

Lean Manufacturing At A Tier-1 Automotive Supplier

by

Mark Lulgjuraj

B.S. Mechanical Engineering, GMI Engineering & Management Institute, 1996

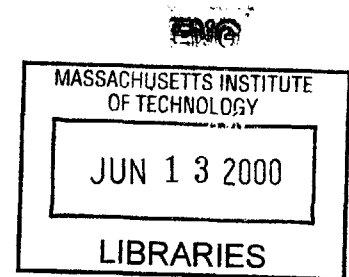
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Signature of Author _____

Handwritten signature of Mark Lulgjuraj

MIT Sloan School of Management
Department of Mechanical Engineering
May 5, 2000

Certified by _____

Richard M. Locke
Professor, MIT Sloan School of Management
Thesis Advisor

Certified by _____

Handwritten signature of Stanley B. Gershwin
Stanley B. Gershwin
Senior Research Scientist, Department of Mechanical Engineering
Thesis Advisor

Accepted by _____

Handwritten signature of Margaret Andrews
Margaret Andrews
Executive Director of the MBA Program
MIT Sloan School of Management

Accepted by _____

Handwritten signature of Professor Ain Sonin
Professor Ain Sonin
Graduate Officer
Department of Mechanical Engineering



Room 14-0551
77 Massachusetts Avenue
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Abstract

The road to lean manufacturing has been long and hard for many companies. Intrigue Corporation is no exception. The company first introduced its version, the Intrigue Lean Manufacturing System, approximately ten years ago. Since then, the company has struggled with the system and continually refined it, attempting to make it stick. Different manufacturing plants have adopted the system with different amounts of energy. This thesis examines these implementations of the Intrigue Lean Manufacturing System and identifies the key factors that have inhibited a more thorough diffusion throughout Intrigue concluding that the ILMS did not take hold for two reasons. First, Intrigue did not understand the dynamics of change. Consequently, they did not take advantage of the high leverage points to tilt the odds of success in their favor. Second, the ILMS was incomplete and unstructured. Many additional elements are needed to guide individuals that are tasked with adopting the principles. The thesis recommends a model for Intrigue and other corporations to use to review the progress of any change initiative. The model is a powerful tool and aids one in understanding which dynamics may be potentially harmful and lead to failure of any change initiative. A redesign of the ILMS was begun to address many of these inhibiting factors. These activities and their subsequent implementation also describe in depth.

Thesis Advisors

Professor Richard M. Locke, MIT Sloan School of Management

Professor Stanley B. Gershwin, Department of Mechanical Engineering

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I gratefully acknowledge the support and resources made available to me through the Leaders for Manufacturing Program, a partnership between MIT and major manufacturing companies. My two years in the program have been nothing short of spectacular. My great expectations were exceeded and I hope I can help cultivate the program in the coming years in return for the knowledge that it embedded in me.

Most importantly, I would like to thank my family for always believing in me. Their continual support over these past two years has been very encouraging. I especially would like to thank my mother whose constant sacrifices have granted me many opportunities during my lifetime. I realize that I can never repay her for all of these sacrifices but I will never stop trying nonetheless.

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Chapter 1: Introduction and Overview

Prior Intrigue Lean Manufacturing System (ILMS) implementations were not successfully diffused throughout all Intrigue manufacturing facilities. This thesis argues that the ILMS did not take hold for several reasons. First, Intrigue did not understand the dynamics of change. Consequently, they did not take advantage of the high leverage points to tilt the odds of success in their favor. Second, the ILMS was incomplete and unstructured. Many additional elements are needed to guide individuals that are tasked with adopting the principles. The thesis recommends a model for Intrigue and other corporations to use to review the progress of any change initiative. The model is a powerful tool and aids one in understanding which dynamics may be potentially harmful and lead to failure of the change initiative.

1.1 Project Description

The lean manufacturing movement began with the exposure that *The Machine That Changed the World* awarded the performance benefits of a lean production strategy. While proponents argue what the primary tools are to support the principles, the main principle is indisputably the elimination of waste. Since the book's publication, a major initiative of corporations around the world has been to transition their current manufacturing practices to target the elimination of all forms of waste in their manufacturing processes.

Intrigue Corporation is one such company. For approximately ten years, they have been trying to adapt their manufacturing system to be more aligned with lean principles. Initial implementation of the Intrigue Lean Manufacturing System, which was constructed from these principles, led to massive productivity improvements. These improvements were short lived as the company reverted back to its old ways of making product. Furthermore, different manufacturing facilities within the company have experienced different levels of success instituting the principles and underlying philosophy of the ILMS.

This paper focuses on determining why the ILMS was so difficult to implement and uses this information to improve the ILMS so that it is sustainable.

