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**Investigation into the
Implementation of the CANDO
Methodology of Visual Workplace
Organisation in Company X.**

Desmond Morrow

**A Research Dissertation submitted in partial fulfilment for
the Degree of Masters of Science in Technology Management
of the National University of Ireland Galway.**

September 2009

**Thesis Academic Supervisor – Dr Con Sheehan
Faculty of Science and Engineering, University of Limerick**

Thesis Industrial Sponsor – Stephen McKenna

CONFIDENTIAL

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Methodology of Visual Workplace Organisation in
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Certification of Authorship:

I hereby certify that I am the author of this document and that any assistance I received in its preparation is fully acknowledged and disclosed in the document. I have also cited all sources from which I obtained data, ideas or words that are copied directly or paraphrased in the document. Sources are properly credited according to accepted standards for professional publications. I also certify that this paper was prepared by me for the purpose of partial fulfilment of requirements for the Degree Programme.

Signed: Des Morrow Date: 2nd February 2009

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Abstract:

The purpose of this research was to investigate the implementation of the CANDO methodology for Visual Workplace Organisation in the Manufacturing areas in Company X. The primary objective was to give a detailed account and insight into the implementation methods employed and to establish whether the implementation succeeded in helping to build the foundation for elimination of waste and non-value-add activities, reduce machine downtime and create an environment where work standardisation and sustaining continuous improvement is achievable and sought by all employees.

An integrated quantitative/qualitative approach of both semi-structured interviews along with participative and direct observation was used in order to collect data and to establish a related set of results.

From the results and findings the actual Company X implementation methodology employed bore strong resemblance to the majority of the literature written on the subject but had some original and slight variations which gave a more thorough understanding of the methods and activities.

The implementation did reduce waste in all of the areas researched but there was no conclusive evidence to show that the implementation reduced overall average machine downtime in the areas researched.

Employees interviewed did feel involved and empowered to take action and make decisions concerning their areas and routines.

The implementation in Company X did achieve some wins which acted as a foundation from which full lean implementation could be achieved through small incremental improvements in all areas.

Continuous employee involvement with strong management commitment and support remains crucial to make ongoing improvement sustainable.

Chapter 1: Introduction

1.1 Introduction to Area of Study:

The present competitive environment suggests that there are constant competitive pressures to meet and add value to ever demanding customer needs while at the same time reducing the cost of manufacturing through the elimination of waste and creating a working environment where both sustainable continuous improvement and innovation can flourish. Simply put the aim is to do more with less – Becoming ‘Leaner’.

“Lean thinking is defined as the dynamic, knowledge driven and customer focused process through which all people in a defined enterprise continually eliminate waste with a goal of creating value.” (Murman et al, 2002).

It is imperative that organisations address the external challenges such as cost, global economy, customer shifts, suppliers, competitors and threat of new entrants so they can develop options to influence them in a way that improves their own competitive position.

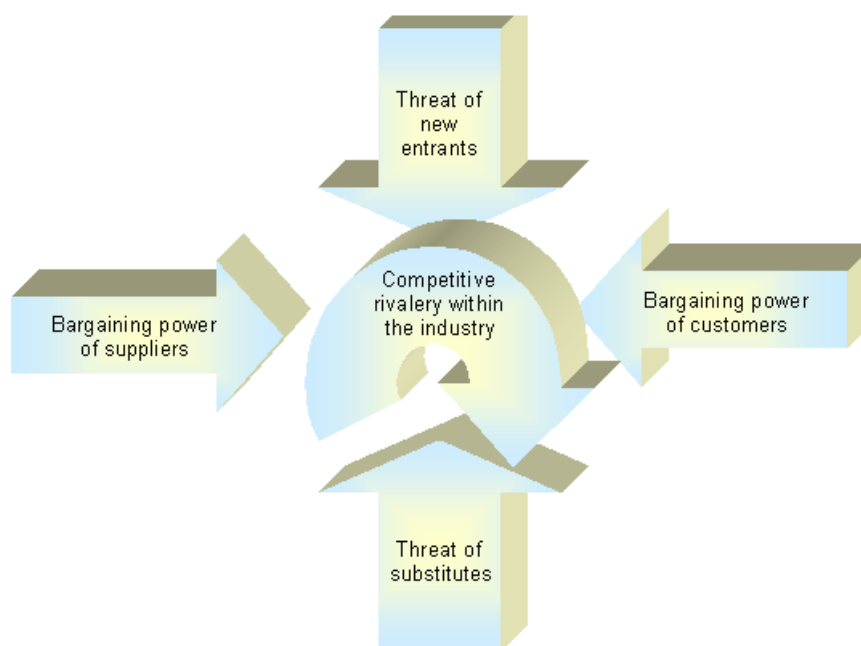


Figure 1.1: Porters five Forces model of competitive forces

As Organisations and Companies strive to attain “World Class Manufacturing” operations they must increase their manufacturing output while maintaining high quality and reduce inventory and manufacturing cycle time using roughly the same resources of personnel and equipment. In order to do this variability throughout the system should be reduced to a minimum and standardisation of work procedures, establishment of self directing teams and ongoing sustainable continuous improvement are crucial to success. Becoming Lean is about changing the way of thinking in an organisation.

In order to become effective companies must firstly look at their own way of doing business and what closer a place to look than the actual workplace itself. Companies must simplify and reduce waste and non-value-adding activities starting within their own workplace. They must standardise work procedures and practices and simultaneously improve safety, quality and efficiency.

1.2 Research Objectives:

The primary objective of this research was to investigate in detail how the implementation of a Visual Workplace Organisation methodology (CANDO) employed in a company can help build the foundation for elimination of waste and non-value-add activities, reduce machine downtime and create an environment where work standardisation and sustaining continuous improvement is achievable and sought by all employees.

This primary research objective was further broken down into two sub-objectives or research questions as follows which are detailed further in the research methodology chapter:

- Did the implementation of CANDO reduce waste, increase work standardisation, decrease machine downtime and enable a drive towards continuous sustainable improvement?

- Did the employees learn from the training and implementation of CANDO and did they feel more involved and empowered in making decisions regarding their workplace environment during and after the implementation?

1.4 Overview of the Chapters:

- Chapter 1 gives a brief introduction and overview of the area of study and gives the rationale and objectives of the research undertaken. This chapter also gives a brief explanation of what is in each of the chapters in the dissertation.
- Chapter 2 gives a concise and critical review of the relevant literature and research done to date relating to the research undertaken. The introduction section outlines the academic argument for pursuing the area of research. The remaining sections follow the main literary themes and research questions and the contents follow clear and logical progression in their arguments. The chapter concludes with a summary of the main points that have been reviewed in the literature.
- Chapter 3 sets the Industry and Company X backdrop from which the need for the research was based on. Prior practices of Company X are discussed briefly and the key performance indicators that relate to the research subject are discussed.
- Chapter 4 gives a concise overview of the research method and rationale used in the research period. The research question is clearly stated and translated into measurable individual questions or hypotheses.
The research methods that could potentially have been used are outlined and discussed and the rationale for the research method employed is discussed in detail.

The chapter continues with a detailed description of how the research was carried out using the chosen method and addresses the limitations inherent in the research method and research carried out.

The chapter concludes with a summary of the main arguments of the chapter.

- Chapter 5 provides the research findings and results and its structure and headings follow the main research questions and themes that run throughout the literature review and research methodology chapters. This chapter presents in detail what was found on each of the research questions, on the basis of the primary research method that was carried out.

- Chapter 6 evaluates and discusses what the results and findings actually mean in terms of the research questions, principles, relationships and generalisations.

The chapter also explores areas where there was a lack of correlation between theory and practice, any unsettled issues and where the findings agreed with or contrasted previously published work.

- Chapter 7 concludes the dissertation by presenting the main conclusions of the research questions and research carried out in terms of what the findings actually meant. The chapter concludes by outlining possible areas for further research which other research could build on.

Chapter 2: Literature Review

2.1 Introduction:

In today's world customer needs are ever changing, new technologies emerging and generation upon generation of newer products are appearing. It is essential that factories, the ones that intend to survive anyway, move away from old methods and customs and strive to adapt new methods. Methods that maximise resources efficiently and minimise waste and in doing so can give value add to customers.

This chapter starts by looking briefly at the concept of how Lean thinking can help such factories by providing a way of 'doing more and more with less and less' (Womack and Jones, 1996, p15). It focuses on the lean principles that are most relevant to the research investigation.

The chapter then addresses the different theories, methodologies and concepts of visual workplace organisation, how it fits into lean thinking and how it can play an important part in elimination of waste and promotion of organisation and efficiency in the workplace.

In order to make the visual workplace organisation a success, a behavioural change needs to be adopted by both management and employees. The chapter examines each phase of the visual workplace organisation theory in detail and the employee involvement associated with each in the drive for a successful and efficient Company workplace.

The chapter concludes by summarising the relevant theories and concepts which were relevant in the implementation of the visual workplace organisation employed in Company X and why they were important to explore during the research.

2.2 The Lean Journey

The goal of lean “is to reduce operational expense and reduce inventory while simultaneously increasing throughput”, (Goldratt, 1984, p.86). “Lean is a way of thinking. It is a journey that is never over”, (Flinchbaugh and Carlino, 2006, p.61).

“Lean Thinking is the dynamic, knowledge-driven, and customer-focused process through which all people in a defined enterprise continuously eliminate waste with the goal of creating value”

(Murman et al, 2002)***no ref

Although lean behaviour and the elimination of waste has been pursued for centuries the term ‘lean’ was universally accepted as being developed by Toyota through their Toyota Production System (TPS) because they were the most successful at implementing it. Their system shifted the focus from individual machines and their utilisation to looking closely at the flow of the actual product through the overall process. It was through matching machine capacity with volumes of product, placing the machines in process sequence and executing quick setups for various products that Toyota were able to obtain low cost, high quality and variety and quicker throughput times which gave them the edge on their competitors. This ‘Just-In-Time’ approach meant that “the right parts needed in assembly reach the assembly line at the time they are needed and only in the right amount”. (Ohno, 1988, p.4).

“Lean production is ‘lean’ because it uses less of everything compared with mass production – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time”.

(Womack et al, 1990, p.13)

According to MacInnes (2002) the goals of lean are to improve quality, eliminate waste, reduce lead time and lastly to reduce

total costs. MacInnes (2002) also suggested that implementing lean tools, methods and practices will enable companies to meet demand with quality product, create efficient and agile processes and help manage costs to provide fair ROI to stakeholders.

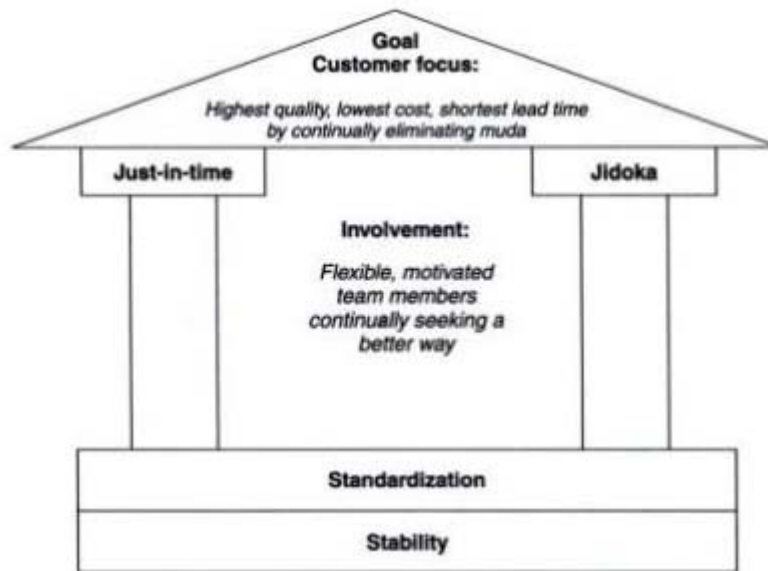


Figure 2.1: House of Lean Production (Dennis and Shook 2007 p.19)

According to Dennis and Shook (2007, p19), their interpretation of the House of Lean production showed the foundation of the lean system providing stability and standardisation while the walls are Just-In-Time delivery of parts of products and ‘jidoka’ meaning automation of the human mind. The overall goal (roof) is customer focus where the highest quality can be delivered at the lowest cost in the shortest time. “The heart of the system is involvement: flexible motivated team members continually seeking a better way”.

Flinchbaugh and Carlino, (2006) described the house of lean slightly differently in that the foundation establishes a high agreement of “what” and “how”, the walls provide systematic waste elimination and problem solving while the roof provides shelter and is about understanding current reality at its source. “It is about understanding the means – not just the ends” (Flinchbaugh and Carlino, 2006, p.5). It involves directly

observing work as activities, connections and flows. Their “heart” of the system is the creation of a learning organisation where action and reflection are ongoing.

Directly observing is sometimes described as ‘Gemba’ which means going to the shop floor or where the work is actually performed. It involves using structured methods of observing, analysing and understanding how work is performed and why is it performed that particular way.

Directly observing:

“encompasses many different behaviours. Quality of information is emphasised over quantity of information.... and seeks to build a common view versus arguing over the ‘right’ view”.

(Flinchbaugh and Carlino, 2006, pp. 6-7)

Dennis and Shook (2007, p20) explained the word ‘Muda’ which means “waste , or any activity for which the customer is not willing to pay” and they refer to it as the “opposite of value”.

“Muda is any activity that absorbs resources and creates no value!” (Womack and Jones, Lean Thinking, 2003)

MacInnes (2002, pp.6-7) referred to the seven types of waste which are defined as follows:

- Overproduction: When operations continue after they should have stopped resulting in excess product and products being made before customers require them.
- Waiting: Refers to inactive periods in downstream processes caused by upstream processes not delivering on time. Can also be caused by set-up time. An example would be logging on to a computer.
- Transport: Refers to the unnecessary movement of materials such as work in process (WIP) materials being transported from one operation or process to another. This is no value-add time.

- Qver Processing: refers to extra operations, like rework, reprocessing, storage that can occur because of defects, overproduction, or too little or too much inventory.
- Inventory: Refers to the excess inventory that is not required for the process or order. This includes holding on to parts that are never used.
- Motion: This refers to the extra steps taken by employees and equipment to accommodate inefficient process layout, defects, reprocessing, overproduction and too little or too much inventory.
- Defects: Refer to the products or aspects of service that do not conform to specification or customer expectations and can make extra work in the form of rework.

Together, the seven deadly wastes make up the acronym 'TIMWOOD' for ease of recall.

Flinchbaugh and Carlino, (2006, p.12) referred to the seventh waste as "waste of correction" as a company should not stop correcting defects, but should instead seek out the source of the defects and eliminate the creation of the defect in the first place. These seven wastes which, when eliminated can lead to Just-In-Time (JIT) production.

Another goal is to standardise activities so that waste can be reduced further in terms of searching, using and returning items.

Standardization means creating a consistent way that tasks and procedures are carried out. When we think "standardization," we should think "anyone." Machinery standardization means anyone can operate the machinery. Operation standardization means anyone can perform the operation. To get along together, we even need to standardize our behaviour to a certain extent.

