of responsibility to cope with and sustain change. Managers lacking common or standard approaches will likely invoke traditional methods, perhaps slightly improved, that are known to be capable of delivering quick results and thus avoid personal risk.

Emiliani (2003) states that conventional management practices perpetuate single-loop<sup>1</sup> learning whereas the beliefs, behaviours and competencies of leaders skilled in the lean management system lead to an organisation where people can engage in double-loop<sup>2</sup> learning to create an environment where change is the norm. Lean leaders strive to eliminate not only waste (*muda*) but also unevenness (*muri*) and unreasonableness (*mura*) in both leadership behaviours and business process (Emiliani 2003). Good leaders develop cross-functional teams that understand the vision and accept their roles in the implementation strategy (Emiliani 2003; Hines, Beale et al. 2006). Leaders must create an organisation that is moving together towards a common goal (Achanga et al. 2006). Hines et al. (2006) identify 5 levels of leadership, with the highest level leading to the most sustainable and effective business. 'Level 5' leaders channel their ego away from themselves and into the larger goal of building a great company. Good leaders usually have a deep knowledge of CI processes and will often go to the *Gemba*<sup>3</sup> and participate in *Kaizen* activities.

Good leaders are usually characterised as having a guiding vision, passion and integrity (Emiliani 2003). Leadership is about establishing direction, developing a vision of the future and setting strategies for making the changes needed to achieve that vision. When leading change they must have high energy levels, be innovative, focus on people, inspire trust, have a long range perspective and challenge the status-quo. The role of the leader is to inspire with words, deeds and actions which involves allowing everyone in the organisation to take part in the strategy, business process and encouraging everyone to get involved in delivering the actual change and reducing fire fighting and non-value adding work (Hines et al. 2006). Achanga et al. (2006) suggests that leaders need to create interest in the implementation and communicate the change to everyone within the organisation. They state that leaders must provide employees detailed information on the lean manufacturing

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1 Single –loop learning: This occurs when errors are detected and corrected and firms carry on with their present policies and goals. Single-loop learning can be equated to activities that add to the knowledge-base or firm-specific competences or routines without altering the fundamental nature of the organisation's activities.

2 Double-loop learning: This occurs when, in addition to detection and correction of errors, the organization is involved in the questioning and modification of existing norms, procedures, policies, and objectives. Double-loop learning involves changing the organization's knowledge-base or firm-specific competences or routines

<sup>3</sup> *Gemba* – the place where value is added

initiative and why it is needed. Leaders must provide employees with resources such as time and materials to allow the employees to successfully participate in the lean manufacturing effort.

A summary of the core principles of leadership as prescribed by the Iceberg Model is presented in Table 2. The summary has been extended to include some of the key recommendations of other recent work in this area.

**Table 2. Summary of sustainable leadership attributes prescribed by the Iceberg Model and recent work**

Key Theme: Leadership		
Key Lessons for Staying lean	Key Skills	Key Tools /Techniques
<ul style="list-style-type: none"> <li>▪ Strong decisive leadership with lean experience is needed in the early phase of the program</li> <li>▪ Leaders must be prepared to review themselves and the process critically in order to push the business forward</li> <li>▪ Continually develop lean leaders at all levels, on all shifts and within all areas of the business and adopt a 'leading the lean lifestyle' program</li> <li>▪ Leaders' role is to set the direction and develop a vision for the future and inspire and align people to achieve this vision through continuous improvements</li> <li>▪ Leaders are responsible for developing people by constantly moving them out of their comfort zones and stretching them a little</li> <li>▪ Leaders create dedicated and fully resourced lean implementation team that understands the vision and accepts their roles in the implementation of the strategy</li> <li>▪ Leaders must strive to eliminate waste in all business processes</li> </ul>	<ul style="list-style-type: none"> <li>▪ Good communicator</li> <li>▪ Has a long-term perspective</li> <li>▪ Respects employees</li> <li>▪ Inspires change</li> <li>▪ Trusting and trustworthy</li> <li>▪ Able to monitor and evaluate outcome</li> <li>▪ 'Flow' thinker</li> <li>▪ Creates a learning environment</li> </ul>	<ul style="list-style-type: none"> <li>▪ Lean leaders program</li> <li>▪ 'Level 5' leader</li> <li>▪ <i>Gemba</i></li> </ul>

#### 1.4.2 Strategy and Alignment

Emiliani (1998a) states that the early process-oriented mass production methods have resulted in

corporate cultures where eventually the voice of the customer and other stakeholders is no longer being heard. Cobb et al. (1998) advocates that change efforts need to focus on increasing alignment with customers and alignment of employees with the organisational strategy. The strategy fundamentals should provide consistency of purpose throughout the whole organisation and these fundamentals should serve as a corporate charter that gets all the units of the organisation going in the same direction and at the same speed (Sussland 2003). Hines et al. (2008) study revealed that many businesses fail to establish a coherent strategy, vision and purpose and that less than 5% of people were directly contributing to effective change.

The following recommendations are made by Hines et al. (2008):

- The strategy needs to describe what the organisational aim is and why this is important.
- The strategy should guide the employees to focus their change activity.
- All the people in the organisation need to clearly articulate what the organisational strategy is and be able to demonstrate what they are doing themselves in their normal job to help organisation achieve this strategy.
- The company's strategy should be fully communicated and deployed throughout the organisation.

The process of strategy deployment should be based on *hoshin kanri*, a methodology originally developed by the Japanese (Kondo 1998). Strategy deployment provides a systematic and detailed approach that deploys the strategies all the way down into specific action plans. The process of strategic deployment goes top-down (ownership of strategy is passed down through the managerial levels) and bottom-up (at each managerial level, the appointed owner of a strategy enlists the co-operation of his colleagues from other functions or units in order to carry out the strategies) (Susland 2003). In *hoshin kanri*, annual policies are decided after top management's policy proposals have been reviewed and revised by large numbers of middle managers. The discussion process that takes place before policy is finally decided is known as 'catch-ball', since the policy 'ball' is thrown back and forth between top and middle managers before a final decision is made (Kondo 1998). The aim of this process of 'catch-ball' is to convert mandatory objectives set by senior management into employees' own self-set targets. Kondo (1998) discovered that *hoshin kanri* proved extremely effective in furthering companywide improvement plans by uniting the efforts of all employees and motivating them.

A summary of the core principles of strategy and alignment as prescribed by the Iceberg Model is presented in Table 3. The summary has been extended to include some of the key recommendations of other recent work in this area.