1.2 Project Goals and Measurements

This thesis has four goals. First, it attempts to surface many of the issues with prior ILMS diffusion attempts. This documentation serves as a valuable mechanism to transmit and communicate knowledge and learnings from these prior implementations. These issues are exposed using an analytical framework that examines the company's present operations and past implementation history through a total system perspective to determine why the ILMS has been so difficult to diffuse. A second intention of the thesis is to present a model to the company that will allow them to evaluate the potential obstacles that may inhibit the diffusion of any change initiative. Such a model offers tremendous value and allows the company to target these factors and improve the likelihood that the initiative will succeed. A third goal of the thesis is to describe the course of events that occurred within Intrigue during my internship to address many of the ILMS issues. A final goal of the thesis is to suggest a future course of action to Intrigue so that they may improve the ILMS and its diffusion within all manufacturing plants.

Many of the concepts herein are related to managing change within an organization. This is an increasingly important task within most organizations as the advancement of information technology speeds the pace of change in all aspects of society. Therefore, many of the ideas are applicable in other settings. The ultimate utility of this thesis will be determined by the degree to which the final recommendations of the thesis are accepted and applied within Intrigue.

1.3 Approach and Methodology

This research project was motivated by repeated difficulties that Intrigue Industries encountered when implementing pull systems in many manufacturing facilities. The project began as a focused effort to uncover the issues with the company's pull system designs and implementations. Over time it evolved

into something much more comprehensive and complex. Many of the lean manufacturing principles seemed to be elusive and unsustainable over time. As these issues were uncovered, an effort began to tackle these issues in a redesign and launch an altered lean manufacturing system.

1.4 Overview

An overview of the thesis follows.

Chapter 2 provides background information on Intrigue's history, strategy, organizational structure and culture. The Intrigue Operating System and the Intrigue Lean Manufacturing System are introduced.

Chapter 3 provides an extensive summary of the prior research on lean manufacturing topics. These topics include the lean philosophy, lean organizational structures, lean measurement systems, and lean manufacturing implementation roadmaps.

Chapter 4 summarizes research in the area of organization change. It specifically unveils frameworks for analyzing change, as well as the leadership and structure of change. It then condenses information on process improvements and introduces a dynamic framework for likening change that will be used throughout the remainder of the paper.

Chapter 5 explains the early activities of the internship and how they revealed many underlying problems with the earlier ILMS undertakings. Some of the tools that are used in this phase are interviews, Ishikawa analysis (root-cause analysis), KJ-analysis (affinity diagram), questionnaires and the three organizational lenses.

Chapter 6 explains how specific parts of the ILMS were revised to address many of the deficiencies identified in Chapter 5. The implementation of the revised system during the internship is also discussed.

Chapter 7 concludes with short-term and long-term recommendations for the company. These recommendations target identified issues that were not implemented during the internship.

Chapter 2: Project Setting and Background

This chapter presents background information on Intrigue Industries to familiarize the reader with the environment the environment currently facing the company and the ILMS. This context is valuable and is often referred to in greater detail in subsequent chapters.

2.1 Company Background

2.1.1 Company History, Products & Customers

Intrigue was founded a quarter century ago by current owner Bob Cramer. Initially a small tool shop in Michigan, the company has grown rapidly in recent years. The company has grown its revenues tenfold during the past five years by expanding its product line, services and customer base. Today, Intrigue is a Tier 1 supplier to the automotive industry and a multi-billion company.

Intrigue has been traditionally known as a plastics components supplier within the industry. Traditional product offerings consisted of interior trim components. Expansion has allowed Intrigue to vastly expand its products to include exterior body panels and more recently sub-assembled interior and exterior modules. Intrigue is now a full system develop and integrator with extensive knowledge and capabilities.

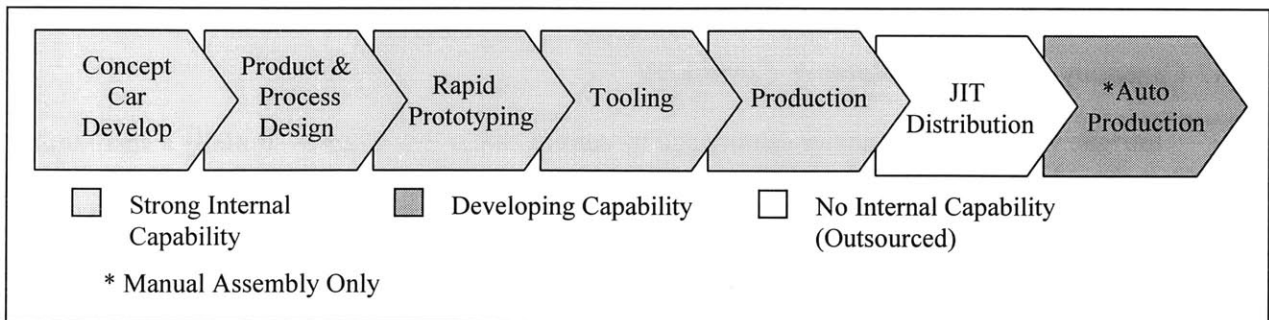
Intrigue has historically operated within North America and Australia and served the “Big 3” automotive OEM’s. Today, Intrigue operates on all major continents and serves a broad cross-section of OEM’s.