(Hirano, H. 1996, Ch.4)

This can lead to a reduction in lead time, which refers to the time taken to complete an activity from start to finish, and can

be very effective for both cost and waste reduction. One key factor in helping with this is quick changeover, which involves making product batch sizes as small as possible enabling a build to customer order giving quicker throughput of products from order to delivery and thus giving good value add to the customer. In order to achieve this quick changeover of product, quick set-up of machines, equipment, specialised product specific tooling and all other things necessary to change, is a must. This leads on to section 2.3 which concentrates on the relationship between lean and visual workplace organisation methodologies and the theory behind them.

2.3 Visual Workplace Organisation:

MacInnes (2002, p.29) suggested that Visual Workplace organisation or management is a set of techniques that can expose waste so that it can be eliminated so it does not reoccur in the future. It can also help make the company's standards known to all employees so that they can be followed easily and it can also improve workplace efficiency through organisation.

“Some people think the purpose of 5S is just “housekeeping”. This could not be more off the mark. Housekeeping and an organised workplace are the results of 5S. But the purpose is to make problems immediately evident”.

(Flinchbaugh and Carlino, 2006, p.86)

Taking a more detailed look at the house of lean (Figure 2.2) we see that 5S and visual order play a major part in its construction from the grass roots up through the foundation to supporting walls and into the heart of the building.

“The word “pillar” is used as a metaphor to mean one of a group of structural elements which together support a structural system. In this case, the five pillars are supporting a system for improvement in your company”.

(Hirano, 1995, Ch 2)

Hirano (1995) referred to the five ‘pillars’ as Sort (Seiri), Set in Order (Seiton), Shine (Seiso), Standardise (Seiketsu) and Sustain (Shitsuke), and because they each begin with ‘S’ they are more commonly known as 5S.

“Seiri means to separate needed and unneeded materials and to remove the latter. Seiton means to neatly arrange and identify needed materials for ease of use. Seiso means to conduct a cleanup campaign. Seiketsu means to do seiri, seiton, and seiso at frequent intervals and to standardise your 5S procedures. Shitsuke means to form the habit of always following the first four Ss”.

(Roll, D. 2008)

There have been alternative Westernised terms which have been used to disguise the Japanese origins of the methodology. These are "Sort, Straighten, Shine, Systemise and Sustain" and a sixth optional S of "Safety". These were arguably derived to stop 5S being looked upon as yet another Japanese improvement process trying to overwhelm Western strategies.

Alternative ‘Americanisations’ have also been introduced, such as CANDO (Clearing up, Arranging, Neatness, Discipline, and Ongoing improvement). Hirano (1995) prefers the terms Organization, Orderliness, Cleanliness, Standardized Cleanup, and Discipline because they are better translations than the alliterative approximations.

Nevertheless 5S or CANDO concept and is a simple, but effective, lean manufacturing methodology that helps organizations to simplify, clean, and sustain a productive safe work environment. It uses the philosophy “A place for everything and everything in its place”.

“When 5S is properly implemented, it creates a visual factory that allows for quick determination of the workplace status.” (Chapman, 2005, p.28).

“As a general rule of thumb, introducing good workplace organization reduces process defects by 50%.” (Masaaki Imai, 1997)

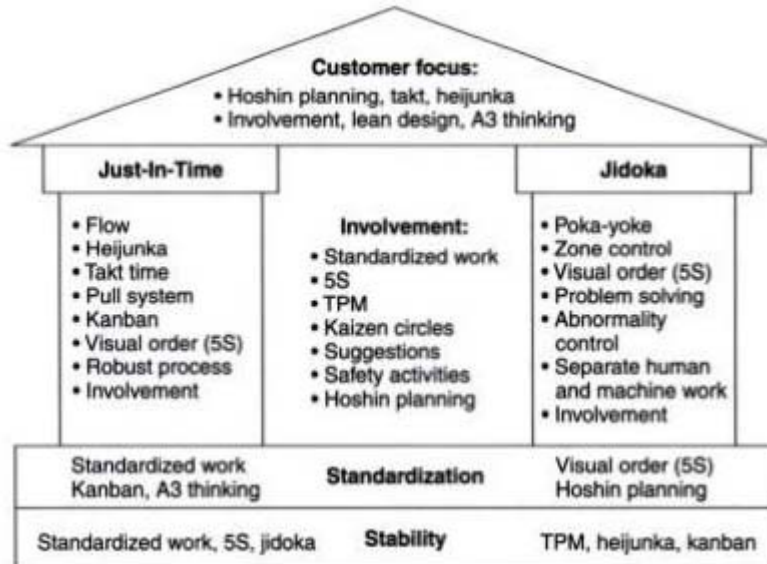


Figure 2.2: Detailed House of Lean Production (Dennis and Shook, 2007, p.20)

MacInnes (2002, p.29) suggested that implementing the ‘visual management techniques’ involves three steps:

- Organisation of the workplace using the 5S’s.
- Ensure all work standards and related information are displayed in the workplace.
- Control of workplace processes by exposing and stopping errors and preventing them in the future.

Use of these visual management techniques can help prevent errors before they occur and detect defects as they occur to ensure a rapid response. The techniques also establish and maintain standards for zero defects, errors and waste.

MacInnes (2002, p.30) also suggested the following prior to embarking on any implementation of a visual management technique:

- Election of team leaders to lead the program.
- Training for all employees.

- Communication to all about the program and how it may affect them.
- Creating storage (“Red tag”) areas for holding removed materials.
- Creation of areas for supplies such as cleaning materials, tags, marking tape and signs.
- Co-ordination with maintenance departments in case of any help needed.
- Communications to employees on the safety regulations and aspects that may arise as they make changes.

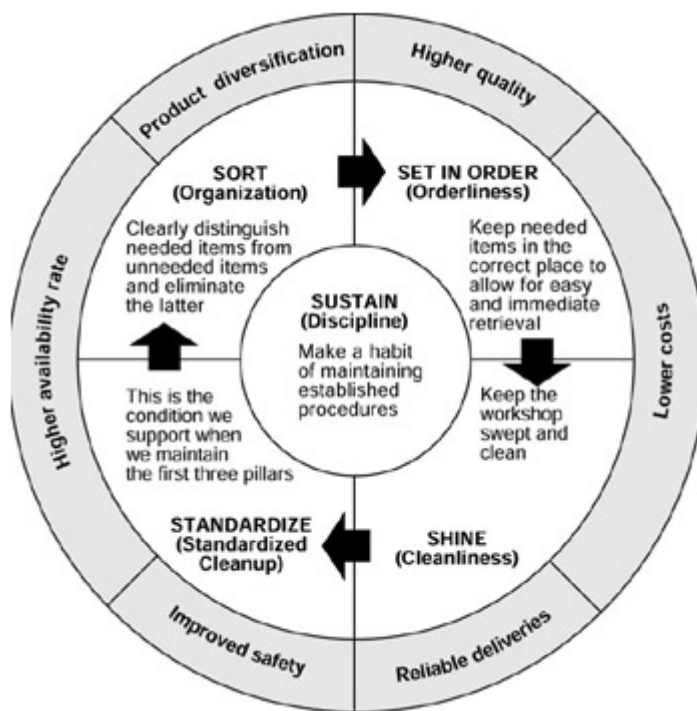


Figure 2.3: Five S Methodology (Hirano 1996)

The First Pillar, Phase 1, Sort, Clearing Up, Organisation:

Sort, the first pillar of the visual workplace, corresponds to the just-in-time (JIT) principle of “only what is needed, only in the amounts needed, and only when it is needed.” In other words, Sort means that you remove all items from the workplace that are not needed for current production operations.

(Hirano, 1996, Ch.3)

Hirano (1996, Ch.3) also suggested “When in doubt, throw it out”. If the first ‘pillar’ or phase is implemented well it enables a reduction in the issues and annoyances in the work flow and can increase communication, product quality and productivity. Hirano also suggests that the following issues can be avoided if implementation is done well:

- Overcrowded Factory.
- Shelves, cabinets and other storage items create barriers for employee communication.
- Unneeded inventory and machinery are costly to maintain.
- Excess stock may hide other types of production problems.
- Process flow cannot improve if unneeded items and equipment are present.

This view is also supported by Paschal Dennis (2002) where he suggested that the lack of workplace organisation is increased hassle and chronically extended lead times.

McInnes (2002) also suggested that appropriate locations should be found for items depending on size, weight, frequency of use and urgency of need. Other storage locations should be sought for less used items or supplies that are not used every day.

Red tagging is a method for identifying, evaluating usefulness and disposition of items that may potentially be unneeded in the factory. Tags are placed on items that have been identified as potentially unneeded based on certain criteria such as frequency of use, space occupied by the item, or quantity required and any excess can be stored away or dispositioned accordingly by either being scrapped, sold, returned to vendor, reused or stored elsewhere. However, in the authors opinion this may be hard to implement for items or equipment that are heavy or secured to the floor, wall or ceiling and red tagging in –situ may be more appropriate.

Hirano (1996, Ch.3) referred to other unneeded items such as defective parts or inventory, outdated or broken jigs, dies, tools,

inspection gear, old cleaning supplies electrical equipment with broken or exposed cords and outdated posters, signs, memos and notices.

Normally the tag will give a date of when the item will be removed or as both MacInnes (2002, p.32) and Hirano (1996, Ch.3) suggest is to remove the item to a temporary holding area where it will sit for a specified period before being dispositioned elsewhere or returned as deemed appropriate.

MacInnes (2002, p.32) proposed that discussion be used with any employees who may disagree with item removal in order to resolve any conflict. This discussion should include the items 'value' add to them and other workers, current and potential use and the impact the item has on the workplace performance.

Hirano (1996) also suggested that all red tagged items are documented and their movement recorded. Once everything unneeded is cleared away it then comes the time to locate the needed items where they are most needed. This is explored further in the second phase.

The Second Pillar, Phase 2, Set in Order, Arranging, Orderliness:

“A place for everything and everything is in its place” includes the placement of such things as machines, tools, storage areas and files. The location should be clear so anyone—including work teams, support personnel and new hires—can find anything at any time, and out of standard situations are obvious to everyone.”

(Chapman, C.D. 2005, p.29)

The idea of this phase is that an environment is created that “talks to you without verbal communication” Chapman (2005).

Hirano (1996) refers to this ‘Pillar’ or phase as the “core of standardisation.” See figure 2.4.

Standardisation can be implemented in such a way that all standards are identified by ‘Visual controls’. This means that

there is only one place to put each item, and it can be spotted straight away whether a particular item is out of place or operation is proceeding rightly or wrongly. Ellis (2004) suggested some examples of visual controls such as shadowed tool boards, colour coding the machine centre, cleaning supply carts, Inventory limit lines and basically locations for everything.



Figure 2.4: Set in Order (Hirano 1996 Ch. 4)

Items in the workplace should be located based on frequency of use. Hirano (1996) suggested placing the frequently used items close to point of use, less frequent further away and items that are needed together for activities are stored together in order of sequence used during an activity.

It is imperative to involve as many people as possible who share the work area in the placement of tools and materials. MacInnes (2002, p.35) suggested ‘brainstorming’ with the teams for ideas for new ways to lay out the workspace.

Another principle in helping decide the best location for items involves the removal and reduction of human motions. Hirano(1996, Ch.4) referred to this as ‘Motion Economy’. It

involves locating equipment, tools, parts and machinery in the best locations possible to eliminate employee excess motion and time moving trunk, legs, feet, arms and hands in performing their daily work activities and retrieving and returning items to their storage places.

Hirano (1996, Ch.4) also suggested the use of a '5S Map' which involved drawing a floor plan of the area and showing the location of specific items. By drawing workflows between items, using sequentially numbered arrows to indicate operations performed, a 'spaghetti diagram' is formed of the current situation prior to the arranging phase.

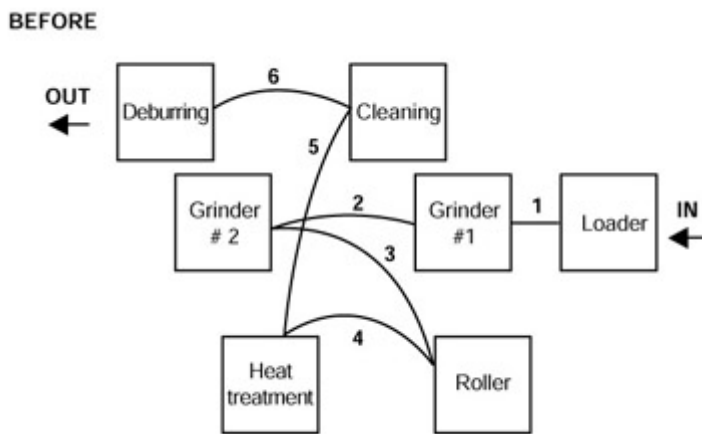


Figure 2.5: Map of old operations layout (Hirano, 1996, Ch.4)

Through experimenting and analyzing different layouts one will come out be more efficient. This can then be implemented and constantly improved on over time.

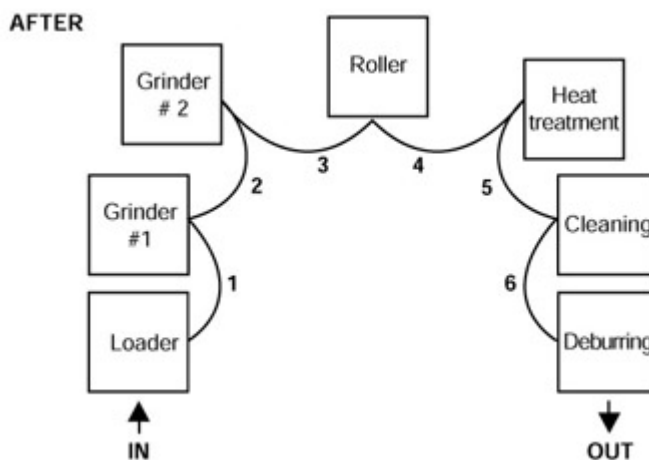


Figure 2.6: Map of new operations layout (Hirano, 1996, Ch.4)

Once the new locations for items have been decided then there is a need for identification of these new locations so that everyone will know what and how many goes where.

MacInnes (2002, p.35) suggested posting a workplace layout in the area. Hirano (1996, Ch.4) suggests the use of signboards to indicate what, how many and where items are stored. He also suggested a “painting strategy” to show walkways, operation areas, and locations for storage and “colour coding” strategy to show which items are to be used where and for what purpose. See Figure 2.7.

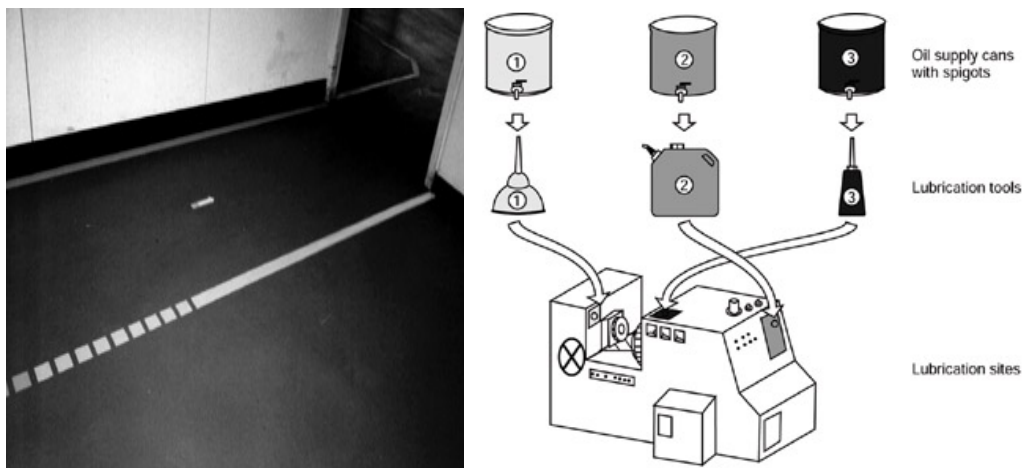


Figure 2.7: Painting and Colour coding strategy (Hirano, 1996, Ch. 4).