**Table 3. Summary of sustainable strategy and alignment attributes prescribed by the Iceberg Model and recent work**

Key Theme: Strategy and alignment	
Key Lessons for Staying lean	Key Tools / Techniques
<ul style="list-style-type: none"> <li>▪ Take time to define clear and stretching critical success factors and build in a plan-do-check-act (PDCA) cycle to improve the deployment process</li> <li>▪ Use Visual Management Systems (e.g. A3s) at all levels of the organisation to deploy and sustain the management process. A3s become the focus of regular review meetings to monitor progress and take corrective action</li> <li>▪ Work to build up the capability of individuals and teams to self-manage the business cockpits at all levels</li> <li>▪ Deploy words and numbers to ensure full 'line of sight' is achieved, so that people know the business plans and their contribution to making them happen. All employees should be engaged from the outset</li> <li>▪ Use key performance indicators (KPIs) to monitor improvement performance. KPIs should be measured and monitored regularly</li> </ul>	<ul style="list-style-type: none"> <li>▪ Policy deployment (<i>Hoshin Kanri</i>)</li> <li>▪ Catchball</li> <li>▪ PDCA</li> <li>▪ Visual Management (A3 planning and storyboards)</li> <li>▪ KPIs</li> <li>▪ Rewards system</li> </ul>

### 1.4.3 Behaviour and Engagement

Emiliani (1998b) argues that success with lean manufacturing can be limited unless it is recognized that the behaviour of employees must change concurrently with changes in business processes. Emiliani (1998b) refers to the '*respect for people*' pillar as instilling lean behaviours in people. He states that lean behaviours together with lean manufacturing gives greater chance for long-term sustainability. Emiliani (1998b) goes on to state that the leaders of companies seeking to implement the lean production and lean behaviours solution must be mindful of the challenges that they are subscribing to because it requires dedicated unlearning of embedded mindsets and habits. Like lean manufacturing, it is a five to ten year challenge for a well-established organisation to develop even the most fundamental capabilities for sustained practice of lean behaviours.

One of the critical factors that may determine the success of a lean project is the organisational culture, as the creation of a supportive organisational culture is an essential platform for the implementation of lean manufacturing (Achanga et al. 2006). Bessant and Francis (1999) argue that the evolution of continuous improvement is an evolutionary learning process, with a gradual accumulation and integration of key behaviours over time. An important feature of any CI system is the feedback of some form of recognition to motivate the employee and to reinforce the behaviour that the organisation is trying to embed (Bessant and Francis 1999).

Dahlgaard and Dahlgaard-Park (2006) state that employees must be given both the freedom to plan and to decide, and the capability to take over this responsibility. To have success with lean manufacturing also requires a company culture where everybody is proactively working in reducing waste and in helping each partner. A lean organisation must have the ability to learn from its mistakes. The ability of an organisation to learn requires an ability to change how it thinks which requires a culture characterized by trust, shared responsibility, and openness to experimentation without fear of failure (Dahlgaard and Dahlgaard-Park 2006).

Kaplan and Richards (1996) advocate that one solution to changing organisational culture is early employee participation in the change process. Employee empowerment, by providing workers with opportunities to influence decisions, promotes worker motivation and reduces worker resistance toward organisational changes. They discovered that early training provided an opportunity to empower and motivate employees and also provides an opportunity to demonstrate management's commitment to empowerment and establish early worker buy-in to the change, thereby reducing employee resistance and increasing the chances of program success. Emiliani (1998b) states that the concept of lean behaviours is analogous to lean production. Lean behaviours are defined simply as behaviours that add or create value. In contrast, behaviours that inhibit workflow are analogous to wasteful batch and queue mass production methods. These behaviours are termed 'fat' behaviours, and are defined as behaviours that add no value and can be eliminated. Once lean behaviours are deeply understood, they must be practiced diligently under all conditions until they become sustaining behaviours that replace old habits.

A summary of the core principles of behaviour and engagement as prescribed by the Iceberg Model is presented in Table 4. The summary has been extended to include some of the key recommendations of other recent work in this area.

**Table 4. Summary of sustainable behaviour and engagement attributes prescribed by the Iceberg Model and recent work**

Key Theme: Behaviour and engagement	
Key Lessons for Staying lean	Key Tools / Techniques
<ul style="list-style-type: none"> <li>▪ To inject pace into the program take experienced, motivated and multi-disciplined people to form an internal lean team</li> <li>▪ Encourage sharing and learning throughout the program, take every opportunity to get people together to discuss continuous improvements. Encourage teamwork</li> <li>▪ lean organisations need lean people who are both competent and capable of pushing themselves and their teams out of the comfort zone and into the stretch zone</li> <li>▪ Training, support and good communication with all employees encourage them to join lean and create lean behaviours. Open, democratic and honest work environment lead to engaged employees and environment where they can excel. Behaviour change and communication are key to engagement</li> <li>▪ Create a 'lean Culture' of waste elimination &amp; continuous improvement. Encourage 'lean Behaviour' of adding or creating value</li> <li>▪ lean organisations have emotionally engaged employees who can envisage link between them and their customers. lean employees challenge the status quo</li> <li>▪ 'Roadblocks' should be negotiated early and motivated employees are encouraged. Use appropriate and satisfactory rewards to keep employees motivated</li> </ul>	<ul style="list-style-type: none"> <li>▪ 7 lean skills</li> <li>▪ Team cultures</li> <li>▪ lean coaches</li> <li>▪ Continuous improvement</li> <li>▪ <i>Kanban</i></li> <li>▪ Problem Solving</li> <li>▪ Catchball</li> <li>▪ Rewards system</li> </ul>

#### 1.4.4 Process Management

Implementing the principles of lean thinking in an organisation, or an extended enterprise, inevitably means changing one or more business processes and adopting new ways of doing business including the use of new tools and techniques. Two things are important when looking at business processes. First, is identifying which processes are key to ensuring that a business can successfully operate its core business; and second, how to design and optimise the key processes in order to deliver value to the customer, business or value stream (Hines et al. 2006).

Value stream mapping (VSM) is a tool designed to improve the business processes. VSMs are one-page diagrams depicting the process used to make a product. VSMs identify ways to get material and information to flow without interruption, improve productivity and competitiveness, and help organisations implement systems rather than isolated process improvements (Emiliani and Stec 2004). VSMs help organisations see waste that exists in business processes. Eliminating waste focuses employee efforts on the value creating activities that customers desire and are willing to pay for. VSMs should be created by cross-functional teams of people who are directly involved in the process under consideration.

A summary of the core principles of business processes as prescribed by the Iceberg Model is presented in Table 5. The summary has been extended to include some of the key recommendations of other recent work in this area.

**Table 5. Summary of sustainable business process attributes prescribed by the Iceberg Model and recent work**

Key Theme: Processes	
Key Lessons for Staying lean	Key Tools / Techniques
<ul style="list-style-type: none"> <li>▪ The application of value stream mapping tools needs to focus on longer-term management, not just mapping</li> <li>▪ Use mapping tools to identify disruption in flow (waste). <i>Gemba</i> used to develop maps. Mapping determines the baseline so improvements can be measured and monitored. This helps sustain the effort and encourages people to improve continuously</li> <li>▪ Use a combination of 'Pillar' and 'Platform' approach to improve processes; possibly starting with pillars for demonstration of improvement benefits and platforms to roll-out improvements across company</li> <li>▪ Senior management need to select strategic key value streams that need sustained improvement focus by addressing pillars and platforms</li> <li>▪ Continuously apply customer value analysis to inform and improve all other key business processes. All employees need to understand the 'Voice of Customer' (VOC) before attempting waste reduction</li> <li>▪ lean organisations have leadership structures based on the value stream requirements</li> </ul>	<ul style="list-style-type: none"> <li>▪ Mapping tools</li> <li>▪ Pull systems</li> <li>▪ 'Voice of Customer' insight tool</li> <li>▪ Pillar/Platform approach</li> <li>▪ Flow</li> </ul>

#### 1.4.5 Tools, Technologies and Techniques

To gain motivation and commitment to the change, early involvement in activities such as 5S to remove the waste in the current system and transferring knowledge and skills through training can be effective (Found et al. 2006). Liker (2004) states that starting with a project or two to generate some enthusiasm is the right thing to do. The application of continuous improvement tools in manufacturing is most effective when they are used concurrently (Emiliani 1998a). The tools and concepts are most productive when daily activities and simple teachings are coupled, and can result in significant improvements to corporate culture and financial performance. However, tools used separately from one another lose their synergistic quality, and can greatly limit efforts to become a lean manufacturer.