2.1.2 Intrigue Strategy

Intrigue is vertically integrated and is responsible for many items within its value-chain. Figure 2.1 is a representation of Intrigue’s Capabilities Chain, demonstrating the activities that Intrigue consciously attempts to develop within the chain. As can be seen, Intrigue handles the design of its products, processes and fixtures. Additionally, the company handles prototyping activities as well as full-time production requirements. Intrigue has taken integration a step forward and has recently purchased

controlling interest in a well-known sports car manufacturer. The intention is that the acquisition will allow them to familiarize themselves with the assembly processes experienced by OEM's. This will give them a leg up in understanding customer processes and needs. Intrigue can deliver value to the customer by addressing their needs. The acquisition will also allow the company to develop internal knowledge and capabilities of marketing to consumers.

Figure 2.1 Intrigue Capabilities Chain



Bob Cramer claims that the acquisitions will push Intrigue into higher profit areas and activities. This vertical business model may make sense for other reasons. According to Fine (1998), change in the auto industry is occurring rapidly or at an increasingly fast clockspeed. This is due to rapid advances in electronics and communication technology. Following Chrysler's lead and their own necessity to compete on cost, many automotive companies have begun to separate their components operations from their automotive operations, moving from a vertical structure to a horizontal one.

These events have given more vehicle content and hence more total vehicle value to the supplier base, who are now responsible for design of components and systems, as well as some assembly and distribution. Fine claims that "once niche players have built significant market power in the now horizontally structured industry, they often move vertically to exploit their newfound market power." Intrigue has admittedly been positioning itself in the belief that the automotive industry supplier base is shrinking. It believes it must offer the customer expanding value through a wide variety of services and solutions. In order to meet the customer's expanding needs and services, Intrigue has acquired companies to build up its capabilities to capitalize on the OEM outsourcing strategy. It believes that this toolkit of

capabilities will allow it to be a key full service supplier that will survive and prosper following the current supplier shake-out.

The company is also looking towards emerging economies for growth. OEM's are fiercely competing against each other for the growing Asian market. As the U.S. and European markets mature, many experts claim that most of the growth in the auto industry will come from the emerging South American and Asia-Pacific markets. To capitalize on this growth, the company has launched operations in China, Russia, India, and other markets. In order to become a leader in such lucrative markets, it is necessary to establish operations in the regions early to establish brand recognition.

Lastly, the company has sought out companies performing poorly, both operationally and financially. By restructuring their inefficient operations and integrating their functional departments, the company has been able to create synergies and make many of these companies profitable.

2.2 Organizational Structure & Culture

Intrigue has grown to its current size by maintaining and cultivating an entrepreneurial culture. The company lacks a formal organizational chart, as the owner doesn't believe in formal organizational structures, stating that "you cannot lead with a big bureaucracy." He wants everyone to have a sense of responsibility for all activities in the company. Bob Cramer has always maintained an open door policy that exists to this very day. Many people have commented about their late night discussions with Mr. Cramer that sometimes carry through until midnight. While a documented organizational chart may not exist, the company is set up according to a loose matrix structure where personnel are positioned functionally but are mainly staffed according to specific projects.

The company is finding it difficult to maintain this entrepreneurial spirit in light of its recent growth. One of the company's methods of increasing performance in its acquisitions has been through the centralization of certain functional areas to gain economies of scale. However, centralization runs counter to a philosophy of autonomy, making it difficult for the company to continue to operate using

historical systems and processes. Additionally, the globalization of activities has made communication slower, creating an additional tension slowing down the company's ability to quickly respond.

2.3 Corporate Lean Manufacturing Initiative

2.3.1 Intrigue Operating System

As a result of these developments and increasing complexity of operations, Bob Cramer created the Intrigue Operating System (IOS) to clearly communicate the processes and systems that must be used by all employees to meet the expectations of the various company stakeholders. He seems to have become somewhat irritated with upper management's difficulty in grasping the IOS. As the following statement indicates, he is somewhat dismayed by what he perceives to be a lack of leadership within the ranks of the organization. "None of you have been required to be leaders because you've had me leading." He likens the development of his people to "turning task maskers into leaders." The IOS is the system he believes will allow them to become leaders.