Hirano also suggested an “outlining” strategy so jigs and tool storage locations are easily identifiable. See figure 2.8.



Figure 2.8: Outlining strategy (Hirano, 1996, Ch.4)

What good is the first two phases of Clearing up and Arranging if the equipment we use constantly breaks down and the tools that are used are dirty. This is where the third pillar comes in.

The Third Pillar, Phase 3, Shine, Neatness, Cleanliness:

This phase emphasises the removal of dirt from the workplace and to keep everything clean and swept. Apart from the fact that people like working in clean and bright work environments, it is important to “keep everything in top condition so that when someone needs to use something, it is ready to be used.” (Hirano, 1996, Ch.5).

MacInnes (2002, p.33) also suggested that it is also a good time to inspect equipment to look for abnormal wear and tear which may ultimately lead to failure. Ellis (2004) suggests that for the initial ‘Shine’ the scheduled preventative maintenance is extended to allow for inspection and deep cleaning of equipment, tools and machines. “Teams learn to clean to inspect and prevent downtime.”

Hirano (1996, Ch.5) suggested that it is the responsibility of everyone who works in the area to be included in the ‘Shine’ phase with area and sub area responsibilities assigned to individuals and teams and it should also be incorporated into the daily routine into a “ five minute concentrated shine session”.

Once the cleaning and inspection assignments are in place Hirano (1996, Ch.5) suggested that schedules and cleaning and inspection checklists should be made known to all and put on walls so they are visible to all. See figure 2.9.

Mechanism	No.	Point	Main Response			
			Clean	Lubricate	Inspect	Restore
Lubrication system	26.	Is there any dirt or dust in the oil inlets?	<input type="radio"/>			
	27.	Do the oil level indicators show adequate levels?		<input type="radio"/>		
1. Oil inlets	28.	Can the oil level indicators be clearly seen?	<input type="radio"/>			
	29.	Are there any cracks in the oil tank?	<input type="radio"/>			<input type="radio"/>
2. Tank	30.	Is the bottom of the oil tank dirty?	<input type="radio"/>			
	31.	Is the oil in the tank dirty?			<input type="radio"/>	
	32.	Is there any oil leakage from the tank or pipe joints?			<input type="radio"/>	<input type="radio"/>
3. Oil pipes	33.	Are oil levels adequate?		<input type="radio"/>		
	34.	Is the correct type of oil being used?			<input type="radio"/>	
	35.	Is there any clogging in the oil pipes?			<input type="radio"/>	<input type="radio"/>
4. Lubrication sites	36.	Is there any dust or dirt at lubrication sites?	<input type="radio"/>			
	37.	Are the lubrication tools dirty?	<input type="radio"/>			

Figure 2.9: Example of a part of an inspection/cleaning checklist (Hirano, 1996, Ch.5)

Hirano (1996, Ch.5) suggested that any equipment abnormalities should be immediately fixed or improved through either instant or requested maintenance.

“Once daily cleaning and periodic major cleanups are a habit, systematic inspection can be incorporated into the Shine procedures. This turns ‘cleaning’ into ‘cleaning/ inspection.’”

(Hirano, Ch.5)

The Fourth Pillar, Phase 4, Standardise, Discipline:

This phase involves the team members from every work area following and maintaining the same Clearing up, Arranging and Neatness steps integrating them into a unified whole.

Hirano (1996, Ch.6) suggested that if the first three phases are not maintained then it can result in setbacks where conditions return to old undesirable levels, items of unneeded items being left around and tools having to be put back in bulk at the end of the day.

In order to prevent this happening the key is to have employee participation throughout. Hirano (1996, Ch.6) suggested a three step approach where responsibilities are assigned to area employees using schedules to maintain the first three phases. The second step is to ensure backsliding does not occur by integrating the three phases into regular work activities and the

third step is to run checks on how well the conditions are being maintained using standardized 5S checklists.

It is imperative that “people know exactly what they are responsible for doing and when, where and how to do it”(Hirano, 1996, Ch. 6) Ellis (2004) suggested that good speedy communication is the key to lasting improvement. Once the standards are agreed, then they should be made known to all so that anything out of place or not complying with procedure is immediately noticed.

The Fifth Pillar, Phase 5, Ongoing Improvement, Sustain.

Hirano (1996, Ch.7) asks the question: “What good are standards and procedures without the discipline to follow them?” MacInnes (2002, p.36) suggested that the gains that are made during the other four phases are only sustained when:

- All employees are properly trained and use visual management techniques.
- All managers are committed to the programs success.
- The workplace is in order and adheres to new procedures that all employees have agreed upon and these procedures become a habit for all.

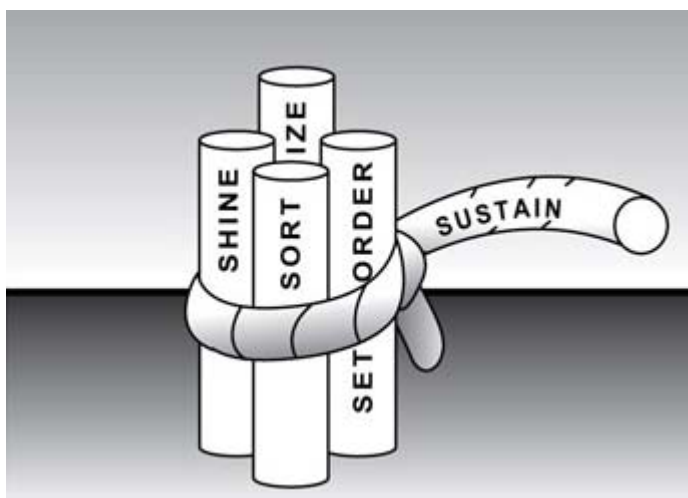


Figure 2.10: The Sustain pillar holds the first four pillars together (Hirano, 1996, Ch. 7)

Commitment to this phase “exists in people’s hearts and minds and only their behaviour shows its presence.”(Hirano,1996, Ch.7). Conditions to support implementation of this phase have to be created and cannot be implemented and it requires commitment from management to make the changes a permanent way of doing business.

Hirano (1996, Ch.7) made the valid point that “time” is crucial in that you need to have enough in the schedule for the 5S implementation. It is important also that people who participate in 5S implementation actually get something out of it and enjoy it and as this excitement and satisfaction gets communicated then the methodology can build momentum and the benefit can spread among all.

Hirano (1996, Ch.7) argues that the role of management is critical in that they need to educate all, create teams and structure, provide resources, acknowledge implementation and ongoing efforts and encourage creative involvement by workers. As people communicate and behave more as a team, it is no accident that Safety improves through it being embedded into all of the improvements. They begin to watch out for each other. They have eliminated hazards, dirt and poor sight lines that complicate the work environment. Productivity, morale, and safety are increased as people focus on process improvement with zero incidents.

2.4 Conclusion:

This chapter has explored relevant lean thinking concepts and theories and how they can be applied to workplace organisation. The chapter has looked at the various visual workplace organisation methodologies and theories and although the various theorists and authors use different acronyms, terms and names there is a similar underlying five step approach to each of their theories and methodologies on the subject:

- Clearing Up – Separating the necessary from the unnecessary and getting rid of unnecessary waste.
- Arranging – Organising the work area and putting everything in its place.
- Neatness - Sweeping, cleaning, inspecting and shining everything around the working area.
- Discipline – Using standardised methods to maintain the work area at the high level implemented so that it is easy to keep everything clean and to hand for a constant state of readiness.
- Ongoing Improvement – Ensuring that all previous phase policies and procedures are followed and proliferated through the entire organisation by means of involvement, empowerment, commitment and accountability and supporting the behavioural change necessary to sustain success.

Hirano (1996) was very detailed in explaining the implementation of each of his five “Pillars” of visual workplace methodology. Other authors also gave overlapping and sometimes different insights or explanations for each step but each emphasised the need for employees to immerse themselves in the implementation of whichever visual workplace organisation methodology they undertook. Constant managerial support and encouragement to participate, a need for personal drive and constant communication is imperative for employees to change their behaviours and adopt the new methodologies. In order to sustain the change, standardisation of behaviour, activity and actions is the key.

Chapter 3: Company and Industry

Background

3.1 Introduction:

This chapter sets the backdrop from which the research was carried out in so far as explaining the industry and background of Company X and the reasoning behind the need for change of the way in which Company X did business. The practices prior to this drive are briefly discussed. The chapter also discusses the key performance indicators that relate to the research subject.

3.2 Company X Background and Industry:

Semiconductors have become part of everyday life. We touch silicon enabled products every day, everything from cars, Televisions, Set-top boxes, Personal Computers, Mobile phones, Camera's, MP3 players, Medical devices and Servers that power the world wide web to name but a few.

Company X, established in the mid to late twentieth century, is one of the largest semiconductor manufacturers in the world with major manufacturing facilities across the globe and has had recent successive global annual revenues of multiple billion dollars and holds a large percentage of market share. Company X remains competitive through a combination of its high intellectual property resources along with a continual investment in research and development to deliver a diverse range of superior quality products faster than its competitors. Company X also uses the strengths of its suppliers and buyers and competitor weaknesses or inabilities to enable the company to continue to grow year on year. In order to remain highly competitive, Company X prides itself with the ability to listen to and deliver what the customer wants and values and also being able to change quickly in order to stay focused on this.

Company X's Ireland semiconductor manufacturing facility, to be known simply as Company X going forward and was researched in this dissertation, employs a skilled workforce in the thousands and produces high volume state-of-the-art semiconductor devices for the consumer, business, desktop and laptop market which are the envy of all competitors. In order for Company X to remain competitive internally within the organisation and to repel other global economy threats it must maintain the high quality that its customers demand in all aspects of the company and do this in a manner which will keep the cost of doing business down.

Semiconductor product fabrication remains one of the most complex manufacturing processes in the world with over five hundred process steps with multiple product variations.

Company X's Ireland facility contains multiple equipment and machinery fleets that are at the forefront of this manufacturing technology but because of the sensitivity and somewhat instability of the manufacturing processes involved the equipment and machinery need scheduled and unscheduled maintenance, engineering work and re-qualification on a regular basis. This alone requires a lot of parts, tools, equipment, technicians and engineering resources and man hours to maintain.

As a result, in order to maintain the equipment and keep the processes and supply chains going in as efficient a way as possible, and still give the customer value, Company X has recently started to explore ways in which waste can be systematically eliminated from all of its processes, work tasks and factory areas. Company X embarked on a factory wide 'Lean' initiative and encouraged ongoing improvement philosophies in order to enable them to sustain and build for the future. They chose to implement the 'CANDO' methodology of Visual workplace organisation to act as a foundation in which to

build the ‘house of lean’ to create and get ever closer to the ideal state.

Prior to this new ‘Lean’ drive, it is in the authors opinion that Company X would have been probably first to admit that there was waste in almost all of the manufacturing and business processes and in all of the areas within the company and there was a real need for change if they were going to survive unscathed into the future. This admission alone has concreted the fact that they have started on the ‘lean’ journey.

3.3 The Key Performance Indicators and Improvement Opportunities:

From the literature and writings on the CANDO methodology for visual workplace organisation there were a suggested number of key performance indicators that could be influenced by its implementation:

- **Safety:** Can be improved through the removal of hazards and clutter and through the use of visual safety aids and signage and having a ‘place for everything and everything in its place’.

- **Cost:** Probably one of the most important of all of the indicators with regard to remaining competitive and providing value to customers. The CANDO methodology has suggested various sub-category indicators that can have an influence on this main Cost indicator:
 - Reduction of Waste: The majority of the seven deadly wastes, referred to as ‘TIMWOOD’ in the literature review, can be reduced and eliminated by the implementation of a properly implemented visual workplace organisation methodology.
 - Machine Availability: Reductions in machine downtime can increase the process available uptime

of machines and can decrease cycle time and increase overall throughput. This means that less inventory is needed in the line as it reaches the customer quicker. Less inventory means less cost. More overall efficiency improvements can result also from CANDO implementation.

- **Quality**: Literature suggests that better workplace organisation and standardisation of work can have a big influence on the reduction of defects and hence will improve ‘first-time-through’ quality of products and services. CANDO implementation can create an environment that prevents errors and defects before they occur, detects those that do quickly so response is quicker, and maintains standards for zero defects, errors and waste.
- **Employee satisfaction**: Improved communication, increased learning and training, sharing of information openly and involving and empowering employees to take ownership can give employee satisfaction an overall boost.

Further investigation into the effect that CANDO implementation had on these key indicators in Company X has been combined into the subsequent chapters of research methodology, results and discussion to provide learning and insight and to prove or disprove the theories put forward.

Chapter 4: Research Methodology

4.1 Introduction

The purpose of this chapter is to give a concise overview of the research method and rationale used in the research period. This chapter will define the research objectives and the methods employed, along with the limitations of the research methods and conclusions.

4.2 Research Objective

The aim of this research was to examine the deployment of a visual workplace organisation methodology, CANDO, the Americanised version of the Japanese 5S methodology, and its effect on eliminating waste, driving continuous sustainable improvement in areas such as work standardisation, reduction in machine downtime and boosting employee involvement (EI) within the manufacturing environment.

In carrying out the research the following questions were answered:

- Did the implementation of CANDO reduce waste, increase work standardisation, decrease machine downtime and enable a drive towards continuous sustainable improvement?
- Did the employees learn from the training and implementation of CANDO and did they feel more involved and empowered in making decisions regarding their workplace environment during and after the implementation?

4.3 Review of Research methods

In this section the research methods that could potentially have been used, given the research aim, are outlined and discussed.

4.3.1 Quantitative Research

Siegle, D. (2008) suggests that quantitative research assumes that social facts have an objective reality and variables can be identified and variables measured. Its purpose is to generalise, predict and seek causal explanations.

The approach centres on hypotheses and theories through manipulation and control using statistical techniques, instrumentation, experimentation, deduction and component analysis. It seeks consensus or the norm and reduces data to numerical indices.

Quantitative data links among clearly defined and measurable attributes.

The quantitative researcher's role is one of detachment and impartiality and gives an objective portrayal of the research. Neill (2007) suggests that the quantitative researcher knows clearly in advance what he/she is looking for.

"The knower and known are independent, a dualism." (Lincoln and Guba, 1985). They also suggest that the "inquiry is value free".

The advantage of quantitative research is that it has wide coverage and can be fast, economical and easy to administer. However, one problem can be that only surface information is sought with no underlying reasoning behind it. Another disadvantage can be onset of interviewee fatigue if there are many questions needed to collect the appropriate data. There may also be inflexibility with quantitative research which may lead to artificially 'made to fit' data being produced.