Sustainable change is achieved by aligning the appropriate technology with strategy and process and then training employees so that they have the correct technical skills to maintain various systems (Found et al. 2006). Misaligned or inappropriate technology leads to inefficiencies in the system and can result in expensive failures. Having technology without the skills to operate and maintain it leads to sub-optimal performance. It is only by taking a holistic approach, that includes consideration of the most appropriate and applicable technology, that long-term sustainable change is realisable (Hines et al. 2006).

A summary of the core principles of sustaining tools, technologies and techniques as prescribed by the Iceberg Model is presented in Table 6. The summary has been extended to include some of the key recommendations other recent work in this area.



**Table 6. Summary of sustainable tools, technologies and techniques prescribed by the Iceberg Model and recent work**

Key Theme: Technology, tools and techniques	
Key Lessons for Staying lean	Key Tools / Techniques
<ul style="list-style-type: none"> <li>▪ Tool selection should be driven by the needs of the customer, the business and the people within the business; they should be pulled, not pushed. Tools need to be part of policy deployment process. Employees need to understand why they are using it and how it will help</li> <li>▪ Early application of the basic tool and techniques needs an emphasis on self-sustaining systems of management</li> <li>▪ Use appropriate 'bundles' and 'combinations' of lean tools &amp; techniques to achieve the specific value stream goals and bottom-line improvements</li> <li>▪ Use simple and proven technologies to better manage and make the bridge between customer and supplier demand profiles</li> <li>▪ Have visible and up-to-date information at the point of operation. Visualize problems and use the plan-do-check-act (PDCA) method in improvement projects. Monitor all improvement projects with KPIs</li> </ul>	<ul style="list-style-type: none"> <li>▪ Mapping tools</li> <li>▪ Pull systems</li> <li>▪ VOC insight tool</li> <li>▪ Pillar/Platform approach</li> <li>▪ Flow</li> </ul>

### 1.5 The aim of this Study

As lean is gaining momentum amongst NZ manufacturers it is imperative that Government, manufacturers, consultants and educators have a clear understanding of what causes companies not to sustain improvements and that the approach NZTE is taking to support lean uptake is ensuring sustained improvements. Research by Wilson et al. (2008) represents the only previous major research conducted on lean in NZ. They looked at how NZTE can transform their current lean strategy into a national strategy for lifting productivity in NZ. Their study focused on assessing how effectively NZTE administered lean to the manufacturing sector with the aim of advising NZTE on how to successfully support enterprises through change initiatives such as lean. Essentially their study specifically focused on engagement, initial results, etc. This report complements the Wilson et al. (2008) work by providing a deeper insight into how NZ organisations can sustain these initial gains and improvements. This study evaluates the potential of companies already engaged in lean to sustain their improvements and provides recommendations for companies that wish to sustain lean. In order to do this the research team undertook extensive interviews with the participating organisations with questions based on the Iceberg Model recommendations.

## **Section 2: Study Methodology**

### **2.1 Study Sample**

This study was conducted using a sample of New Zealand based manufacturing organisations who had taken part in a NZTE lean initiative, funded either through the *Aichi program* or the *Direct program*. The Aichi program began in 2004 and ended in 2008 with 15 companies having participated. NZTE also sponsored 8 other firms in since 2007 on their lean journeys through their *Direct* program. The resulting combined sample of 23 manufacturers was divided into different clusters based on the year each organisation initiated lean and the approach they undertook to implement lean. All organisations were supported by an NZTE nominated consultant for 12 months. NZTE employed two different approaches to initiate lean with the lean clusters. The *Aichi* cluster used the 20 Keys approach and the *Direct* cluster used lean consultants, who may not have used the 20 Keys approach.

The two key factors for this study were the timeline and the lean approach. This study tested the theory that a lean culture takes a few years to embed by looking at various implementation timelines. The leading advocates of lean (Kobayashi 1995; Hines and Taylor 2000; Liker 2004; Found et al. 2006) suggest that successful lean transformations take about three to five years. The impact of time on lean sustainability was investigated by selecting companies with different lean implementation timelines. The impact of the approach on lean sustainability was studied by selecting cases from both the *Aichi* and *Direct* clusters. Of the 22 companies sponsored by NZTE, 11 companies were selected to fulfil the requirements of this study. Out of the 11 companies selected only 9 were able to participate fully in this study. Due to severe financial difficulties two companies had ceased operations during the data collection phase and were not able to fully participate. One was an *Aichi 2* member and the other was a *Direct* member that initiated lean in 2007. The final sample contained six organisations from the '20 Keys' approach and three from the 'Consultant' approach. The sample also contained a good spread of organisations across the various timelines as shown in Table 7.

No. Of Case Studies	NZTE Classification	Year of Implementation (Timeline)	Approach
3	<i>Aichi 1</i>	2005	20 Keys
1	<i>Aichi 2</i>	2006	20 Keys
2	<i>Aichi 3</i>	2007	20 Keys
1	<i>Direct</i>	2007	Consultant
2	<i>Direct</i>	2008	Consultant

**Table 7: Number of case studies and implementation approach**

The resulting sample of manufacturers who have implemented lean can be considered a representative subgroup of the population of NZ manufacturing organisations in terms of demographic profile and specialism's, and so the results of this study can be generalised as representing NZ manufacturers with an acceptable degree of validity.

## **2.2 Measuring Organisational Lean Sustainability**

Case study research techniques were used to extract qualitative data from nine manufacturing companies. Interviews and site tours were carried out within each organisation to evaluate the level of lean sustainability. The organisational lean sustainability was measured using the Iceberg Model (Figure 1). The Iceberg Model offers a set of criteria for attaining lean sustainability and hence the case study protocol, including the interview questions, was designed to measure conformity to these key criteria. Using the Iceberg Model meant that we were testing against the proposition that a company is sustainable if they are competent in leadership, behaviour and engagement, strategy and alignment, business processes and tools, and technologies and techniques. Using the iceberg criteria, which has been subject to international peer review, also gave a measure of reliability to the data collection approach and case study protocol.