2.3.2 Intrigue Lean Manufacturing System

The elements that comprise the IOS are shown in Figure 2.2. The model was created considering the main stakeholders who have an interest in the company's operations. The premise is that the company's activities should be aligned and focused on delivering value to these stakeholders. The Intrigue Lean Manufacturing System (ILMS) is one element of the broader Intrigue Operating System. In an effort to streamline their manufacturing operations and make them more responsive to customer demands, management decided to transition their old manufacturing model into a lean manufacturing system. More recently, the company has begun to pursue lean business processes. The ILMS is but one part of the broader Intrigue Lean System, which targets the elimination of waste from all business processes.

The principles behind the ILMS are not unlike those of other lean production systems. The Intrigue version consists of seven fundamental elements or tools that are described in Figure 2.3. Two

principles underlie all of these elements. First, the entire workforce must participate in the ILMS and the elimination of waste. Second, all elements must be viewed with a continuous improvement mentality.

2.3.3 Difficulties with ILMS Implementations

The company has attempted to make its manufacturing facilities lean by focusing on the above elements. From the first trial attempt of a decade ago, the ILMS has evolved considerably over the years. There has been considerable variation in the acceptance and diffusion of these principles across the different facilities. Many plants experienced initial success but were unable to sustain the changes over time. Certain elements such as workplace organization have been easier to implement, while others such as pull systems have been much more difficult and elusive.

The thesis examines past systems and implementations and identifies the causes that led to the troubled ILMS implementations. These root causes are then addressed in the redesign of the ILMS.

2.4 Summary

This chapter provided information on Intrigue Industries and the IOS and ILMS. This information is important because it describes the struggle the company has faced in achieving its growth. This growth has added complexity and the need for standardized and structured systems. The notion of standard systems runs contrary to the company's traditional entrepreneurial culture and the workforce has hesitated in embracing them. The ILMS is one such system that has struggled to gain acceptance. The following chapters examine the ILMS in detail to diagnose the major factors that have limited its acceptance.