4.3.2 Qualitative Research

Unlike Quantitative, Siegle (2008) suggests that qualitative research assumes that reality is socially constructed and the variables are complex, interwoven and difficult to measure. Its purpose is to contextualise, interpret and understand the actor's perspectives and Neill (2007) suggests the qualitative research aim is for a complete, detailed description. The approach also differs in that it ends with hypotheses and grounded theory and uses the researcher as an instrument to search for patterns and seek pluralism and complexity through the use of detailed interviews and participant observation. Siegle (2008) also suggests that the researcher may only know roughly in advance what they are looking for and is subjective in that the individual's interpretation of events is important.

Neill (2008) also suggests that qualitative is in the form of pictures, words and objects and is more time consuming and less able to be generalised. The researcher's role is one of "partial personal involvement with empathy towards individuals where the researcher immerses themselves in their subject matter."

4.4 Choice of Research Method

Based on the research questions posed it was best to combine a combination of both quantitative and qualitative research into a mixed method based on direct evidence. Qualitative techniques were used coupled with quantitative techniques to analyse the data received. Qualitative research also facilitates understanding human behaviour and its interaction with the CANDO implementation. This approach did not combine the two research methods but, instead used them in parallel and/or sequentially. See figure 4.1.

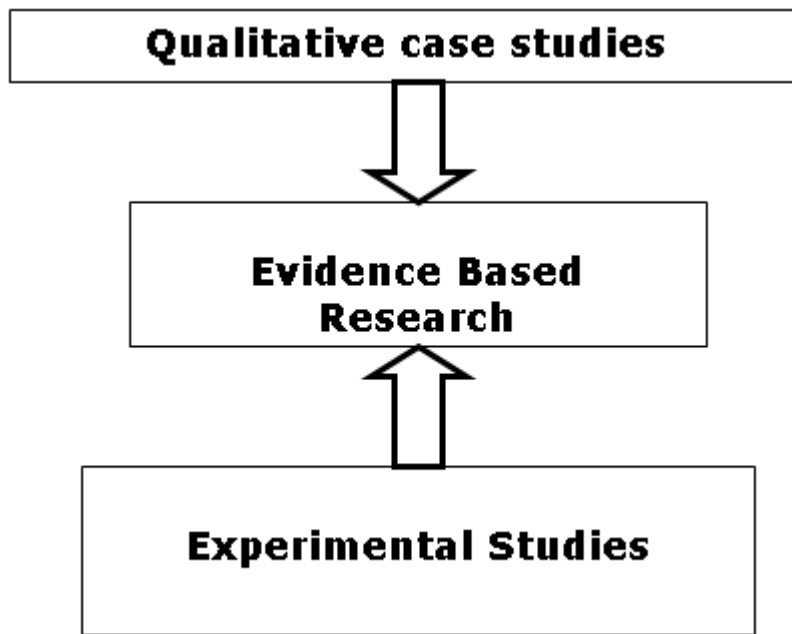


Figure 4.1: Combination of Quantitative and Qualitative Research

The aim was to carry out empirical research in order to capture the contextual data and complexity of the visual workplace organisation methodologies employed and subsequent employee reactions in order to address the research questions. This empirical research was based on evidence and observation and was geared to provide a better understanding of whether the CANDO methodology employed helped in eliminating waste, decreasing machine downtime, increasing standardisation, involving employees more and improving the operating environment. See figure 4.2.

It was an integration of research and practice and was also designed so others can learn from the experience and foster an environment for enhanced understanding of the methods employed. It moved beyond simply reporting observations and tried to explore the relevance of the theory by putting it into context in a real world environment.

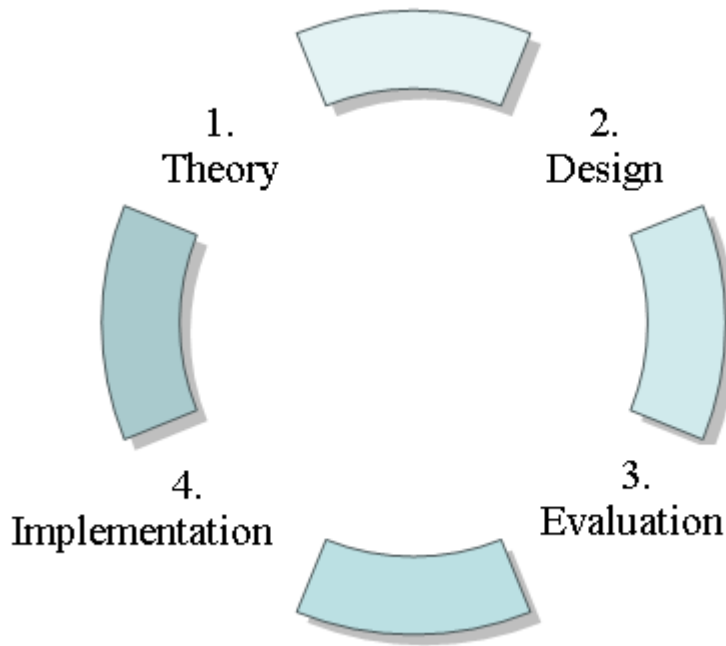


Figure 4.2: Empirical Research

An integrated approach of both semi-structured interviews along with participative and direct observation was used in order to collect data and to establish a related set of results.

4.5 Detailed Description of Research Method

The following research methods, which were employed by the author during the research period, provide enough information so that the research could be reproduced by another researcher and a similar judgement made regarding the validity of the work:

4.5.1 Direct and Participative Observation:

As part of the implementation team within the factory area, the author worked firstly in a more educational role and then as both a participative and observational role throughout all of the workplace organisation methodology steps or phases. This included area training and preparation ahead of the activity, and also providing workplace layout and manufacturing support and guidance throughout. When the author was not participating as a key stakeholder the time was used in an ‘observer as participant’

or spectator role where the research intent was known to all concerned.

Even as a stakeholder, the author made notes using primary observation of what was happening and what other people were doing throughout all stages of the CANDO methodology implementation. The author also used this time to collect other research data using semi-structured interviews at varying stages before, during and after the methodology implementation.

The key observations, questions needed to be answered and data collected throughout the research period were as follows:

- Information was collected about what was done at a factory level prior to actual implementation of the CANDO methodology:
 - Was there any training given to employees on the CANDO methodology and how was it rolled out?
 - Was there any implementation planning done?
 - Who did this planning?
 - How was it planned?
- Information was also collected about the key stakeholders who were necessary in implementing the workplace organisation methodology within the factory areas:
 - How were they selected?
 - What were their roles during implementation?
 - What pre-implementation work did they do and how did they do it?
- Collection of detailed information, observations and data pre, during and post all phases of implementation of the CANDO methodology was critical for replication of research:
 - Who was needed during each phase of the implementation?
 - What exactly was done during each phase of implementation and why?

- What were the outcomes and findings of each phase? (Pre, during and post)
- What evidence was there of waste elimination pre, during and post implementation?

4.5.2 Semi-Structured Interviews:

During the research period the author took advantage of the amount of time spent at the ‘GEMBA’ and other areas before, during and after implementation to hold non-standard semi-structured interviews with a cross section of various stakeholders and area workers from across all shifts and areas. The amount of interviews conducted was large enough to give the researcher enough data in order to answer the research questions posed. Although the main questions were focused on factory workers there were some that were applicable to other stakeholders involved in the implementation. Note taking was used to collect data based on a pre-planned list of questions and themes.

4.5.2.1 Interview planning:

In planning the interviews, the author used the following criteria:

- The author had good prior knowledge of the subject matter in question and had a list of potential questions and themes ready which would help in answering the research question posed. See section 4.5.2.2.
- The interviews were arranged by the author making direct contact in person with the interviewee and following up with an e-mail to confirm date and time of interview agreed by the interviewee.
- The author stressed that the potential interviewees were under no obligation to be interviewed or answer any questions that made them feel uncomfortable, or unable to answer, and that the interview was confidential and anonymous and would only be used for research

purposes. The author also offered to clarify any questions that confused, or seemed ambiguous to the interviewee.

- The author always made sure to bring his interview questions and themes at all times when approaching potential interviewees if they decided that an informal interviewee at the time of meeting was okay for them.
- The author explained briefly to the interviewee his role in the implementation of the CANDO methodology and about the purpose of the research and research questions posed.
- Location of the interviews was at the interviewee's discretion, although most chose their own work environment, factory floor or office, instead of a designated meeting room as they were at ease and relaxed there.

4.5.2.2 Themes and Questions:

The themes and questions to be answered varied from interview to interview and were quite informal, so as to let the interviewee express his/her opinions at ease, but the author tried to work, in general, from the following themes and question types in order to answer the research question posed:

Training and Lean drive:

- What was your initial reaction to the whole Company Lean drive prior to it taking place?
- Was the CANDO and Lean principle training provided of help in enabling you to participate and implement the workplace organisation methodology into your work area?

Employee Involvement:

Implementation phases:

- What was your involvement with the implementation of the CANDO implementation in you're workplace?

After implementation in your area:

- Is the area safer to work in?
- Is there a place for everything and everything in its place?
- Do you think that there has been a reduction in waste in the area?
- Do you feel that you have more ownership for the area now?

Sustaining Continuous Improvement:

- Do you know the process for continuous improvement and the process for changing the work area?
- Do you feel happy and confident to use this process if you have an idea that may add some value to the area?
- Did you get full management support for this activity including the resources required before during and after implementation?

4.5.3 Other Data collection that was needed during the research period to address the research questions posed:

- Measurement of average machine availability both pre and post implementation and at varying intervals post initial implementation.
- Measurement of distances travelled by employees during specific tasks pre and post CANDO implementation.
- Measurement of time taken for employees to carry out specific tasks both pre and post CANDO implementation.

4.6 Limitations

As with every research method used there are limitations. The main limitations that were identified are as follows:

- **Information/data bias:** The qualitative research was only going to be as good as the design or the research and sample size taken. To counter this limitation a cross section of employees across the shifts were involved in completing the informal interviews and data was collected randomly from all shifts.
 - **Intellectual Property Restrictions:** Company X's policies on the publication of external documentation, such as this research dissertation, has meant that strict guidelines are in place which all documents must comply with. In addition to these guidelines, an internal approval process must be followed before publication. Although this is just a reinforcement of previous guidelines, it does restrict the amount of information that can be shared as part of a research dissertation.
 - **Results Data:** All key metrics data collected during the research period was actual data but no actual absolute values or scales were presented in the findings and results. The pre-implementation data was normalised and all other data was based on ratios and percentages of the initial data. This enabled the author to give true accurate reflections of performance and improvements and not disclose true company performance metrics.
 - **Informal interviews:** These were time consuming to complete. Surveys may have been a better option of providing the data faster and in a format that was easier to interpret.
- Interviewer bias:** The answers to the questions may also have been filtered or misinterpreted by the interviewer and their perception of what they heard, rather than what they

actually heard may have come through in the results and findings.

Interviewee bias: Perceptions about the interviewer may make the interviewee react to questions in a way that suits the interviewer's bias and what the interviewer wants to hear or in a way that painted the company in a positive fashion and only a partial picture is uncovered.

- **Direct observation:** As the factory operated a shift pattern which covered 24hrs a day, 7 days a week, it was both a time and a resource constraint to carry out observations of the CANDO methodology implementation on all of the shifts. The observer effect could also have contributed to behavioural changes in employees carrying out tasks as they knew that someone was observing them. The author did, however, try and have minimal interaction when engaged in pure observation research periods. However, the power of direct observation outweighed the cons, and participant observation was the most comprehensive of all types of research strategies employed in this research.

4.7 Conclusion

The purpose of this chapter was to define the research methodology. The research questions were outlined as to what was hoped to find out through the research. The various research methodologies were outlined and the choice of a mixed approach of both qualitative and quantitative research was outlined.

The qualitative research methodology used facilitated an opportunity to observe the implementation of the CANDO methodology as well as performing semi-structured interviews, while quantitative research then facilitated data gathering and analysis to test and validate the changes before, during and after implementation. The limitations of the research methodologies used were reviewed lastly and how these may have been a contributing factor to the findings and results obtained.

Chapter 5 Results and Findings:

5.1 Introduction.

Having considered the overlap that some of the research questions posed, it was in the opinion of the author that the results and findings be divided into two separate chapters. The following section 5.2, was to be structured chronologically in order to explore in detail the implementation of the different phases of the CANDO methodology process in the factory and to give an insight into the research results and findings as they happened throughout the research period.

Section 5.2 attempts to answer the first of the two research questions posed:

- Did the implementation of the CANDO process reduce waste, increase work standardisation, decrease machine downtime and enable a drive towards continuous sustainable improvement?

The next section, 5.3, concentrated on the reactions of employees to the semi-structured interview questions and addressed the second research question posed:

- Did the employees learn from the training and implementation of CANDO and did they feel more involved and empowered in making decisions regarding their workplace environment during and after the implementation?

5.2 CANDO Implementation:

5.2.1 Initial Planning and Training

As part of a Companywide workplace organisation drive, with full senior management backing, the Visual Workplace Organisation methodology of CANDO was rolled out throughout the factory along with other mandatory lean principle classes.

The communication, training and roll out alone took quite a bit of time to do due to the scale of the task and to make sure that everyone knew what the whole lean concept was all about and when it was starting.

The CANDO methodology employed by Company X incorporated a sixth element, unlike normal 5S methodology, to include ‘Safety’ which remained a priority throughout the whole exercise. See figure 5.1.

This sixth safety element meant that all the other phases during their implementation had to incorporate and address dangerous and hazardous work conditions, but also take into consideration the high level of quality required in the area.

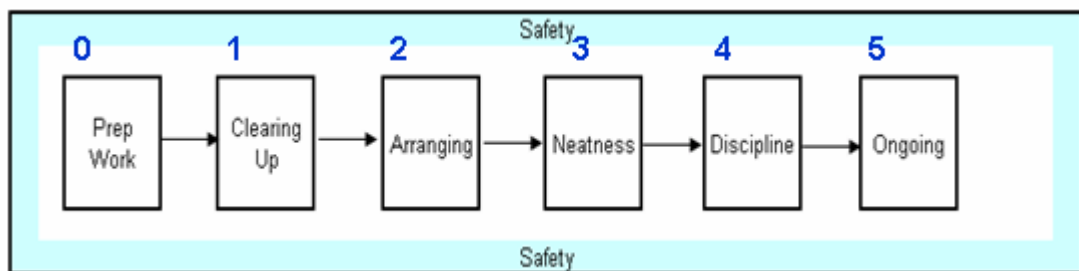


Figure 5.1: CANDO methodology employed in Company X with surrounding Safety element.

During the extensive training it was paramount that all members of the Company had prior understanding of what the CANDO methodology and the terminology surrounding it were, and how they related to the Japanese 5S principles and other lean principles, before embarking on the implementation stage. This was done by relating the 5S implementation to the detailed ‘House of Lean’ referred to in figure 2.2 and stressing how important good visual workplace organisation was as a building block in the ‘house’ in the quest to build the ideal state.