## **2.3 Pilot Study**

The case research protocol was piloted at two organisations. Both organisations were attempting lean transformations independently and were in different stages of implementation. Undertaking pilot interviews meant that the questions were tried and tested and the researcher knew what to expect, in order to enhance validity of the protocol. The pilot organisations had no involvement with the NZTE lean program or any other lean cluster. One was a large NZ organisation, whilst the other was a SME. The interviews at the large organisation were arranged by one of the project supervisors through personal contacts and the interview at the SME was organised by the researcher who knew the informant through prior employment. The pilot studies resulted in minor changes to the questionnaire and interview protocols, and ensured that the researcher's interviewing approach was consistent and reliable.

## **2.4 Key Informant Interviews**

Following the pilot data collection, two key informants were interviewed from each participating organisation. One informant was from the senior-management level and one was from the middle-management level. The prerequisite for key informant selection was some level of direct involvement in implementing lean so that the informant could give a better insight into the organisation's lean journey. The senior level roles covered operations manager, manufacturing manager, CEO, etc. The middle-management roles were mostly department team-leaders or production supervisors. Staff from two different levels was used to investigate if the CI culture is embedded throughout different levels of the organisation. Interviewing middle-management allowed us to test how far lean aspects have infiltrated down the organisation, giving a good idea of sustainability.

## **2.5 Data Collection**

Data collection began in December 2008 and was completed in March 2009 with each site visit lasting two to three hours. Most but not all data was collected through interviews. To augment the on-site interviews observational tours of the manufacturing facility were carried out. The observations were used for verification and clarification of interview responses, as well as providing the interviewer with a feel for the overall work environment and systems. The site tour was also used to observe visual displays of lean strategies, process improvements, standard operating procedures (SOPs), etc. The informants generally had only an hour available for the interviews. An hour mostly proved sufficient to explore the constructs under investigation. The site tours lasted on average no more than 30 minutes and all the organisations were eager to demonstrate their change efforts.

## **Section 3: Case Study Results**

### **3.1 Manufacturers' Experiences in Sustaining their Lean Programs**

Overall the lean concept has been positively received in NZ although the word lean created some initial resistance on the shop floor due to it being linked to redundancies. This resistance in some cases led to employees choosing to leave the company, but in most cases once an organisation had done some training and had implemented changes, the resistance had decreased. It is very important for leaders of companies and consultants to demonstrate improvements early on to get buy-in from the staff. The ownership from the shop floor was generally high after six months of implementation.

Some companies had seen good productivity gains while others had seen a change in staff attitude as their biggest gain. In general most companies experienced a drop in improvement momentum after the first year. This coincided with the departure of the consultant. The organisations no longer had a resource to continually drive the initiative and their internal capabilities were not at a level where they could self-manage the change process. Nonetheless, companies that had attempted improvements had progressed from their initial state.

This study revealed that when compared with the Iceberg Model sustainability markers; eight out of the eleven companies had either not sustained or looked unlikely to continue to sustain their lean transformations. Evidence shows that none of the organisations that had implemented the 20 Keys program had sustained lean and only Company C, which had taken the *Direct* approach, looked likely to sustain lean. However, the two other organisations that had undertaken the *Direct* approach did not seem likely to sustain lean. There was insufficient evidence to suggest that one approach was markedly better or worse than the other for sustaining lean.

Company C, who were the only company who looked likely to sustain lean, were barely 12 months into their lean implementation. Other organisations that had been attempting lean for much longer periods had either not sustained or looked unlikely to continue to sustain lean. This study showed that a longer period of implementation did not necessarily lead to lean sustainability. Building a culture does take time but this varies between organisations and time cannot necessarily be used as a measure of CI sustainability. In addition, a company's size had no marked impact on their ability to sustain lean.

### **3.2 NZTE Involvement**

To give a company the impetus to sustain rather than to just try out lean, it is imperative that there are strong drivers initially to get the commitment needed to take on the long lean path. Usually companies' spring board their lean energy from a situation of crisis (Womack and Jones, 1996). Most Senior Management Teams (SMT) failed to identify strong external 'pull' or internal 'push' factors to drive change. The subsidy provided by NZTE was the main driver to undertake lean for several organisations. This supports the findings of Wilson et al (2008) who state that for the firms supported by NZTE, the co-funding played a critical role in their decision to adopt lean. The NZTE funds served as a low-risk investment and the organisations relied on the consultant to provide the impetus for change. Once the funding had dried up and the consultant departed, many of improvement initiatives were put on the '*back-burner*'. It is likely that many of the organisations would not have undertaken lean if it was not funded.

The training and support provided by NZTE was positively received by all firms participating in the lean programs and many of the companies were still hoping for future NZTE funding to deliver further improvements. The introductory lean courses were highly beneficial, as was NZTE's efforts to create lean clusters amongst the manufacturers. All firms were satisfied with the consultant's training

methods and approach and they all reported learning new ideas and theories from the consultant. The common problem reported by all the job-shop organisations was that the consultant struggled with implementing the 20 Keys into the job-shop environment. These firms noticed that their lean progress was much slower than the batch manufacturing organisations. In all four cases the 20 Keys had been adapted or modified to suit the job-shop environment.

### **3.3 How the Organisations' Measured Against the Iceberg Model**

Evidence from the companies studied supports Hines et al. (2008) findings, in relation to the Iceberg Model, that companies primarily focus 'above the waterline' on tools and processes and place little emphasis on 'below the waterline' aspects of lean. Evidence from the case studies showed that this lack of focus on 'below the waterline' aspects of lean does inhibit lean sustainability. The study has raised some common issues experienced by the organisations in sustaining their lean transformations.

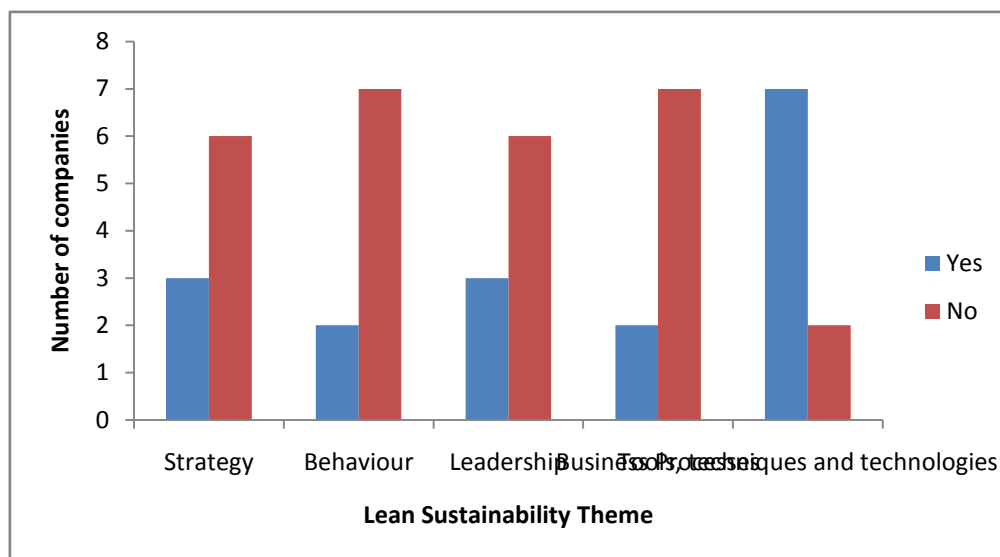
The majority of the participating companies had implemented the 20 Keys methodology. Our study found that this approach delivered varying levels of gains and the bulk of the companies focused on Key one which is cleaning and organising with the consultant, and most of them remained stuck on Key one. It seems that the majority of organisations failed to implement the 20 Keys methodology as prescribed by its author. The author of the 20 Keys suggest a radical approach of implementing all 20 Keys if a lean culture is to be imbedded within 2-3 years, i.e. focusing on 7 Keys per year driven by 'below the waterline' aspects of lean.