STAKE-HOLDERS	BUSINESS GOALS	SYSTEMS AND PROCESSES	STRATEGIC BUSINESS UNIT LEADERS RESPONSIBILITIES	PLANTS & STAFFS (EMPLOYEES) RESPONSIBILITIES	RESULTS
CUSTOMERS	CUSTOMER SATISFACTION	<ul style="list-style-type: none"> • CUSTOMER BUSINESS TEAM EXECUTIVES • PROCESS DEVELOPMENT FOR CONSUMER FEATURES • PROGRAM EXECUTIVE PLAN (PEP) • CUSTOMER SUPPORT TEAM DEVELOPMENT 	<ul style="list-style-type: none"> • SUPPLIER OF CHOICE • PLANS TO DELIVER 6% NEW BUSINESS YEAR • PROVIDE VALUE TO CUSTOMER • PEP BOOK EXECUTION • PERFORMANCE TO DATA CARD 	<ul style="list-style-type: none"> • „GIVE THE CUSTOMER WHAT THEY WANT WHEN THEY WANT IT“ • 100% REPEAT BUSINESS • SUCCESSFULL LAUNCHES • STRIVE FOR STRETCH GOALS 	WORLD CLASS PREFERRED SUPPLIER
EMPLOYEES	EMPLOYEE EXCELLENCE	<ul style="list-style-type: none"> • INTRIGUE QUEST • EMPLOYEE DEVELOPMENT AND EDUCATION • GAINSHARING BASED ON PERFORMANCE 	<ul style="list-style-type: none"> • EMPLOYER OF CHOICE • PROVIDE FOR LEARNING, IMPROVEMENT, AND DEVELOPMENT WITH 100% EMPLOYEE PARTICIPATION • CREATE A QUALITY & SAFE WORK ENVIRONMENT 	<ul style="list-style-type: none"> • DESIRE TO LEARN • HAVING FUN BEING THE BEST • DECISIONS AND ACTIONS AT LOWEST LEVEL • QUEST PROJECTS INITIATED/RESULTS • MEET BUSINESS PLAN SET OUT BY DATA CARD 	WORK QUALITY OF LIFE
SHARE-HOLDERS	OPERATIONAL EXCELLENCE	<ul style="list-style-type: none"> • PRODUCT DEVELOPMENT PROCESS • QS-9000 • LEAN MANUFACTURING SYSTEMS • SUPPLIER MANAGEMENT • INFORMATION SYSTEMS 	<ul style="list-style-type: none"> • REMOVE OBSTACLES • ENABLE PLANTS/PEOPLE TO MEET DATA CARD PERFORMANCE GOALS • FOSTER A LEAN/FLEXIBLE (MATRIX) ORGANIZATION • RAPID EFFICIENT PROGRAM INTRODUCTIONS • SHARE INFORMATION 	<ul style="list-style-type: none"> • ELIMINATE WASTE THROUGH EMPLOYEE INVOLVEMENT • CONTINUOUS IMPROVEMENT IN QUALITY AND PRODUCTIVITY • ACHIVE PLANT CONTRIBUTION OF MORE THAN 35% • INSURE PLANTS ARE RUN TO INTRIGUE LEAN MANUFACTURING SYSTEM • INITIATES DATA CARD 	RETURN ON INVESTMENT
	PROFITABLE GROWTH	<ul style="list-style-type: none"> • BUSINESS PLANNING • NEW BUSINESS DEVELOPMENT PLANNING • STRATEGIC OPPORTUNITY DEVELOPMENT PROCESS • COMMODITY SYSTEM TEAMS FOR ADVANCED BUSINESS DEVELOPMENT 	<ul style="list-style-type: none"> • ESTABLISH COMMUNICATIONS AND OVERSEE PERFORMANCE TO STRETCH GOALS • CREATE NEW BUSINESS OPPORTUNITIES 	<ul style="list-style-type: none"> • ENTREPRENEURIAL WITH ACCOUNTABILITY • OBLIGATION TO CONTRIBUTE TOWARDS COMPANY GOALS • MEETING BUSINESS GOALS SET OUT IN DATA CARD 	
	FINANCIAL RESULTS	<ul style="list-style-type: none"> • DATA CARD PROCESS • CASH FLOW MANAGEMENT • CAPITAL MANAGEMENT • TOTAL COST MANAGEMENT 	<ul style="list-style-type: none"> • MEET CORPORATE GOALS • PROVIDE FOR A SUCCESSFUL FUTURE • SET STRETCH GOALS FOR DATA CARD 	<ul style="list-style-type: none"> • MEET BUSINESS PLAN GOALS • CONSERVE RESOURCES • STRIVE TO MEET DATA CARD STRETCH GOALS 	
COMMUNITY	CORPORATE CITIZENSHIP	<ul style="list-style-type: none"> • POLICIES/PRACTICES • PUBLIC RELATIONS 	<ul style="list-style-type: none"> • EMPLOYER OF CHOICE • POSITIVE COMMUNITY IMAGE AND CITIZENSHIP • PROVIDE FOR CIVIC INVOLVEMENT 	<ul style="list-style-type: none"> • VOLUNTEER IN COMMUNITY ACTIVITIES • SECURE OUR FUTURE THROUGH COMPETITIVE QUALITY PRODUCTS 	HELP TO MAKE OUR COMMUNITY A BETTER PLACE

← ACCOUNTABILITY

Figure 2.2 Intrigue Operating System

Figure 2.3 - Elements of the Intrigue Lean Manufacturing System

Lean Principle	Explanation
Waste Identification	This principle states that the workforce should identify any of the seven principle wastes as defined by Taichi Ohno (see Section 3.1). Intrigue believes that all workers need to be trained in the process of identifying waste. TQM tools are often taught and used to help workers identify waste.
Waste Elimination	Once the wastes have been identified, the workforce must act to eliminate them. Intrigue stresses the use of several tools to do this.
Lead Time Reduction	By focusing on reducing the lead time, the company can increase its manufacturing responsiveness. This reduction focuses on reducing tool change times, allowing the company to reduce the lot sizes of its production runs and ultimately the waste of holding unnecessary inventory. Many other wastes are also addressed, such as the waste of machine operators waiting for the machine to come back on-line.
Work Place Organization	“A place for everything and everything in its place” is the quote the company often uses to describe this element. By standardizing all work areas, problems will become more visible to those doing the work. Addressing these problems will lead to higher quality and a reduction in the waste of defect production.
Visual Controls	Visual controls are of vital importance in letting those doing the work understand the present state of the system. For example, boundary samples are often used to visually indicate the characteristics of a good part. They can compare a current production part and know when a quality problem exists. Andon lights are also a visual indicator that are used to communicate the existence of a problem that requires immediate attention.
Standardized Work Methods	Underlying TQM is the principle that in order to improve a process, there must first be a standard process to improve. Thus, a central theme of the ILMS is the standardization of all processes. This focuses on several of the fundamental wastes. First, standardization reduces process variability, leading to lower required inventory levels. Additionally, problems become evident when they occur, targeting the waste of unnecessary processing.
Pull Systems	Traditionally, this has been the most focused upon facet of lean manufacturing. Pull systems relate to the idea of eliminating waste by “producing what is needed when it is needed.” Implementation of pull systems addresses all of the seven fundamental wastes.