Explanations were given to the employees of the benefits of embarking along this lean journey and why this visual workplace organisation method was going to be implemented. In order to

make the activity a success it was necessary that employees became involved, contributed and committed to the training and the process and could raise any issues or concerns as and when needed without fear of reproach. To enable this, the training also incorporated some team building and teamwork exercises to show the various concepts and principles in a more practical way.

A Company wide project management team put a detailed project plan in place in order to manage the full implementation phase. This small team consisted of managers, both senior and junior, who had expert lean implementation and project management experience and training. This had initially involved them using external and internal experts and going through pilot programs with and without expert guidance.

Taking into account the scope, timelines, quality and costs involved in implementation, the plan they came up with clearly documented what was needed, when and how it was to be done and who was needed to do it. See figure 5.2. The order of implementation of areas to address first was decided based on initial need and where the payback time was shortest.

These areas were to be used to provide good examples for other subsequent areas of what CANDO was all about and demonstrate the early wins from its implementation. Full Company communication of the results and progress of CANDO was ongoing throughout so all employees had some involvement and visibility to the drive.

	Category	Duration to complete	Team leader	Area Supervisor	Technicians/ Workers	Lead technician	Machine Engineers	Lagout Engineer	Manufacturing Support Manager	Industrial Engineer	Safety/ Quality experts
prep work	Complete CANDO Overview training	x hours	Attend	Attend	Attend	Attend	Attend	Attend			
	Set-up Area Core teams	X day		Lead	Attend		Attend				
	Complete Core team training	X hours	Facilitate	Attend	Attend	Attend	Attend	Attend	Attend	Attend	Attend
GEMBA activity	Define Area requirements	X weeks	Facilitate	Approve	Lead	Input	Input	Input	Input	Input	Input
	Define the storage unit inventory, quantities and location	X weeks	Facilitate	Approve	Lead	Input	Input		Support		
Layout agreement	Complete Red Tagging	X weeks		Approve	Lead	support	Input				
	Schedule Final Area walk			Lead							
	Complete Area walk	X days	Attend	Lead	Attend	Attend	Attend	Attend	Attend	Attend	Attend
	Agree Area layout	X week	Approve	Lead	Input		Input	Input		Input	Input
Back-end process (implementation)	Update Lagout with Changes	X days	Approve					Lead		Approve	
	Implement Lagout changes				input	support			Lead	Input	
	Submit work orders	X week							Lead		
	Purchase new Support tools / specific Equipment (jigs & fixtures, Hand-tools)	X weeks			Approve	Support			Lead		
	Install new equipment / new Support tools / specific Equipment (jigs & fixtures, Hand-tools)	X weeks			Lead	Support			Input		
	All changes implemented										
Final Approval phase	Develop VBKM for new layout	X week	Approve	Input	Lead	Input					
	Implement Storage / Labelling / ID's	X weeks		Input	Lead	Support			Input		
	Complete final Labeling and Approve area	X days	Approve	Lead	Input	support					
Sustaining	Audit Schedule set-up and communicated	X days	Approve	Lead	Input	Support					
	Data uploaded to Central Web Site	X days	Approve	Lead		Support					
	Total	X days									

Figure 5.2: Example section of CANDO Implementation Checklist employed during Company X implementation. (Note that the checklist has been changed to hide true Company X methodology, sequence of events and participants)

5.2.2 Preparation work: Phase 0

The first phase of implementing the CANDO methodology was Prep work, Phase 0 in figure 5.1, which was done prior to the other five activity phases by core teams. Team leaders were assigned for each area within the factory with which they had detailed knowledge of and were already in a manufacturing management role in the area so they could relate to the workers and their needs. Other core team members were picked based on their expertise in a given field, and their roles and responsibilities for the activity were identified. These CANDO

core team members and their roles in the implementation consisted typically of the following:

- Area supervisors, who were assigned sub-areas each to own during the implementation phase.
- Lead technicians from each of the sub areas who had good machine maintenance and tool requirement expertise.
- Other area technicians to act as support during CANDO implementation who also had maintenance and tool experience.
- Machine Engineers who had detailed process and machine experience.
- Area or machine type Industrial Engineers with lean implementation knowledge along with detailed area/machine capacity and resource requirement knowledge.
- Factory Layout Engineer and Planners with detailed area and machine layout requirements and factory planning knowledge.
- Factory Manufacturing Support Manager: who had detailed knowledge of suppliers and support equipment along with the project management skills necessary to manage all of the resources required to remove, dispose and add items to the area as required.
- Health and safety officer: Expertise in all safety aspects and could address all safety concerns and needs during the implementation in the various areas.
- Factory quality experts with knowledge in allowable contamination and materials in the manufacturing area environment.

Other experts in area specific fields were called into the core team or consulted as required.

When the core team came together for the first time they held a meeting and discussed the various roles and responsibilities that

each core team member had during the implementation phase and aligned them with the overall CANDO methodology and where it sat within the overall Company lean drive. It also gave the team time to get to know each other, as some members may not have worked together previously. Each phase of the CANDO was mapped out so everyone knew when, how, why and what their role was during implementation.

The first task for the core team was to go to the ‘Gemba’ which literally translates from Japanese to "the place where the truth can be found." The reason for doing this was, firstly, to get a better understanding or sense of the area in which the problem or opportunity lies by mainly observing, occasionally questioning, but not guiding or directing.

Going to the ‘GEMBA’ also gave the core team time to do a full audit of the present state ‘AS-IS’ and take down a full inventory of what was in the area and where items were situated in the layout. One or more visits to the ‘GEMBA’ by the core team may or may not have been required dependent on the complexity of the implementation task that lay ahead.

While observing the employees carrying out specific tasks, which were part of their day to day activities in the area, the core team, which included the author, were able to use spaghetti diagrams to identify and map out walking distances travelled by employees and the areas travelled to and tools and equipment they used most often. See figure 5.3.

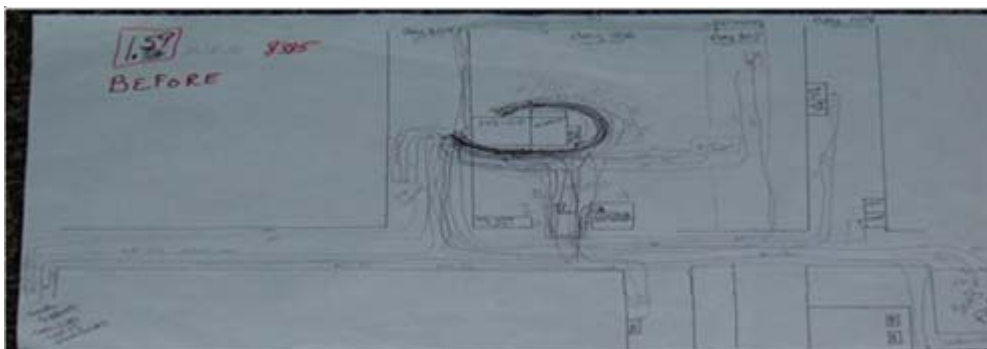


Figure 5.3: Spaghetti diagram of an area activity during research period and prior to Company X CANDO implementation.

The picture in figure 5.3 of a spaghetti diagram drawn on large plain paper by the core team members is taken directly from one of the areas during the preparation phase of the CANDO implementation. All movement of the employees during the observation period were mapped, and tasks, time taken and areas visited were written on the paper and numbered in sequence of activity done. Measurements of actual distances travelled by employees were taken using average employee step measurements and step counters while at the ‘GEMBA’ and totalled to give a total distance travelled during a particular activity. This process was again repeated after the CANDO implementation phase which follows later in this chapter.

The initial spaghetti diagram process enabled the core team to identify areas of waste and subsequently help direct the CANDO activity to eliminate those areas of waste which, often, is the cause of employee inefficiency, frustration and subsequent lowering of morale. As well as using diagrams, the core team took photographs of the area and storage spaces in the present ‘AS-IS’ state so comparisons could be done throughout the CANDO implementation phases. Figure 5.4 shows an example of a storage drawer and a factory area prior to CANDO implementation.



Figure 5.4: Pre-Implementation photographs (Note photographs disguised to protect IP)

While at the ‘Gemba’ the core team also discussed and agreed the set of goals for the area and ‘brainstormed’ ideas and

solutions to any opportunities or issues that were immediately present. A 'TO-BE' goal state was discussed which was how they envisioned the area to look after implementation. This again gave the core team members a clearer understanding and sense of ownership of what the CANDO activity would involve and what problems, technical or otherwise, could arise in its implementation.

These implementation problems were discussed and 'brainstormed' while at the GEMBA, and either the solutions were forthcoming immediately or the team members tasked would work on them when they dispersed from the immediate activity. This involved the team leader giving clear direction, timelines and ownership to team members to help resolve any issues. Once this was done, and the path was clear to continue with implementation, the clearing up phase could begin.

5.2.3 Clearing Up (Sort): Phase 1

This activity consisted of sorting through all the tools, materials and equipment in the work area and keeping only the necessary items that were needed for the area. Everything else was to be stored or discarded.

This activity mainly involved the team lead and the technicians and machine engineers who used the area daily.

It was essential that everyone understood that they were trying to create a clutter free area where only necessary value add items should remain which could be found easily and quickly when required. In the quest for value add and waste elimination, friendly reminder signs similar to that shown in Figure 5.5 were put in the areas so they were clearly visible to all as they entered and exited.

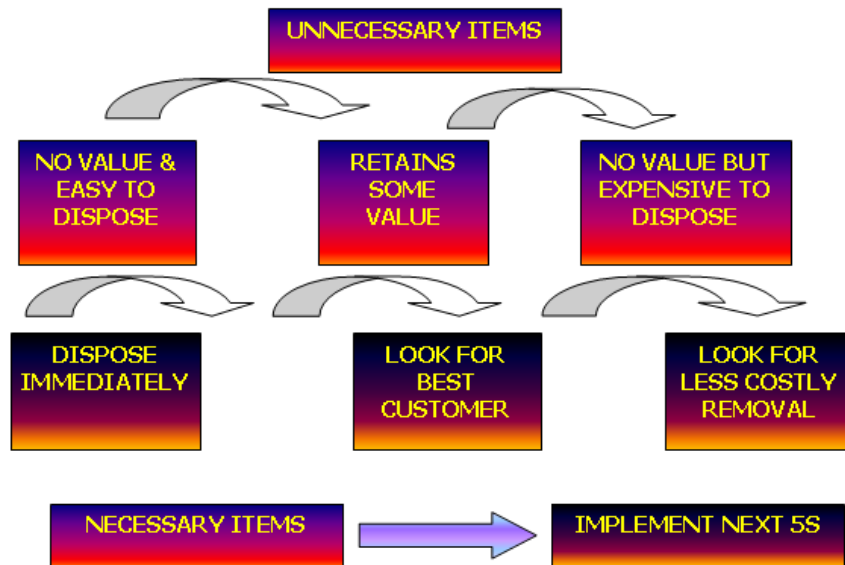


Figure 5.5: Example of Company X signage.

The factors that would determine the necessity of an item during the clearing up phase in Company X were based on the following:

- The degree of the items usefulness for job performance.
 - Do I intend to use it?
- The frequency of using an item.
- The quantity needed to carry out the job immediately.

Items that were deemed unnecessary would be ‘Red Tagged’ for disposal. These red tags would be physically put on items in the area for everyone to see. An Area location and date were put on the tag when the item would be removed which was typically in the order of 2-3 wks. The tags also had additional lines where anyone objecting to the item removal could write their objection on and contact details.

When the work team came to dispose of the item on the agreed date, and there were no objections to removal, then the item was removed and placed in a central storage area for subsequent disposition. The items removed were to be dispositioned in any number of ways – reuse elsewhere in Company X, returned to vendor for credit, used for parts, sold on or scrapped. The final exact disposition of the items was not recorded due to timelines

involved and scope of the research which focused mainly on the implementation.

Those items with objections were either left in-situ or dispositioned accordingly by the factory support manager with other core team member input considering the objection raised.



Figure 5.6 ‘Example of Red tag employed.

5.2.4 Arranging (Set In Order): Phase 2

When the clearing up phase was completed for the areas then the work of creating an optimum workplace environment began. This entailed the core team, with supporting technician and operators help, creating a detailed tabular categorisation of items in the area by type and/or frequency of use.

The core team referred to the spaghetti diagrams also to help with this activity of identifying items and areas used frequently or infrequently.

From the table and lists generated it meant that the team layout and planning experts could work in conjunction with the other team members with the area layouts to determine a near optimum efficient layout in terms of storage and work areas that would be acceptable to all of the area and team members so that necessary items were to hand with minimum travelling and effort needed to get them. There may have been several iterations of the layout required so as to ‘fit’ and get as close as possible to the ‘TO-BE’ near ideal state. It was also stressed to all that this would be an ongoing process.

The original area layout and the agreed ‘TO-BE’ layout and all changes necessary to transition from one to the other were captured in a single document for implementation by the work teams under guidance of the factory manufacturing support manager.

The Factory Manufacturing Support Manager provided all scope, costing, resources and timelines required for the arranging activities and sought full senior manager approval prior to implementing the changes required. A storage area had been designated for all of the removed “Red tagged” items prior to factory implementation began. The core team provided guidance and support if issues arose during the implementation of the arranging phase.

The core team reconvened at the ‘GEMBA’ after the arranging was done to firstly check to see everything was as to plan and, secondly, to decide on what visual controls and indicators would be necessary for the specific areas which would be standardised across all of the factory areas.

The following are examples of some of the visual controls and indicators used:

- Colour coded specific areas, like kanban or hazardous areas or walkways and additional colour outlines on the floor of where each item in the area should be stored. See figure 5.7.



Figure 5.7: Colour coded areas

Clear signage of emergency exits and routes, safety equipment and hazardous materials and area protocol. See figure 5.8 for example safety signs used in Company X.



Figure 5.8: Example of general safety signage which may have been used in Company X.

- Clear labelling of all items within the area for easy identification.



Figure 5.9: Example Company X items with clear labelling.

- All storage cabinets, cages and toolboxes had clear labels on the outside detailing the exact numbered contents for each drawer or compartment and additional pictures of exactly what should be in each and its exact location within. Foam cut-outs with the tool and item shapes were used inside the storage drawers so every item had a specific place. These pictures were placed on the outside of the storage items for ease of identification and reference by employees.



Figure 5.10: Pictures of storage with clear labelling. (Note that pictures amended to avoid relation to Company X areas or items)

- The whole area was photographed again from varying angles to capture all area items and the pictures were placed surrounding the corresponding layout drawing using computer downloads and a template. This template, which was a Visual Best Known Method (VBKM) for workplace organisation in the area, was then printed on large laminated paper and placed close to the entrance and exit doors for ease of reference. A standard template for all areas was used. See Figure 5.12.