The *Aichi 1* members were all at different stages of embedding a culture change. All three companies had suffered significant down turns from the economic slowdown and two companies had lost a lot of lean experienced staff. Losing lean knowledge did have a negative impact on lean progress. One organisation had completely stopped the 20 Keys project due to a resource constraint. The two *Aichi 1* member companies that were continuing with their lean projects had come to the realisation that the 'above the water line' aspects of lean would not continue to deliver improvements unless they put greater focus on 'below the waterline' aspects of lean. These companies had made changes with their strategy and alignment of people to the strategy in order to make their improvement changes stick

Table 9 summarises the results from the case study companies when evaluated against the key themes of the sustainability model. As the research protocol was based on the Iceberg Model, which enabled open-ended questions to be asked relating to the Model, it was possible to evaluate the adherence of the companies to the five key elements of the sustainability Model. It outlines whether strengths and progress was demonstrated in relation to the five key themes outlined as critical for sustaining lean. Figure 2 shows the individual company competencies in each of the five key themes outlined in the sustainability model.

**Table 9. Summary of the case study companies demonstrating competence across the key themes of the sustainability model**

	Strategy	Behaviour	Leadership	Business Processes	Tools, techniques & technologies
Company A	No	No	No	No	Yes
Company B	No	No	No	No	No
Company C	Yes	Yes	Yes	Yes	Yes
Company D	No	Yes	No	Yes	Yes
Company E	No	No	No	No	No
Company F	No	No	Yes	No	Yes
Company G	Yes	No	No	No	Yes
Company H	Yes	No	Yes	No	Yes
Company I	No	No	No	No	Yes

**Figure 2. Numbers of companies showing competency across the five key themes of the sustainability model**

Whilst this evaluation is quite general the following sections highlight specific findings relating to Hines et al. (2008) five themes discussed in the Iceberg Model.

### 3.3.1 Leadership

A few organisations are showing positive signs as their leaders are embracing lean and taking appropriate leadership measures to drive change. Company C was making the strongest progress towards sustaining lean and this was driven by a motivated CEO who was committed to changing the organisation culture. He was driving lean daily on the *Gemba* and the organisation was taking big

strides towards embedding a CI culture. The Operations Manager (OM) of Company F was also committed to lean had a good understanding of the lean methodology *“lean is about culture change, waste elimination and adding value”*.

However, several of the lean leaders do not fully exhibit the leadership traits that are expected to sustain a lean program. In our view, leadership emerged as the single biggest problem facing these companies in sustaining improvements. The leadership problem generally resulted from a lack of lean understanding and implementation experience amongst the SMT. Company A for example was committed to culture change but lacked the knowledge and experience to implement and sustain lean changes. They formed lean teams to take ownership of different projects but these teams did not have the skills to make meaningful changes. The consultant was driving changes and once he left the momentum stalled. The shop floor was struggling to sustain the basics of 5S. The 20 Keys program had achieved very little for Company E as the consultant was sole driver of the improvements and he was on the *Gemba* only once a month. The shop floor staff did not have the skills to lead the lean initiative in his absence. This organisation lacked lean leadership from the start and this meant that they had achieved little to nothing in terms of improvements.

Several companies experienced a lack of SMT commitment to change with many of the SMT not participating directly in the improvement activities. For example, at Company I the perception on the shop floor was that the SMT were not committed to lean. The team leader felt that *“the management at the top had backed-off on implementing lean hence staff lost motivation for lean”*. The SMT failure to actively drive improvements had greatly inhibited the progress of the lean initiative and their ability to get full staff buy-in.

The key issues to result from a lack of leadership were inadequate implementation processes, associating lean with job losses and lack of employee engagement. The lean implementation process is usually led by a champion and supported by a team. The majority of companies did appoint an internal lean champion to oversee the initiative but they either did not engage the consultant to develop the champion's capabilities to lead the changes into the future or the training did not satisfactorily prepare the champion with the skills that she/he needed to lead the changes. Most organisations relied heavily on the consultant to drive shop floor changes. The consultants had generally done a good job with lean but their time had been invested in delivering quick-wins rather than long-term internal capability development to continue to drive the lean momentum forward. One manager stated that *“we had the consultant driving lean all the time last year. This year it has stagnated as I haven't had time to be able to push it along”*.

Whilst we agree with Wilson et al. (2008) that consultants are a good method to springboard a lean transformation, it is crucial that the consultant's lean knowledge and skills are transferred to the organisation; so that once the consultant leaves, the company has the capability to sustain their lean transformation. However, it is quite clear that organisations either did not engage the consultant to develop the champion's capabilities to lead the changes into the future, or the training did not satisfactorily prepare the champion with the skills that she/he needed to sustain the lean transformation. One of the managers mentioned that *“our biggest inhibitor with [sustaining] lean is the lack of knowledge or expertise internally”*

Womack and Jones (1996) have made it clear that if employees associate lean with job losses then it's impossible to make and sustain superior performance. Several of the companies had high staff turnover rates from redundancies due to the economic downturn and one organisation clearly used lean as a way to reduce labour costs. The team leader for this organisation stated that *“at the moment the word lean means less staff, more work for those left”*. The redundancies from downsizing led to resistance to change from the shop floor as staff feared further job losses. There was little evidence of

managing the linkage between lean and redundancies. This could be linked to a lack of lean strategy. Experts say if you foresee an excess in human capacity you need to address this issue before implementing lean so that staff do not associate lean with redundancies. The high staff turnover rates also led to a loss of lean knowledge within several of the companies studied.

Many of the organisations faced strong resistance from the staff at the start of the lean initiative. This does not concur with the findings of Wilson et al. (2008) who mention that the initial fears of major staff resistance within the NZTE sponsored organisations were not realised during the implementation. It is likely that the differences in findings between the two studies is a result of Wilson et al. (2008) having a single key informant from the senior management level as opposed to this study where two key informants from two levels (SMT and middle-management) were used to gain a more comprehensive understanding of each firm's lean experience. A team leader mentioned *"that their "biggest inhibitor [to implementing lean] was that people were negative towards it. [Staff were] not wanting to buy-into it and resisting change"*

Initially there were several sources to staff resistance within the companies. Redundancies, remuneration issues, a lack of SMT commitment, insufficient lean understanding and lean implementation skills were some of the major issues behind staff resisting change. The insufficient lean understanding on the shop floor meant that staff viewed lean as more work and as just another management fad which served as further sources of resistance. However, this study did show that staff resistance had declined gradually through the years in many of the companies as staff began understanding the benefits of the improvements they were making.