Chapter 3: Research on Lean Manufacturing

This chapter compiles research findings on different aspects of lean manufacturing. This is important in the overall context of this thesis for two reasons. First, it introduces the reader to the experiences and knowledge of others in lean manufacturing principles, organizational structures, performance measures, implementation road maps, and other important elements that combine to form a comprehensive lean manufacturing system. Second, it provides a baseline that the company can compare the ILMS to and identify fundamental weaknesses that may be inhibiting the diffusion of the ILMS.

3.1 Lean Manufacturing Philosophy & Principles

'Elimination of waste' explains lean manufacturing in three simple words. Everything else that is stated or written about it refers back to this common and unifying principle. All of the tools and methods that are thought of as being lean are all addressing the need to eliminate waste. Black (1991) states that the originators of the lean movement, the Japanese, really believe in two fundamental principles. "The Japanese firmly believe that industry must eliminate waste, and they practice a great respect for the people." Waste refers to anything that is done that does not add value that the customer is willing to pay for. Ohno (1988) describes seven principle wastes: overproduction, delay, transport, processing (inspection and other non-value-added processes), inventory, wasted motion, and making defective products. Black's second point can also be considered a form of waste – the waste of an unmotivated workforce. He goes on to state that "employee involvement is deeply rooted in the idea that no one employee is better than another."

Much has been documented in the past on the Toyota Production System and the principles and tools of lean manufacturing. Shingo (1989), Womack (1996) and Black (1991) provide much detail on the principles of lean manufacturing. I will limit the discussion to key areas that are more relevant to the objectives of this paper. Appendix A contains a glossary of lean manufacturing terms that may serve as a helpful reference as you read through the chapter.

The philosophy of eliminating waste from any process is a logical desire. While many prior researchers have investigated so called lean operations and published their findings, the underlying practices that have kept these systems functioning have often not been evident. Instead, researchers and practitioners have focused on the tools or 'by-products' of these systems such as Kanban, Heijunka and Andon.

Many companies that have rushed to transition their operations and base them on lean manufacturing principles have focused on these tools. Consequently, many have had minimal success in achieving the operational improvements that they initially sought. Spear and Bowen (1999) try to shed some light on the failures of many of these companies and state that these companies and many other observers often confuse the system as being the tools and practices that they can visually see during their plant tours. Spear and Bowen believe that the key to the system is not as evident and cannot be clearly articulated or documented. They identify four principles that capture this tacit knowledge and are used to "guide the design, operation, and improvement of every activity, connection, and pathway for every product and service." The four basic rules follow.

Rule 1: All work shall be highly specified as to content, sequence, timing, and outcome.

Rule 2: Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.

Rule 3: The pathway for every product and service must be simple and direct.

Rule 4: Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

These rules suggest that the system is set-up as a scientific experiment. Rule 1 is in place to minimize the possible variation in the system. If the work content is not completed according to this standard specification and within its stated variation, then this deviation becomes clearly evident and a flag is raised indicating that an underlying scientific hypothesis has been violated. Immediate action is taken to resolve the problem. Rule 2 ensures that everyone knows how to respond to every possible outcome. "The rule creates a supplier-customer relationship between each person and the individual who is responsible for providing that person with each specific good or service." Rule 3 addresses predictability and tracability by ensuring that every product and service follows a prespecified path. This

is counter to queuing theory and operations principles that boast of the benefits that the pooling of resources delivers such as reductions in lead time and inventory. There is obviously a trade-off that must be made between the benefit of increased quality and the cost of additional capacity to maintain an appropriate service level. Rule 4 sheds light on the scientific grounding of the system.

3.3 Lean Organizational Structures

Much has been published on the topic of organizational structures. Research indicates that an organization's structure should be such that it is aligned with other elements of the company such as the strategy and culture. If the company's manufacturing strategy is centered on the philosophy and principles of lean manufacturing, then the ideal structure is one that enables the basic principles of eliminating waste and empowering the workforce to take hold. A typical organization consists of a hierarchy with several layers. In order for such a hierarchical system to fit with a lean manufacturing strategy, the responsibilities of the various levels must be clearly defined so as to enable and support a lean operation.