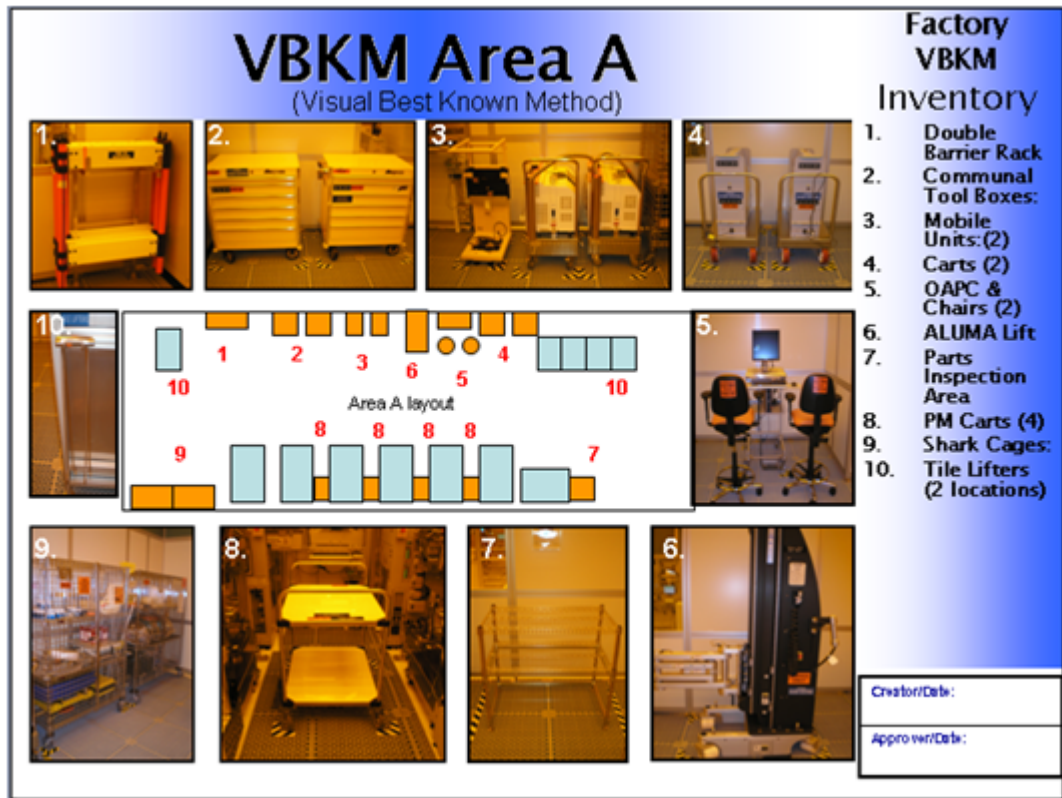


Figure 5.11: Example of the Visual BKM template used in Company X during implementation (Note: Layout locations omitted and true equipment names changed).

The core team also worked with the area technicians and operators to arrange the items in their storage areas using the criteria shown in figure 5.12:

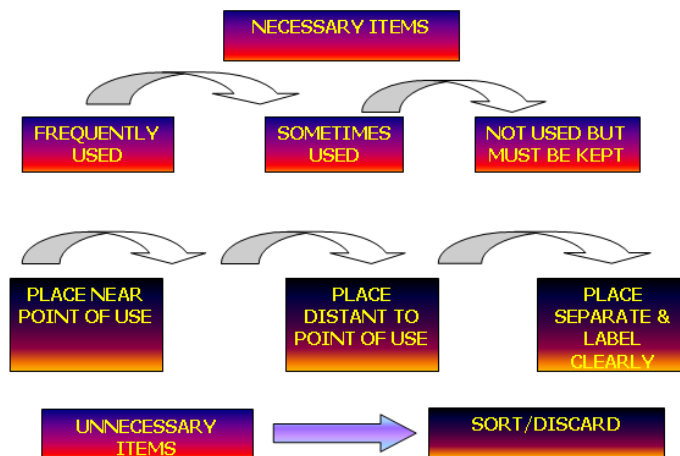


Figure 5.12: Arranging criteria used in Company X.

This whole activity was geared towards creating a workplace environment where there was ‘a place for everything and everything was in its place’. See figure 5.13.

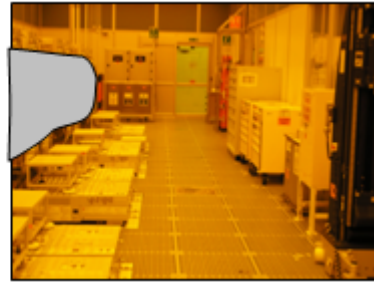


Figure 5.13: Pictures taken Post CANDO implementation (Note photographs disguised to protect IP)

After this phase the core team reconvened at the ‘GEMBA’ and repeated the spaghetti diagram exercise, as previously done in the preparation phase, using the same employees and the exact same unchanged work task. See figure 5.14. In 100% of the cases researched there was a significant decrease in travelling by the employees. The time to do the specifically researched regular tasks was also reduced as the items they needed were readily available but the number of steps in the task remained the same.

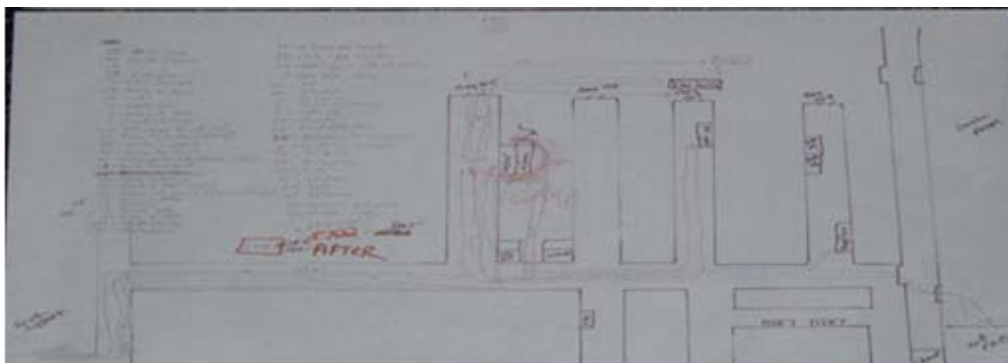


Figure 5.14: Spaghetti diagram of the same area and activity done in Phase 0. This was done after CANDO implementation.

In the researched area above there was a 33% decrease in travelling after Phase 2 compared to before implementation. This was consistent with all other areas researched where there was an average of 28% reduction in travelling required.

Scheduled and unscheduled maintenance activities took less time and became more predictable. See table 5.2. A large proportion

of this was due to having the right equipment to hand and in its place for ease of access.

As this was part of an overall Company Lean drive which involved other ongoing parallel activities such, as quick changeover (Single Minute Exchange of Die: SMED), it was impossible to exactly calculate how much of change in equipment availability and a decrease in maintenance activity was attributable directly to CANDO implementation. If CANDO was implemented solely this measurement would have been easier to record both pre and post implementation and a true reading of the effects of CANDO on equipment availability and activity reduction would have been recordable.

Table 5.1 shows the percentage improvement or non-improvement in average Machine availabilities post the CANDO Implementation. Note that these percentages are taken with reference to pre-CANDO machine availability and are not actual percentages of a week with regard to time. For example: If Machine A had a pre-CANDO average weekly availability of Z%: For the first 13 Wks post CANDO there was a Z% x 3% non improvement. For the following 8Wks after this period there was a Z% x 3% improvement in availability compared to Pre CANDO implementation average.

Machine type	Average Weekly % change as % of Pre CANDO Machine Availability (Reference Availability taken over 13 Wks Pre implementation)		
	0 - 13 wks Post CANDO Implementation	14 - 21 wks Post CANDO Implementation	Average change per Machine type
A	-3.0%	3.0%	0.0%
B	6.5%	0.1%	3.3%
C	6.9%	8.2%	7.5%
D	0.6%	4.4%	2.5%
E	-0.2%	0.1%	0.0%
F	-1.9%	-0.3%	-1.1%
G	1.5%	1.7%	1.6%
H	11.9%	11.4%	11.7%
I	-0.7%	1.3%	0.3%
J	-5.4%	1.0%	-2.2%
K	-2.3%	-0.7%	-1.5%
L	8.5%	6.9%	7.7%
M	-7.1%	-1.6%	-4.3%
N	-0.3%	0.8%	0.2%
O	-3.3%	-1.0%	-2.1%
P	-0.8%	-1.1%	-0.9%
Q	0.3%	1.0%	0.6%
R	-0.7%	-0.2%	-0.5%
S	-0.6%	0.4%	-0.1%
T	0.0%	0.6%	0.3%
Average Overall % change compared to Pre CANDO	0.5%	1.8%	1.1%

Table 5.1: Area Machine Availability improvements/non improvements post CANDO Implementation.

		Post CANDO Implementation Scores	
Area researched	Task researched	% improvement in distance travelled. (Taken from comparison of pre and post implementation spaghetti diagrams and distances calculated)	Average % improvement in time taken to carry out task. (Taken from pre and post CANDO average task times)
1	A	16%	4.1%
	B	25%	6.3%
2	C	39%	12.2%
	D	18%	5.4%
3	E	24%	5.0%
	F	38%	14.0%
4	G	33%	10.3%
	H	29%	7.9%
Average		28%	8%

Table 5.2: Distance travelled and Preventative maintenance activity comparisons between pre and post implementation.

5.2.5 Neatness (Shine): Phase 3

As the initial ‘creating’ phases had been completed there was a transition to a more sustaining phase. This involved cleaning and looking for ways to keep the area neat and tidy.

Once the cleanliness standards had been agreed by all who worked in the area, including managers, technicians and engineers, it was up to all the area employees to maintain the cleanliness in the area as if the area had just finished the arranging activity. The process to attain the agreed cleanliness standard and maintain it was agreed and documented. Simple area, sub area checklists and Visual Best Known Methods (BKMs) were employed and placed so all could see them as they entered or exited the area. See figure 5.15.

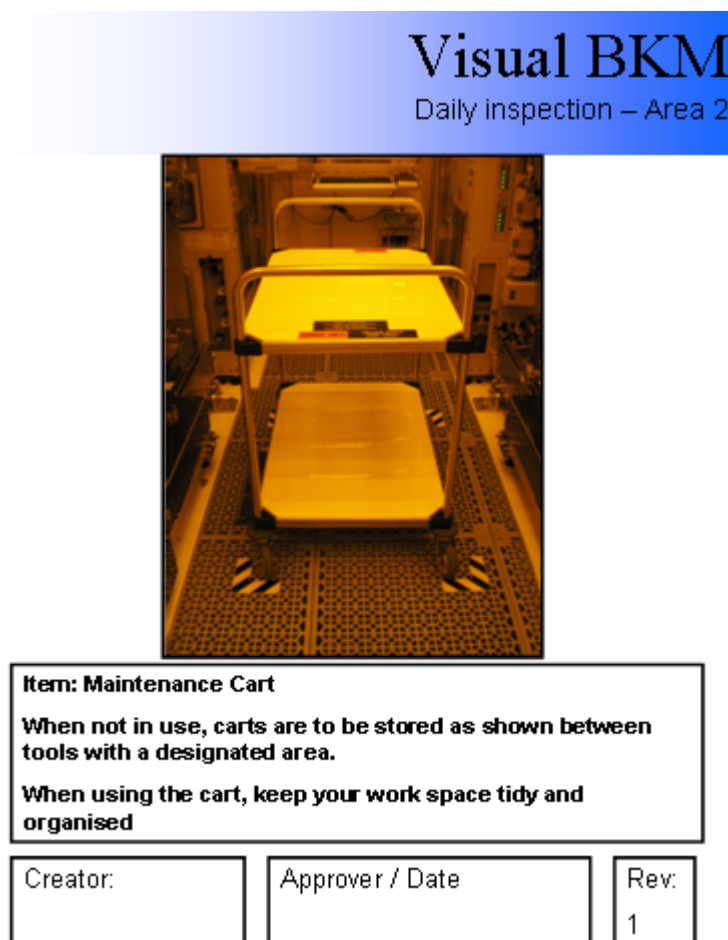


Figure 5.15: An example of a Visual BKM used in Company X during CANDU implementation. (Note that Visual BKM disguised to avoid relation to specific Company X area or item)

It was imperative that employees got into the habit of continually cleaning up after their work activities and restoring items to their place after the work activities were over. Planned regular checks (audits) and clean ups were scheduled based upon frequency requirements agreed to ensure the areas and sub areas remained to standard.

This activity required a ready supply of cleaning materials to be made available and stocked in specialised storage units on a regular basis so as the areas would never run dry of them. Factory support teams were set in place to react to items that were running low of such materials. A 'Kanban' system was put in place to flag when materials were running low. The results showed that no areas had run out totally of such materials on any occasion during the research period observations.

To ensure compliance and a dedication to this phase an area inspection audit, see figure 5.17, was also done on an unscheduled recurring basis by employees to ensure that the areas were always to the best possible standard given the activity circumstances happening in the area at the time.

5.2.6 Discipline (Standardise)

In order to maintain the area workplaces so as to continuously meet the standard that the first 3 phases had implemented it was necessary to provide additional training to employees so that both the area standards and inspection routines were being adhered to rigidly across the entire factory workforce. This would allow for control and consistency. The training was geared so that the employees would know exactly what their responsibilities were with regard to maintaining an organised workplace and housekeeping duties became standardised and part of everyone's daily work routine. Figure 5.16 shows some example signage that was used to compliment the additional training.

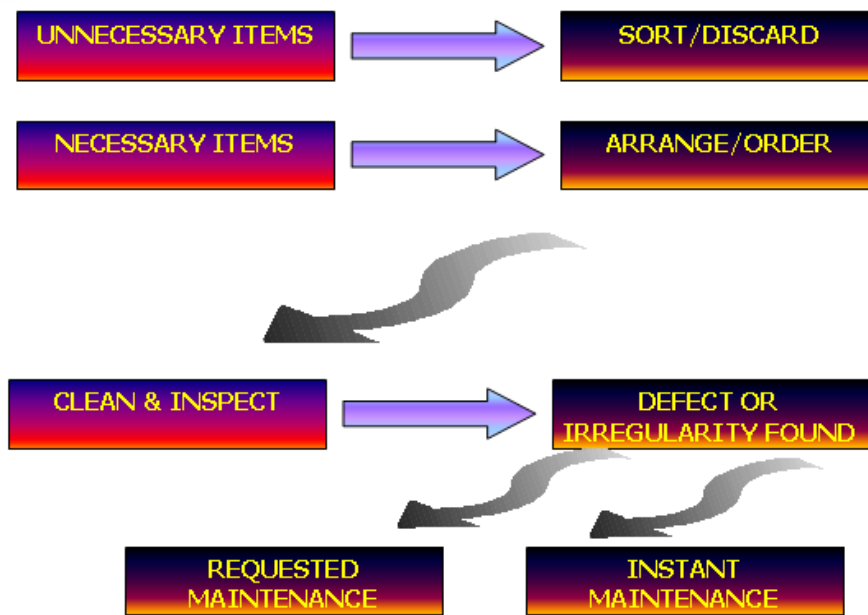


Figure 5.16: Example Company x signage to complement training.