### **3.3.2 Strategy and Alignment**

All companies had a 'higher-level' strategy and their SMT generally understood the importance of having these company-wide goals. Some companies had dedicated much time in developing their strategies and had clearly defined short, medium and long-term goals. Company C for example had clear strategies and they had successfully deployed these to engage staff. The SMT were using the PDCA cycle to review changes and were using visual management for feedback and tracking. However most organisational strategies were mere 'words' of little consequence. Company F for example had a 'higher-level' strategy but no implementation action plan to achieve their goals. The organisations that did have clear visions, goals and/or action plans let themselves down through or no deployment. This was clearly highlighted by many of the team leaders not being aware of their organisation's strategy and goals, a team leader responded with *"probably, I am not aware of it"* when asked to if he was aware of his companies strategies and goals during one interview.

Organisations were weak in this area as the consultant seems to have had spent little time in developing organisational strategising skills. Companies did not understand the basics of policy deployment or how to utilise tools such PDCA, A3 management or visual management to achieve staff engagement. One organisation for example, wanted to become a 'World Class Manufacturer' but they did not have an action plan to implement the pillars that would lead them to becoming a 'World Class Manufacturing' organisation. The majority of the organisations were in the same situation.

### **3.3.3 Tools, Technologies and Techniques**

Organisations actively pursuing lean improvements showed the highest level of competency in implementing tools, technologies and techniques. 5S was the most widespread tool across these organisations. In some instances lean was seen simply as 5S and one team leader stated that *"lean means clean to me"*. Organisations' used 5S to demonstrate quick-wins to encourage staff buy-in, to improve the flow of the factories and to simply lay a solid foundation before attempting bigger and



more complex projects. All organisations that had implemented the basic tools of lean had reported some level of improvement on the shop floor, with a clean and tidy factory leading to improved staff morale being reported as the most common improvement. Company H for example have successfully implemented common lean tools such as OEE, 5S and process mapping across their site. Although these tools were applied in isolation to their strategy and the VOC, they had seen good gains.

All but one organisation had common tools pushed onto the shop-floor and not pulled as part of a strategy or value stream map as advocated by the Iceberg Model. Company C had 'pulled' several lean tools and techniques as part of their strategy. Flow improvements were in place and they had successfully used the pillar and platform approach. They had used the basic lean tools on building self-sustaining systems of management and were making good use of visual management systems.

### 3.3.4 Behaviour and Engagement

Organisations that had attempted lean improvements had seen a change in the attitude of people towards lean and many companies experienced an unprecedented number of improvement ideas from the shop floor. Although the majority of the shop floor staff saw the benefits of lean, there was a general lack of understanding of lean in most organisations. For example the SMT of Company F felt that their current improvement ideas were worthless due the lack of lean understanding and they were using the consultant to improve the level of understanding on the shop floor so that they could embed lean behaviours.

Wilson et al. (2008) state that the resident level of knowledge and experience of lean in NZ is minimal to non-existent at both managerial and operational levels. Evidence from this study not only supports their findings but also shows that the understanding of lean within the NZ manufacturing sector is largely limited to tools alone, with small consideration of sustaining continuous improvement in line with a strategy and a supportive culture. To sustain lean it is essential that a continuous improvement culture is created and nurtured throughout the organisation. This culture has also been coined 'living the lean lifestyle' by Hines et al. (2008) where improvement becomes part of everyone's job, without even thinking consciously about it. This study has shown that for the majority of the companies studied the lean lifestyle is non-existent. Production took precedence and lean improvements were generally attempted during slack-time. A production supervisor mentioned that *"when production pressures were high, management forgot about lean"*.

The understanding of the principles and philosophies of lean was a major problem faced by many of the case study organisations. This study showed that this lack of understanding pervades throughout an organisation; both at the SMT and team leader levels. One team leader mentioned that the *"hardest thing to do when you are not busy is finding work for the guys; lean is a useful tool in that respect"*. Evidence suggests that lean was commonly implemented as a package of tools and this resulted in the mere attachment of popular tools onto the existing organisational procedures and culture. Iwao Kobayashi (the creator the 20 Keys program) states that the implementation of the 20 Keys needs to be part of a wider improvement philosophy and there needs to be a readiness, strategy and alignment with customer demand and all these aspects need to occur in a synergistic approach to sustain CI (Kobayashi, 1995).

Every organisation had managed to eliminate their major roadblocks and reduce the resistance to change. Although many of the leaders claimed that staff were engaged with lean, the shop floor could not see the link between them and the customers. Some organisations encouraged problem solving through the opportunities for improvement system and the company that had made the most progress had the highest number of improvement ideas from the shop floor. Some organisations saw the merit in investing in ongoing training and development of staff whilst others felt that the 12

month NZTE training was a sufficient foundation for culture change. The use of reward systems was not common amongst the organisations.

### **3.3.5 Process Management**

The application and understanding of process management principles was particularly weak amongst all the organisations studied. Staff were not fully aligned with their customer demands and could not see the real value adding versus non value adding steps. All companies were utilising basic process mapping tools to improve flow and identify waste but none of the organisations had actually done full value stream mapping. None had undertaken any VOC studies or surveys to understand what their actual customer demands were and what processes were value adding and non-value adding. Staff were not engaged with their customers and neither were the SMT. Mapping was not part of any long-term management plans or organisation strategy. The leadership structures were not based on the value stream requirements as advocated by the Iceberg Model. Several organisations chose to implement the pillar and platform approach as advocated by the Iceberg Model. Most were successful in demonstrating improvements in their pillars under the consultant's guidance but struggled or failed to replicate the improvements across the organisation.

## **Section 4: Conclusions and Recommendations**

### **4.1 Conclusions**

Overall the lean initiative had delivered some degree of gain for all organisations that had made an effort to improve their processes. These varied from behavioural changes to financial gains. Two organisations had gone into receivership during this study and their lean efforts could not be evaluated. It is not possible to make any judgement of the effectiveness of lean in these cases. The training courses and general support provided by NZTE was well received by all the companies and they all found the courses to be informative and educational. They were satisfied with the level of support and involvement from NZTE. All companies were keen to see a continuation of NZTE financial and/or training support in some capacity however most organisations did not see the continuation of the NZTE funding as critical to embedding a lean culture. Most organisations felt that any NZTE assistance would relieve some financial stress of the lean initiative during the economic downturn. The length of time organisations had been attempting lean and the two different lean implementation systems had no bearing on their ability to sustain improvements.

All organisations faced some level of difficulty in sustaining their lean efforts. The change management process was not properly managed to take companies from the initial tool stage to a long term culture change. There was nothing new about the problems experienced by these organisations in sustaining lean. These problems were comparable and were also consistent with problems experienced overseas by manufacturers attempting to embed and sustain a CI culture. However, some of the forces behind the problems were stronger in NZ such as the abundance of small owner-operator enterprises, limited supply-chain involvement and a low level of lean understanding. NZ organisations are especially weak at the 'front-end' aspects of change such as establishing a strategy for change, understanding customer value and getting staff and management commitment to change.