The executive or upper management level of the hierarchy must be forward thinking. Their main tasks are to set the strategic direction and goals of the company. They should not be overly concerned with the daily operational problems. Bartlett and Ghoshal (1997) claim that they are the institutional leaders and must create the values and norms of the corporation. In other words, they are the drivers of the overall organizational culture. In order to drive the values and principles of lean manufacturing, they must commit to the philosophy and challenge the rest of the corporation to do the same. The lower hierarchical level runs the day-to-day operations. They are responsible for initiating change through continuous improvement activities. They must be treated equitably and incented for their accomplishments. The middle level serves as the bridge between the executive level and the lower level of the organization. They must make sure that those below them are aligned with the executive level strategy. Their main function is to support the lower level. They are tasked with ensuring the buy-in of

the lower level, providing training to develop the appropriate capabilities, encouraging improvement, recognizing and celebrating accomplishments and removing any obstacles. Bartlett and Ghoshal (1997) state that they must also constantly look for ways to develop individuals and leverage improvements, knowledge, skills and best practices across units. This is because there is not one consistent organization form for such a system. The organization must be set up to fit each individual company and its specific facets.

3.4 Lean Performance Measures

The philosophy of lean manufacturing and a lean enabling organizational structure are important but insufficient in describing and implementing such a system. A measurement system that supports and enables the diffusion of the system is an important addition. Measurements are important because they influence behavior. Because of this characteristic, it is vital that the measurements elicit behavior that is aligned with lean manufacturing principles. Substantial literature exists on the design of performance measures. This research falls into two classes: measurements designed to meet a set of characteristics and measurements created from an organized design methodology. The following sub-sections define these two methodologies in greater detail and summarize this research.

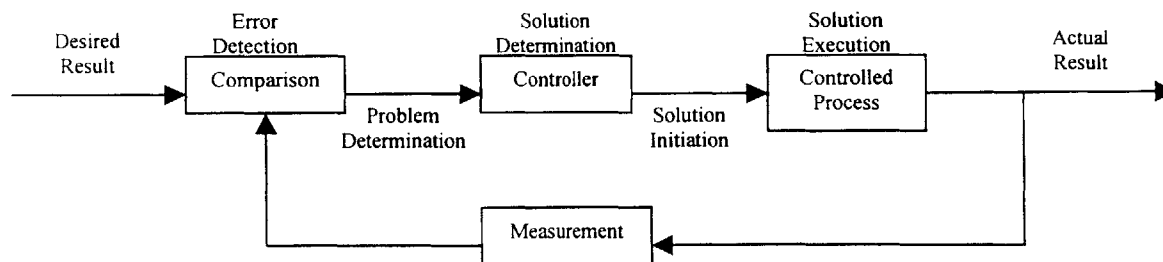
3.4.1 Characteristic-Based Measurements

Often times measurement systems are designed around the idea of meeting select criteria or characteristics. For example, Maskell (1993) claims that ideal measures are timely, non-financial, simple and easy to understand, consistent with the manufacturing strategy, complementary, continuous improvement promoting, and flexible. Other characteristics that have been defined in research are that measurements should be related to customer driven success factors, should promote intrafunctional communication, should focus on trends and forecasts, and should feed back performance relative to best-in-class leaders.

Maskell proposes that the measurements should be non-financial because financial measures are results-oriented and tell you where you stand relative to your goals. Grief (1991) recommends the use of process measures as opposed to these results measures. Process measures inform you of the effectiveness and state of the process itself instead of the outcomes of the process. The processes are the true cost drivers. Deming (1982) reiterates this belief by stating that “managing by numerical goal is managing without knowledge of what to do.”

Process measures require more frequent reporting than result measures because their use is intended to control the process to deliver the proper result. Figure 3.2 indicates the purpose of measurements in the operation of processes and systems. Measurements are taken to track performance relative to a goal. A gap will exist if there is a difference between this goal and the measurement. Action will then be taken to correct the error and control the process to obtain the desired outcome. Stec (1998) claims that internal measures are fed back to the operators of the system for internal control. External measures are fed back to management and engineers so performance of the system relative to external customer wants can be evaluated. The key is that a mix of results and process oriented measures is desired depending on their use within the organization. Process oriented measures are needed where the costs are accrued and results oriented measures where determining the overall performance of the system is vital. He states the sampling frequency must be less than the time interval for control and that the people closest to the controlled process must have decision-making authority over the process. Kowalski (1998) discusses a similar idea of a control hierarchy consisting of different levels of decision making.