Area 1 Audit Sheet					
	Storage Location			Date:	
	»Is the item stored in the correct location as per Visual BKM?			Auditor	
	Item	Look For:	Comments	Add Value A	Add Value B
Mobile Items	Specialist Lifter	Compare to Visual BKM			
	Storage Cage # 1	Compare to Visual BKM			
	Storage Cage # 2	Compare to Visual BKM			
	Process A ladder	Compare to Visual BKM			
	Wip mover	Compare to Visual BKM			
	Work Table process A	Compare to Visual BKM			
	Work Table process A	Compare to Visual BKM			
	3 Step Ladder	Compare to Visual BKM			
	Preventative Maintenance Cart	Compare to Visual BKM			
	Stored Contents»Are the items contained stored in the correct location as per VBKM?				
	Shelf	Look for:	Comments	Add Value A	Add Value B
Storage Cage # 1	Top Shelf	Compare to Visual BKM			
	Middle Shelf	Compare to Visual BKM			
	Bottom Shelf	Compare to Visual BKM			
	Cart interior quadrant	Look for:	Comments	Add Value A	Add Value B
Preventative Maintenance Cart	Top Left	Compare to Visual BKM			
	Top Right	Compare to Visual BKM			
	Bottom Left	Compare to Visual BKM			
	Bottom Right	Compare to Visual BKM			
	Preventative Maintenance In Progress				
	»Are the activities being performed in keeping with the CANDO methodology				
Methodology	Example		Comments	Add Value A	Add Value B
Clearing Up	Is rubbish being disposed of, are workspaces cluttered				
Arranging	Can tools/parts be found easily				
Neatness	Is the area neat and tidy				
Discipline	Are all those present inspecting and enforcing methodology				
Qn-Going Improvement	Is there feedback from all involved				
Extra element: Safety	Are Barriers up, Ergonomic aids being used, etc.				
			Total Additions:		
	Area workplace organisation shifflly audit.				
	Item to be checked shifflly			Addition	
	1	Equipment missing from location		Add Value A	
	2	Equipment present but not as Visual BKM or correctly in layout.		Add Value B	
	3	Equipment in wrong location		Add Value A	
	4	Technician not aware of work place organisation/CANDO procedures		Add Value A	
	5	Parts/spares left in area from previous repair/preventative maintenance.		Add Value B	
	6	Work table layout untidy		Add Value B	
	All Areas start with a score of 0 and Additions are Added to this value				
Pass/Fail	If score < Y : Fail			Overall Score:	
	If score >= Y : Pass			Pass / Fail	

Figure 5.17: Example of part of an Area Audit sheet in Company X. (Note that there have been changes made to hide true Company X scoring methodology and area specific items).


Separate routine inspections of the areas were also done by specialist employees who had specific knowledge in carrying out factory wide inspections and highlighting issues. See figure 5.17.

This activity was geared to continuously drive a consistent standard across all areas in the factory.

5.2.7 Ongoing Improvement (Sustain).

In order to keep the momentum going it was imperative that employees had the self discipline to adhere to the CANDO methodology on a habitual basis. It was also important that new ideas, suggestions and feedback on the methodology, or anything related, could be captured so as to highlight areas for improvement and any issues with the CANDO implementation, inspections and sustaining process. This was done through an idea bank which was developed and used web application forms for submitting ideas and it was supported by a database for ease of grouping and rounding up of data. See figure 5.18.

Please enter your Suggestion/Improvement/Idea Information in the form below



1. Enter your description (Mandatory)
Please describe the present situation and your suggested improvement
(MAX 1000 Chars) In addition to submitting the Idea, please try to quantify the ROI/Benefit of the idea as much as you can.

2. Enter your (Reportee) details **3. Enter details**

Reportee : (Your ID Number)	<input type="text"/>	<input type="checkbox"/>
Business Unit :	<input type="text"/>	<input type="checkbox"/>
Department :	<input type="text"/>	<input type="checkbox"/>
Reportee Shift : (Your Shift)	<input type="text" value="1"/>	<input type="checkbox"/>

Details of Where and When

Campus :	<input type="text"/>	<input type="checkbox"/>
Geog :	<input type="text"/>	<input type="checkbox"/>
Location :	<input type="text"/>	<input type="checkbox"/>
Date Recorded :	<input type="text" value="20 Aug 2008"/>	<input type="checkbox"/>
Program :	<input type="text" value="Work Elimination"/>	<input type="checkbox"/>
(To which initiative does this belong?)		

4. Answer below question (determines if Idea will require a team.)

Can you implement this suggestion by yourself?

* Indicates that the field is mandatory

Figure 5.18: Example of Company X idea/suggestion and improvement web application. (Note that this figure has been changed to eliminate any Company X application specific information).

After initial implementation of CANDO further developments were made in the area audit process and were geared towards not giving a pass or fail but directing the focus to areas for improvement. As the audits were done at regular intervals they were only ‘snapshots’ in time of the area and it became clear that it was better to know if the areas were in control and if any ongoing improvement opportunities were present. With the new

process the regularly done audit scores were based on an improved CANDO methodology matrix as illustrated in figure 5.19.

AUDIT				Area 1								
S	No	Check items	Descriptions	Score								
				0	1	2	3	4				
DISCIPLINE												
DISCIPLINE	1	Improvement Memos	Improvement BKM's are regularly being generated & distributed?									
	2	Improvement ideas	Are improvement ideas being acted on & followed regularly?									
	3	Key procedures	Are there any unused jigs, tools, dies or similar items around?									
	4	Improvement plan	Are VBKM, Specs, AR's are clear, documented and actively used?									
	5	The "CAN" sections	Are CAN (Clearing up, Arranging & Neatness) items fully maintained?									
Sub Total												
ONGOING IMPROVEMENT												
ONGOING IMPROVEMENT	1	Training	Adequately training is provided to area MTs & maintained?									
	2	Tools & Parts	Are hand tools and spare parts being stored with correct protocol?									
	3	Protocol	Cu/Clean room protocol and other fab protocol are maintained?									
	4	SPECS/BKMs	Are specs & BKM's are up-to-date and regularly "RnU"/reviewed?									
	5	Activity board	Audit reports, corrective actions etc. updated & regularly reviewed?									
Sub Total												
Grand Total												

Figure 5.19: Partial Extract taken from a typical Company X audit sheet. (Note that Company X specific information and methodology is removed)

The regular audits were compared to each other on an ongoing basis so that areas for ongoing opportunity and trends could be highlighted and addressed by area workers.

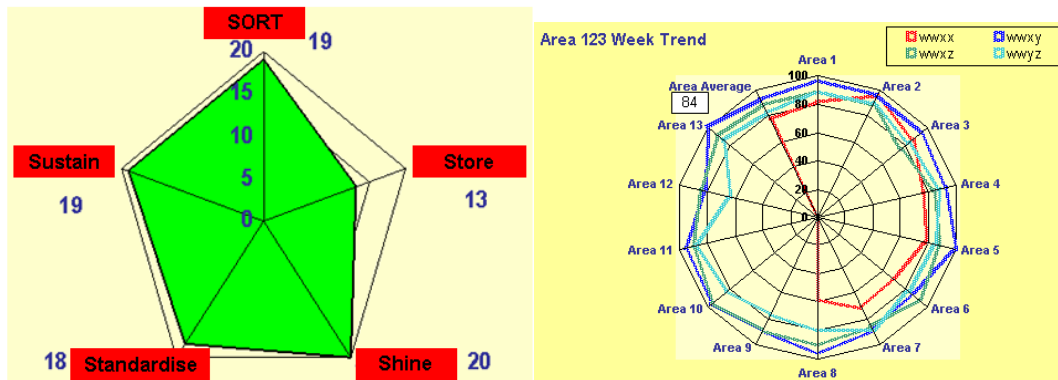


Figure 5.20: Extract taken from typical Company X area trend charts. (Note: Company X specific information and methodology removed)

All new employees who came into the factory or moved area were trained on the CANDO and lean principles or area specific CANDO methodologies employed where applicable.

It was important that the standards were maintained factory wide to keep it in a safe and efficient order day after day.

5.3 Semi-Structured Interview findings

- Did the employees learn from the training and implementation of CANDO and did they feel more involved and empowered in making decisions regarding their workplace environment during and after the implementation?

5.3.1 Training and Lean drive:

- **What was your initial reaction to the whole Company Lean drive prior to it taking place?**

Overall, the reaction was positive towards the whole Company drive as employees were able to understand the rationale, in the current economic climate, of cutting costs and increasing productivity with an increase in employee involvement. However, a couple of individuals felt that the lean drive and subsequent activities would make more work for them and they were not used to the idea of a continuous improvement environment where inputs from everyone were encouraged. They were used to big single changes of which they had no control over and they had no responsibility for. All interviewed did, however, accept that the drive to eliminate waste in their work tasks and environment was a step in the right direction and would hopefully make their work easier and a better and safer place to work in.

- **Was the CANDO and Lean principle training provided of help in enabling you to participate in and implement the workplace organisation methodology into your work area?**

After the initial Company wide standardised training was rolled out, the majority of interviewees were overwhelming positive towards what the CANDO methodology and lean was all about and what it could do for the areas they worked in. Some understood that this drive was not just another 'Fad' that the company was going through and that it was here to

stay. The training encouraged both group and individual contributions. Both management and employees were learning and participating together and it became apparent to the employees that they would and could have a say in how their areas were organised.

Other interviewees liked the way the training put emphasis on the fact that it would take commitment and involvement from everyone to make the implementation of CANDO a success. Some did have reservations about how this could be sustainable for the long term and how peoples interest could dwindle and the areas would go back to the way they were.

One interviewee also indicated that it was acceptable for most people to take care of their own waste, but few like to take care of other peoples waste.

5.3.2 Employee Involvement:

Implementation phases:

- **What was your involvement with the CANDO implementation in you're workplace?**

All of the interviewees suggested that they had taken some part in the implementation phases of CANDO. Some interviewees did not work directly in the factory areas but were involved only in the planning phases prior to implementation. Others worked within the core team which gave them the opportunity to be involved throughout all of the phases and interact with all of the shifts involved. The vast majority of those interviewed did, however, work on shift in the areas where the CANDO implementation had taken place and was ongoing. Because the factory was shift based, some employees did stress that they would have liked to be involved more in certain implementation phases but were unable due to shift rosters and CANDO implementation timing.

However, some interviewees liked the way that if changes were going to take place in their area that they were always kept in

the loop and informed about it through communication from supervisors and from other workmates on different shifts. They were also able to keep up to date with visual layout updates and 'red tagging' of items to be removed.

After implementation in the area:

- **Is the area safer to work in?**

All interviewees felt that there was good emphasis put on the safety aspect of the visual workplace organisation throughout the implementation phase and the areas were a lot safer because of the visual controls put in place. All felt that the area safety equipment, walkways, exits and entrances were clearly marked and were easier to find. Others found that the updated layout, pictures and lists also gave them an easy reference to items that should not be there and issues and safety problems were more easily identifiable after the activity phases.

- **Is there a place for everything and everything in its place?**

This question was directed more to the employees who worked in the areas where CANDO implementation took place and the majority of interviewees said that it was a lot easier and quicker to find items than it had been previously. Most interviewees said that this was due to the visual photographs and lists posted on storage areas and equipment and because the items used most often were now stored closer to where they were needed. However, a couple of interviewees said that they had on occasion gone to look for something and it had not been where it should have been and the items were only found after a bit of searching around the area or even in a different area. Sometimes replacement items would have to be bought or supplied if not found. They did suggest this was an issue, especially during a change over of shift and break

coverage times, and it was hard to engrain into people's minds the philosophy of getting everyone to return the items after use before they leave the area. When asked if this was an ongoing issue the reply from the interviewees was that it was at the start just after implementation but that the issue was not as bad some time after implementation and the constant training and support received helped.

- **Do you think that there has been a reduction in waste in the area?**

In asking this question the author used the 'TIMWOOD' waste structure so the interviewees could identify the different types of waste and relate them to the changes in the areas and activities during and after implementation.

- **T – Transportation:** Most of the interviewees agreed that stored items that were used regularly would not have to be moved as far as before as they were in closer proximity now to be taken or replaced from their storage areas. Others referred to the fact that Work benches and jigs were also placed closer to the equipment so that when carrying out maintenance there would be less distance to cover to fetch them or to carry parts and other items to them.
- **I – Inventory:** Because the areas were more visually organised some of the interviewees said they could find important fixtures and jigs and specialist equipment more easily and hence there was less downtime on equipment and in carrying out tasks and hence less product queuing for the equipment. Others said that the activities they did involved processing specific orders and again through an organised workplace and storage system were able to complete those orders quicker than before.

- **M – Motion:** Again most interviewees said that they no longer had to walk or travel long distances. They agreed that the use of spaghetti diagrams was good as it gave them a better understanding of the amount of wasted travelling they actually did to carry out their daily tasks. All interviewees said that they now had less distance to travel than before the implementation. Others emphasised the fact that they had previously been prone to poor ergonomics carrying out certain activities but the new layout was arranged to fit and coincide with the workers activities instead of previously putting items wherever they would fit.
- **W – Waiting:** Most interviewees made the point that they no longer had to wait for long periods for parts and specialist tools as the areas that supplied or held these items were also improved visually so they could be found quickly. Again some interviewees stressed that the items that were needed for regular issues and problems with equipment were now close to hand so action could be near instantaneous if an issue arose. However, some interviewees said that they may have to wait some time for approvals to carry out certain actions on equipment and this was frustrating for some.
- **O – Over Processing:** A couple of the interviewees originally thought that doing daily inspections on their area and returning items straight after use all the time was going to add to their work load and was not value add to anyone. However, after implementation the same employees said that it took very little time to carry out these extra tasks and it saved them time overall when it came to looking for items.
- **O – Over-Production:** There were only a couple of interviewees that could relate to this waste with regard to the CANDO implementation. However, one point was

that because everything now had a place and everything was in its place there was less need to over order tools, parts and other equipment as it was visible to all and exact amounts to be ordered could be calculated easily just by visually seeing quantities 'in place' and also by referring to the list of what quantity should be in place.

- **D – Defects/Rework:** A couple of the interviewees mentioned that because exact tools and jigs were in place and returned directly after use they could not now be mistaken for different size tools or items. Before implementation it was sometimes an issue that incorrect tools or jigs were used on equipment which ended in either error, faults or a breakage to screw heads, bolt threading and misalignment issues. Most agreed that this was now a very rare occurrence.

- **Do you know what the area should look like and how to maintain this standard?**

All of the interviewees were able to explain what their work areas should look like in detail and they explained that the use of the visual photographs, foam cut-outs, markings and lists acted as constant guidance to them to keep things as per initial standard set. A couple of interviewees stressed that it depended on the overall behaviour and commitment of all who worked in the area to whether the standard was maintainable. The area cleaning checklist was also mentioned on a number of occasions as another guide to maintaining the standard.

- **Do you feel that you have more ownership for the area now?**

There was overwhelming consensus that the employee involvement and responsibility change, both during and after

CANDO implementation, compared to previously, was remarkable. Interviewees were delighted that they had been given a chance to actually create a work environment that they were proud of which was more efficient and met their needs. They enjoyed carrying out the CANDO activities and the vast majority reported that they had felt more committed to maintaining the area post implementation.

5.3.3 Sustaining Continuous Improvement

- **Do you know the process for continuous improvement and the process for changing the work area?**

This question did cause some confusion for some employees. Some reacted by wondering why the area would need to be changed after implementation. Others indicated that the area would never be perfect and changes and little ‘tweaks’ would be an ongoing process for the future. Most interviewees were able to indicate that an idea bank and improvement process was in place where employees could log issues, ideas and suggestions for improving their work environment further. They indicated that all of the inputs logged were dispositioned or assigned for follow up by appropriate experts or managers and all would be addressed accordingly and in a timely manner.