The organisation that looked most likely to sustain lean had invested much time and resources into building their 'below the waterline' capabilities and they were reaping the rewards. They focused on developing lean leaders and the continuous education of all staff. They had achieved a high level of staff buy-in which was providing strong drive for improvements. Their biggest success was strong management commitment and leadership. All management spent time on the shop floor and made lean a priority. The SMT led by example and showed that lean was there to stay.

### **4.2 Recommendations**

Lean manufacturing has an enormous potential for productivity growth within the NZ manufacturing sector but greater work needs to be done by NZTE and the companies implementing lean in ensuring the progress is delivered with a long-term strategy in mind. Companies need to put equal time and resources into developing their 'above the waterline' capabilities as well as their 'below the waterline' capabilities if they want to progress past quick-wins to embedding a culture of continuous improvement. There is no doubting the ability of lean manufacturing as a methodology for embedding a culture change, however the change process with the NZ manufacturing has to refocus on long-term culture change through developing lean leaders. The word lean could be replaced with continuous improvement to eliminate negative perceptions currently held amongst many NZ organisations. The following sections look at several solutions aimed at assisting organisations' successfully implement and sustain lean manufacturing.

#### 4.2.1 Specific Solutions for Embedding Long-term Culture Change

We recommend the following actions be taken to enable NZ manufacturing organisations to sustain lean improvements:

- **Implement lean as a ‘holistic therapy’ rather than a ‘tools and techniques pill’**

Overall the findings from this study are in line with other lean studies such as Hines et al. (2008) and Liker (2004) that you need to simultaneously focus on aspects such as strategy, culture and leadership, in conjunction with the tools and techniques of lean to sustain improvements. We wholly support the Iceberg Model as an approach to sustaining lean but it has to be adapted to NZ conditions; as it is developed from the context of large manufacturing organisations.

Our findings clearly show that most lean implementations currently focus on the tools and techniques (above the waterline), which generally tends to be 5S or good housekeeping. Due to this focus it seems that NZ companies are struggling to develop a solid platform for sustained improvements within their organisations. It is suggested that before organisations embark on change transformations they undergo a period of change preparedness; to ensure that they are building strong foundations so that the ‘below the waterline’ aspects develop. The first step in a change transformation should be to determine with some precision where the organisation stands in relation to strengths and weaknesses for a successful transformation especially in regards to leadership commitment and abilities. Once an organisation recognises its current position, the leaders are better able to devise short, medium and long-term strategic plans for making improvements and reaching goals.

Some of the general issues that need to be considered in a readiness phase are listed below:

- Leadership commitment to change and understanding of CI
- Leadership abilities
- Organisational understanding of CI
- Level of employee resistance
- Understanding of customer value
- Motivators for change
- Organisational goals and strategies
- Effective change management strategy

- **Develop stronger leadership capability**

Many manufacturers have limited their capability for sustained improvement because they allow lean to be driven by an external source rather than themselves and their employees. Getting the support and knowledge is an initial crucial step but making Lean Thinking an inherent part of a leader’s mindset is much more difficult. Leaders must endeavour to create a culture that continuously reflects and improve and diligently support that culture by leading by example.

It is quite clear that many organisations do not have sufficient capability within their management teams of providing the leadership to create a sustainable lean initiative that is aligned with a clear strategy. Leading lean and CI researchers (Buckler 1996, Emiliani 2003, Hines et al. 2006) advocate that success with embedding a CI culture (i.e. sustaining lean) depends on the leader’s ability to create a learning environment where individual, team and organisational learning is facilitated. They also endorse that good leaders develop an environment where change is the norm, nurture people, inspire trust and constantly challenge the status quo. Importantly they must be fully immersed with the *Gemba* (i.e. the place where value is added) not just by words but with deeds and actions thus encouraging everyone to get involved in delivering changes. As proven by Toyota the key to sustained

improvements lies with an organisation's ability to become a learning organisation that nurtures its employees to continuously improve business processes.

*How do we suddenly change the ethos of our manufacturing leaders?*

NZ manufacturers themselves acknowledged that leadership is a capability gap in NZTE's 2005's study of the manufacturing sector in their Manufacturing+ Report. What is also pertinent in this report is that their proposed transformational model suggests that growth can be achieved through leadership in conjunction with education and research. In fact, they advocate that attitudes to lifelong learning in the workplace need to be developed and that organisations must place a high-priority on skill development for senior staff. The authors strongly agree with this study and support the need for ongoing learning as this is a key foundation stone for continuous improvement and recommend the following to help support this initiative:

- **Create a coordinated and facilitated strategy at all education levels to create an ethos for CI learning to support manufacturers**

In relation to education and research it is strongly recommended that current educators should form a Partnership whose aim is to significantly broaden the reach of CI curriculum and provide communication between Universities, Institutes of Technology, Polytechnics, Wānanga s, Industry Training Organisations and Private Training Establishments, as well as linkages to the other key stakeholders. It should help facilitate the operation of curriculum development and its deployment around New Zealand, so that CI education becomes accessible to manufacturers right across the country.

Organisational leaders should be encouraged to do not only CI courses but general business degrees, leadership training, etc. Education will bring the ability to solve problems, give individuals a different view on business practices, equip them with the ability to find new information, expose them to other business practices and processes and widen their scope to help them create learning organisations. Therefore, the Partnership should work together on making it easy for manufacturers to see how they and their staff can progress through the academic channels. As educators the partnership should encourage 'Life Long Learning' and establish clear routes for students to gain qualifications; from Continuing Professional Development (CPD) courses, Certificates, Diplomas through to, Degrees and Postgraduate Degrees.

- **Government support for industry education**

Whilst we support Wilson et al. (2008) suggestion in that the *Aichi* format should become the main vehicle for sponsored CI implementations in the future we encourage government bodies to take a wider view (not just in CI) of supporting education in the workplace.

We recommend that bodies, such as NZTE and the Tertiary Education Commission (TEC), look very closely at how they are encouraging industry and tertiary education organisations to align and support NZ's economic development. In these times of economic volatility, countries such as the United Kingdom (UK) are realigning their education strategies to ensure their education sector (universities in particular) build new partnerships with business and industry. For example, the UK Commission for Employment and Skills (UKCES, 2010) recent audit stated that:

“teaching and research professionals across the education sector will be essential to support the supply of new recruits to a number of priority sectors. As businesses develop their technology and production processes this will require close and on-going co-operation between education providers and employers to ensure that evolving curriculums effectively meet industry needs. This will be

especially important in key areas such as STEM related subjects where there is a more general emerging skills need for multi-disciplinarity both within science, technical and business areas”

The UK are also changing their higher education progression model from that where predominantly school leavers progressed to study conventional three year degree programmes, to that where they are widening participation through the expansion of the number of adults at university by promoting a broader range of program models alongside the three year degree. Tertiary education institutions in NZ should be considering these alternative education models.

Although the recommendations have been targeted at both government and education it is equally important that NZ businesses need to be active and engage with the Tertiary education sector. Businesses must begin to commit to education and continuing professional development. Organisations need to allocate time and resources to educating their staff; especially the managerial levels.

- **Provide focused research to support CI development in NZ**

Further research needs to be done on developing NZ’s capabilities in specific areas through answering questions such as:

1. How do we get NZ organisations ready for change transformations and establish a long-term philosophy?
2. How do we fix the national problem of insufficient organisational leadership?
3. How can NZ organisations become learning organisations?
4. How do we encourage industry leaders, practitioners, managers and other key stakeholders to engage in on-going continuing education and professional development?

## **Section 5: References**

- Achanga, P., Shehab, E., Roy, R., and Nelder, G. (2006). "Critical success factors for lean implementation within SMEs." *Journal of Manufacturing Technology Management Decision* 17(4).
- Bessant, J. and D. Francis (1999). "Developing strategic continuous improvement capability." *International Journal of Operations & Production Management* 19(11).
- Bhasin, S. and Burcher, P. (2006). "Lean viewed as a philosophy." *Journal of Manufacturing Technology Management*, 17(1), 56-72.
- Buckler, B. (1996). "A learning process model to achieve continuous improvement and innovation." *The Learning Organization* 3(3): 31-39.
- BusinessNZ (2009). *Setting New Zealand Apart: Getting More Productive And Competitive A Plan for Action*, BusinessNZ: 32.
- Czabke, J., Hansen, E. N., Doolen, T.L. (2008). "A multisite field study of lean thinking in U.S. and German secondary wood products manufacturers." *Forest Products Journal* 58(9): 77-85.
- Dahlgard, J. J. and S. M. Dahlgard-Park (2006). "lean production, six sigma, quality, TQM and company culture." *The TQM Magazine* 18(3): 263-281.
- Emiliani, M. L. (1998a). "Continuous personal improvement." *Journal of Workplace Learning* 10(1): 29-38.
- Emiliani, M. L. (1998b). "Lean behaviors." *Management Decision* 36(9): 615-631.
- Emiliani, M. L. (2003). "Linking Leaders' beliefs to their behaviors and competencies." *Management Decision* 41(9): 893-910.
- Emiliani, M. L. and D. J. Stec (2004). "Using value-stream maps to improve leadership." *The Leadership & Organization Development Journal* 25(8): 622-645.
- Emiliani, M. L. and Stec, D. J. (2005). "Leaders lost in transformation." *Leadership & Organization Development Journal* 26(5): 370-387.
- Found, P., Beale, J. and Rich, N. (2006). *A theoretical model for sustainable change*. Cardiff, Cardiff University Innovative Manufacturing Research Centre.
- Hines, P., Beale, J., Found, P., Naim, Mo., Rich, N., Sarmiento, R. and Thomas, A. (2006). *Holistic framework for the economic sustainability of manufacturing*. Cardiff, Cardiff University Innovative Manufacturing Research Center.
- Hines, P., Found, P., Griffiths, G. and Harrison, R. (2008). *Staying lean: thriving, not just surviving*. Cardiff University, lean Enterprise Research Centre.
- Kappelman, L.A. and Richards, T.C. (1996), "Training, empowerment, and creating a culture for change", *Empowerment in Organizations*, 4 (3), 26-9.
- Kippenberger, T. (1997). "Apply lean thinking to a value stream to create a lean enterprise." *The Antidote* 2(5): 11-14.
- Kobayashi, I. (1995). *20 Keys to Workplace Improvements*. New York, Productivity Press.

- Koenigsaecker, G. (2009). *Leading the lean enterprise transformation*. New York, Productivity Press.
- Kondo, Y. (1998). "Hoshin kanri – a participative way of quality management in Japan." *The TQM Magazine* 10(6): 425-431.
- Mann, D. (2005), *Creating a Lean Culture: tools to sustain lean conversions*, Productivity Press, New York.
- MED (2009). "Questions and Answers: Response to Manufacturing+ Report." Retrieved 20 August, 2009.
- New Zealand Trade and Enterprise, 2006, *Manufacturing+: A Vision For World Leading New Zealand Manufacturers: A Strategic Framework*, New Zealand.
- OECD (2010). "Economic Survey of New Zealand 2009." Retrieved 25 January 2011, 2011.
- O'Reilly, P. (2006). "Productivity: who's doing it best, why it matters and how we can get more of it." Retrieved 24 August 2009.
- Redman, T., and Grievess, J. (1999). "Managing strategic change through TQM: learning from failure." *New Technology, Work and Employment*, 14(1), 45-61.
- Shin, D., Kalinowski, J. G., El-Enein, G.A. (1998). "Critical implementation issues in total quality management." *SAM Advanced Management Journal* Winter: 10-14.
- Shingoprize (2008). "The Shingo Prize for Operational Excellence." Retrieved 2/12/2008.
- Soltani, E., Lai, P., and Gharneh, N. (2005). "Breaking Through Barriers to TQM Effectiveness: Lack of Commitment of Upper-Level Management." *Total Quality Management*, 16(8-9), 1009-1021.
- Statistics NZ (2011), *Economic Survey of Manufacturing: September 2010 quarter*, [http://www.stats.govt.nz/browse\\_for\\_stats/industry\\_sectors/manufacturing\\_and\\_production/economic\\_survey\\_of\\_manufacturing\\_hotpsep10qtr.aspx](http://www.stats.govt.nz/browse_for_stats/industry_sectors/manufacturing_and_production/economic_survey_of_manufacturing_hotpsep10qtr.aspx)
- Sussland, W. A. (2003). "Align your management processes for effectiveness." *The TQM Magazine* 15(2): 108-116.
- Sutton, J. (2005). "Projects extend benefit of Aichi World Expo." Retrieved 26 November, 2008.
- Todd, S. (1995). *The process of organisation change: case studies of the implementation of TQM within four medium-sized manufacturing organisations* School of Business. Palmerston North, Massey University. Masters of Business Studies: 185.
- UKCES (2010). *Skills for Jobs: Today and Tomorrow. The National Strategic Skills Audit for England 2010. Volume 1: Key Findings*.
- Venkateswarlu, P., and Nilakant, V. (2005). "Adoption and Persistence of TQM Programmes - Case Studies of Five New Zealand Organisations." *Total Quality Management*, 16(7), 807-825.
- Wilson, M., Heyl, J., and Smallman, C. (2008). "Supporting Lean Manufacturing Initiatives in New Zealand." *Final Report*, Lincoln University, Christchurch, 52.
- Womack, J. P. and Jones, D. T. (1996). *lean Thinking: Banish Waste and Create Wealth in Your Organisation*. London, Simon & Schuster.



Womack, J. P., Jones, D. T., and Roos D. (1990). *The Machine that Changed the World*. New York, Rawson Associates.

Woods, J. and Robert, H. W. (2008). *Leading the working culture revolution. Sustaining lean: case studies in transforming culture*. New York, Productivity Press.

Worley, J. M. and Doolen, T. L. (2006). "The role of communication and management support in a lean manufacturing implementation." *Management Decision* 44(2): 228-24

1. Take an active interest in all that surrounds us and link this to engineering principles.

2. Creatively apply our engineering and contextual knowledge to the solution of problems - today and in the future.



3. Ensure that our inventions are focused on social or commercial wealth creation

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