- **Do you feel happy and confident to use this process if you have an idea that may add some value to the area?**

The vast majority said that they were happy with the system but a couple of interviewees indicated that further improvements could be made to the timeliness and the appropriateness of follow up actions. When asked to comment further they indicated that not all issues raised were dispositioned appropriately first time and further inputs and feedback were needed in order to do so which may have resulted in delays in action.

- **Did you get full management support for this activity including the resources required before during and after implementation?**

All interviewees reported that they had received full senior and junior management encouragement and backing throughout the entire CANDO and Lean drive and implementation phases. From the training received, through all of the CANDO implementation phases and into the present sustaining phase, all of the interviewees said they received all resources needed along with the support and guidance required to continue to sustain and improve on the related activities into the future.

Chapter 6: Discussion:

6.1 Introduction:

This chapter explains, evaluates and discusses what the actual findings and results actually meant in relation to theory, the influence on key performance indicators and the research questions posed:

- Did the implementation of CANDO reduce waste, increase work standardisation, decrease machine downtime and enable a drive towards continuous sustainable improvement?
- Did the employees learn from the training and implementation of CANDO and did they feel more involved and empowered in making decisions regarding their workplace environment during and after the implementation?

6.2 Evaluation of Results and Findings:

Before the CANDO methodology was implemented in Company X there was a lot of prior lean training and specific methodology training done along with up front planning to ensure the improvement methodology was rolled out properly. One of the top mistakes in any project is improper planning and the 5 Ps are representative of this: Proper Planning Prevents Pitiful Poor Performance.

The planning and preparation in Company X took quite a bit of time to do because of the scale involved. The company had to build strong expertise in both lean and CANDO implementation among managers ahead of any roll out which showed the commitment of senior management to the drive and to provide expert advice throughout. The full scope and costing was done upfront and full plans were put in place so people knew what, where, when, why and how the lean and CANDO roll out and implementation was to take place. Much of the theory and authors on the subject seemed to move on swiftly to the implementation phases and did not go into much detail about the

full planning requirements for implementation of lean methodologies into large factories.

The theory tends to focus on implementation in a single area and suggests that CANDO and any visual workplace organisation implementation can happen almost instantaneously after initial communication with employees, election of team leaders, brief training and allocation of space to accommodate unnecessary items. Although lean philosophy encourages small incremental changes the theorists did not consider the scope of planning required if these small incremental changes are to happen simultaneously in multiple areas with a multitude of people involved.

Company X had to ensure that all the resources, training facilities, facilitators, communications equipment and material were planned from an early stage before the lean drive began so that it could reach as much of the company population simultaneously. Constant communication of the lean drive, methodologies and opportunities was a must for Company X to win people over to the new ideas and give them an insight into the value add it could bring to both the employees and the company as a whole. It also cemented in the employees minds that this drive was here to stay and it would need their participation to succeed.

The theory suggested that people can go straight into the “Clearing up” phase without any true scoping of what was involved first or what the outcome may look like. The findings from Company X showed that it was important to get a good understanding of what the current “AS-IS” situation was. Going to the “Gemba” was an important starting point for company X. It was only through having a full understanding and discussion of the area with regard to issues, wastes, employee needs and opportunities that an ideal state could be envisaged and it gave people in Company X something to work towards. Constant communication and employee interaction was encouraged

throughout. This gave the people involved a sense of ownership and the goal of a more efficient, tidier and cleaner workplace as a goal they could be proud of and something they could be involved in.

Company X used strong core teams with good expertise in various discipline, and clear roles identified, so that issues and problems could be resolved quickly. The core team remained virtually intact throughout all of the implementation phases and updates were regular.

The core teams used direct observation of people at work during the phases. Alternatively Video could have helped with the spaghetti diagrams and mapping of activities but may have been seen as a bit intrusive to employees.

The Clearing Up phase did produce some quick results in Company X in that it lead to fewer hazards and less clutter to interfere with productive work thus eliminating elements of waste. There were many items that were removed during the clearing up phase in the areas which were either reused elsewhere or either resold or scrapped based on their usefulness. There was no definite overall price or cost put on the items and equipment removed from the areas researched but having seen the items and the amount removed it was in the authors opinion that the potential cost savings of having items available for reuse, returned to vendor for credit and resale values of other items put the total savings into the high hundreds of thousand of Euro.

The “Red tagging” theory suggested moving items immediately out into allocated areas which was an “If in doubt, throw it out” rushed approach. What if the items had to be put back at a later stage through necessity? It would be wasted time and effort. Company X used a longer wait period so every shift would be aware of what was going to potentially be removed so they could object through a specific process, which involved good communication and support, if the item was truly needed. This

approach maintained a sense of area ownership and empowerment amongst the area workforce instead of them coming in to a workplace that had been stripped bare because someone else decided what could and couldn't be taken away!

In Company X, the shift work system meant that all area workers were not involved all of the time through all of the initial and activity phases of CANDO implementation which was frustrating for some. The theory assumed that all area workers are involved through all phases for their input. The only way around this in Company X was constant communication of area plans and updates to workers of what, where, when and how so that activity phases did not slow to a complete halt and increase the overall implementation time.

It was important that there were as many workers and core team as possible involved in the arranging phase to get as near optimum a workplace solution as possible. It was important that the area workers and technicians helped to lead this activity as they were the ones that had to live with the changes after. Thorough analysis of work activities was important in order to create safe efficient solutions and eliminate as much travelling and fetching and returning parts, jigs and tools.

The results showed that during certain tasks significant reductions in time wasted searching for items through the use of Visual Best Known Methods (BKMs), signage, colour coding, photographs, storage solutions and travelling to and from areas. This had always been an extremely frustrating part of the workers lives previously but they just put up with it as it was the only way to do it at the time. The visual controls and signage used in Company X were specifically designed so that a new employee or anyone coming into the area for the first time would immediately be able to find items and work areas straight away. It meant that the implementation successfully enabled employees to be able to spot issues, waste and opportunities immediately.

The theory suggested that CANDO would significantly reduce waste and the results in the areas researched definitely showed this to be the case for a variety of the deadly wastes. There was an average reduction in distances travelled by workers of 28% and average times to complete specific scheduled tasks reduced by 8% compared to before implementation in the areas researched. Some tasks were, nonetheless, better or worse than others which could have been due to the specific activities and the lack of potential waste opportunities which were or were not realised. Looking at individual tasks more closely we see a direct correlation between the two sets of figures. On average, for every 4% reduction in distance travelled there was a 1% reduction in task time taken. There was no research done of the total daily productivity increases of all of the workers in the areas due to the CANDO implementation as to have done so would have taken many more resources and was well beyond the initial scope and timelines of the research carried out.

Contrary to popular theory on the methodology, when we compare the reduction in task times to machine availabilities post implementation there is no immediate direct correlation between the two.

It was noted that some machine average availabilities post the implementation were poorer than pre-implementation, approximately 40% of machines measured. This could have been due to a number of factors, such as the rise in average factory product loadings which was in place in the post implementation period in the area researched. For preventative maintenance which is based on number of products through the machine, Wip based PM counters instead of time-based, this would mean higher than average scheduled activity needed as product loadings during the post period measured were up.

Another factor could have been due to unfamiliarity with the workplace and activity changes and employees having to learn to get used to the new changes in the area. We see quite a few

examples of this in the data that indicates there was a dip in machine availability immediately after implementation but in the second measurement period, 14-21 weeks, there was a small incremental improvement on the first post measurement. It seems from the data gathered that there were some machine types where their availability did not improve at all during the post measurement period. Again, it must be stressed that the CANDO implementation is an ongoing activity and it can take time for the rewards and benefits to pay off and start to pay dividend. From the data collected during the research period there was no conclusive evidence to suggest that machine availability was dramatically improved due to the CANDO implementation and there was no direct correlation between the improvements made in distances travelled and scheduled task times.

The research into the reduction of task time was only aimed at a few specific regularly scheduled tasks and although we did see improvement in these activities there must have been some other activities and tasks, scheduled or unscheduled, which were taking longer than normal and which were reflected in the average negative machine availability scores.

The main CANDO arranging activities were geared specifically for the regular scheduled tasks with items used in these tasks placed near the work areas. Items used in less regular and unscheduled tasks were either stored further away or located in separate storage areas based on the infrequency of those activities. The cause of the lower availability figures may have also been directly related to technician unfamiliarity with the new changes and new locations of items in the area. It is in the author's opinion that the benefits coming from the implementation of the CANDO methodology take time to 'bed in' where technicians and other workers need time to familiarise properly with their new work patterns and surroundings.

Theory has suggested that CANDO can help to enable improvements in machine availability but it is in the opinion of

the author that Visual workplace organisation should be combined with other Lean techniques as a pre-requisite to activities such as value stream mapping, Kaizen events, Single Minute Exchange of Die (SMED) or quick changeover. Only after a combination of all of these systemic waste elimination techniques will the true improvements in availability become evident.

Employees were again involved heavily in the “Neatness” phase and were consulted to agree the cleanliness and adherence standards and checklists that would work for their areas so that they were in keeping with other area standards. Responsibilities were given to workers to carry out recurring checks of how the area was doing compared to the standard which again empowered the workers to take responsibility for their own workspaces.

It was noted during the interviews, that there were times especially after shift changeover, when items were not where they should have been or were hastily put in the wrong place just to save time for someone. This came directly down to a lack of fully instilled behaviour and non conformance of certain individuals. It was noted, however, that through constant management support, ongoing training and a behavioural shift that this was becoming less of an issue. It is in the author’s opinion that again it took time for the new routines and activities to become clear for the workers and it took time for the behavioural shift of employees owning the areas to transfer to everyone.

As there was nearly always some scheduled or unscheduled machine activity happening during inspections and checks there were separate cleanliness checklists employed geared specifically so they would not penalise the area for not having the ‘TO-BE’ layout at all times. This showed initiative and adapting checklists to suit activities and not activities being adapted to an audit process.

In order to standardise all areas across the factory specialist employees carried out separate audits of the areas and comparisons could be made and issues highlighted. Company X also provided additional training on how the area standards and inspections could be adhered to and help with standardisation across all of the areas.

In order to assist with sustaining the areas as per immediate post implementation and to encourage ongoing improvement it was important for Company X to constantly keep the momentum and support for the lean drive going which showed the commitment of both senior and junior management. Feedback was openly encouraged and facilitated with websites and support staff to deal with ongoing issues, ideas and suggestions. This again was evidence of employee involvement and empowered workers to get involved more in the improvement and innovative drive the company was engaged in.

Further training and updating of skills was paramount for Company X in trying to instil the standardised employee behaviour necessary for the drive and CANDO implementation to succeed and sustain and this ongoing improvement is an essential element in all of the literature reviewed.

The training and upskilling in Company X also helped to raise awareness of the help and support structure that was available to employees if any issues, defects or irregularities were found during inspections so that they could resolve them as they arose.

Chapter 7: Conclusion and Further Research:

The overall aim of the research was to investigate the implementation of the CANDO visual workplace organisation methodology in Company X. The primary objectives were to detail the implementation and record data, through the use of direct observation, data collection and semi-structured interviews, and present the findings in such a way that showed the CANDO implementation in a true light.

The CANDO implementation in Company X was tailored to suit Company X alone and a lot of prior planning, preparation and training was done upfront in order to give the implementation the best shot at success and not to rush anything. Clear roles and responsibilities were identified from the outset. Adequate resources and funding was also put in place so that the activities could be completed on schedule and done properly.

The detailed research into the actual implementation of the CANDO visual workplace organisation methodology bore strong resemblance to the majority of the literature written on the subject. There were, however, some slight Company X differences in the way that certain phase activities were carried out which were noted in the results and findings.

The research findings and results showed that the implementation did reduce waste in all of the areas researched. Employee travelling and task times reduced significantly and areas started to become more efficient and clutter free where 'everything was in its place and there was a place for everything'. Unneeded items were removed completely and reused elsewhere, resold, used for parts or scrapped as appropriate which also helped save money for Company X. The work areas had transformed and been reinvigorated into a cleaner, practical and more efficient place to work. Work

standardisation among employees started to become the norm throughout the implementation and sustaining phases.

However, there were questions raised whether machine downtime had reduced and the results and findings were not conclusive evidence that the implementation reduced overall average machine downtime in the areas researched. There were, however, some machines that did achieve incremental reductions in downtime but further ongoing analysis may be necessary to establish whether incremental improvements across all machines in Company X are forthcoming following the initial implementation and through the ongoing improvement phase.

The semi-structured interviews findings showed that the vast majority of interviewees, when they got the chance, actually enjoyed the opportunity to have a say in the way their workplaces were managed. The training before implementation and the subsequent ongoing training did help the employees interviewed to better understand the lean concepts and CANDO methodologies and give them a building block from which the drive for continuous sustainable improvement could be achieved. Due to the extent of employee involvement in the implementation it also acted as a forum for shared learning and building of relationships among all who were involved, from the technicians on the ground, to the core team, and right through to senior management level. Open honest communication was encouraged throughout. There was a shift for the better in behaviour amongst those interviewed which was enabled by the chance to feel involved and empowered to take action and make decisions concerning their areas and routines and there was a sense of pride in what they had achieved. People who had never worked before with each other are now joining in the ongoing improvement effort across the factory areas.

It must be stressed that the implementation of the CANDO methodology in Company X is still an ongoing process and cannot be considered an overnight success so that things may

start slipping and returning to as before. It is only a foundation from which full lean implementation is achievable. Company X has had some wins out of the initial implementation but there is still a lot of work to do and employee involvement is the key to making ongoing improvement sustainable. There was evidence in the findings of some ongoing improvements in areas such as raising suggestions and ideas and in the area audit process which reflected the willingness to adopt new ideas and take them seriously and act on them.

The strong support and commitment from both senior and junior management and employees in Company X during the initial implementation period needs to continue and the encouragement of small incremental changes and improvements in all of the areas needs to continue.

A possible area for further research on the subject might take into consideration a full employee productivity analysis before, during and some time after CANDO implementation and not just specific task time and distance travelled improvements.

Another area for further research which may be considered is a full Return Of Investment (ROI) analysis of the full cost and benefits of implementing a visual workplace organisation methodology. The 'investment' side would involve taking into consideration the cost of planning, specialist consultants, training resources and the cost of having all staff trained and putting exact costs to the resources needed to implement the methodology. On the 'return' side the analysis would involve putting costs to all unneeded items removed from the factory and new item cost avoidance overall. Also the machine availability increase effect on factory cycle time and product costs, and measurement of the cost of employee time saved travelling and carrying out all daily activities.

Some further more in depth research into the overall reactions and employee behavioural shift before, during and after implementation may also be worth considering. Although this

further research may take a lot longer to complete, and builds on this research, it may give a more complete holistic view of the benefits and issues associated with a company embarking on such a journey.

Note: Because of the Company X IP Restrictions this Dissertation remained in the Company X approval process from initial submission on 29th August 2008 (Ahead of Thesis submission cut-off date) until 26th January 2009. Approximately Two Thousand words had to be deleted totally and other sections re-written in order to comply with the IP policy.

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