Figure 3.2 – Role of Measurements in System
Source: Stec (1998)



3.4.2 Design-Based Measurements

Instead of focusing on desired characteristics, design-based measures are designed to specifically address the needs of the system they are supporting. Kowalski (1998) believes that measurables are an important part of manufacturing system design. Measurements cannot be defined independent of the system and are optimally designed along with the system. He uses a design methodology known as axiomatic design (see Suh (1990)) to derive an optimal set of measurements for the Ford Production System. Another popular methodology known as the House of Quality (see Hauser (1988)) may be used to design a setting-specific measurement system. These systems start by defining the needs that the measurement system should address. Although needs are unique to specific situations, Kowalski (1998) states that common needs are often external reporting, performance evaluation, operational control and employee behavior influence. Using the design methodologies, these needs can be converted into concrete measurements that are aligned with the other aspects of the system design and strategy of the company.

Too often companies fail to realize the importance that their measurement systems play in their operations. Thus, new manufacturing methods are often adopted while old manufacturing measures persist. This creates confusion and often causes others to question the effectiveness of the new methods. Measurements must change whenever the system changes to accurately meet the needs of that particular system. While both characteristic-based and design-based measurement system methodologies have merit, it is my belief that an ideal design process should combine aspects of both to yield setting-specific measurements that are timely, simple, flexible and appropriate for the control level.

3.5 Lean Manufacturing Transitions & Implementations

In addition to specifics related to the system design, most companies have to transition to a lean manufacturing system. They do not have the luxury of designing the system and immediately operating

according to the principles. Instead, they have to implement the different elements while meeting current production requirements. This reality has made lean manufacturing transitions and implementations another central area of lean manufacturing research. This research is particularly important to this project and various transition models are described in the following subsections.

3.5.1 Shigeo Shingo's Lean Transition Model

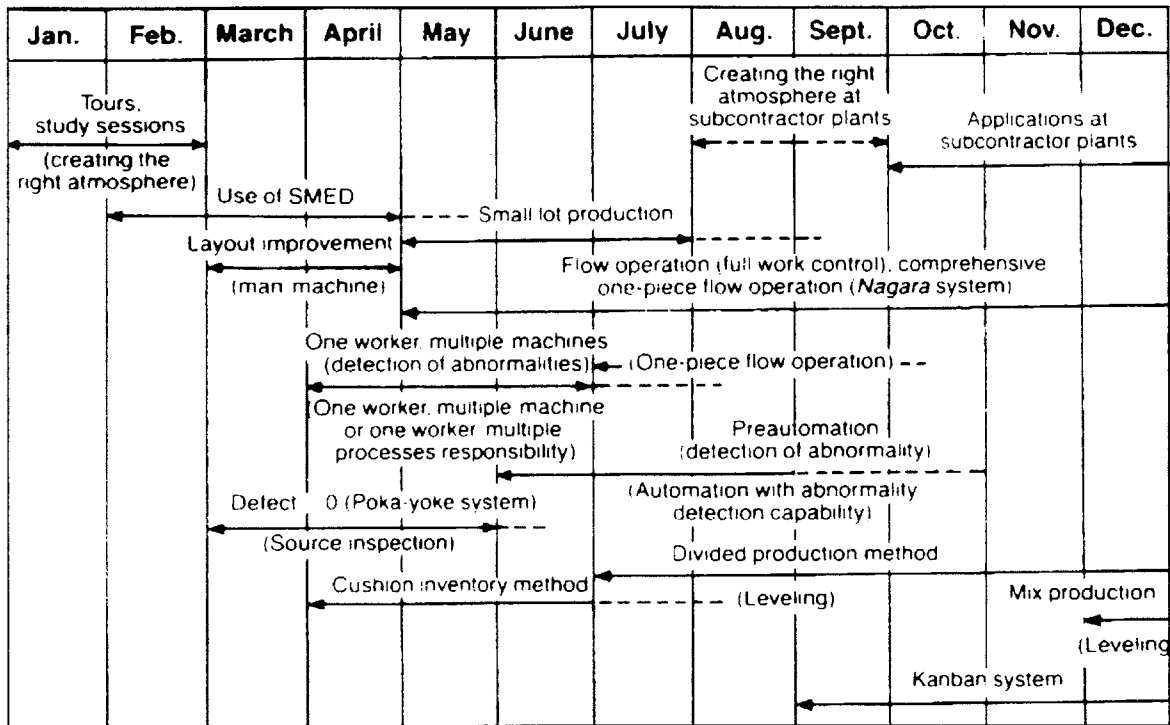
Shingo (1989) recommends that a company implement the Toyota Production System according to the guideline in Figure 3.3. He recommends that time be set aside for initial touring, benchmarking, and studying of principles. The elimination of waste is then targeted by improving floor-layouts. Simultaneously, the SMED (Single Minute Exchange of Dies) process is started to reduce setup times. Shingo states that "elimination of the waste of over-production cannot be achieved without SMED...SMED must be achieved if we want to respond to changes in the customer demand." Quality is then dealt with through 100% inspection or the Poka-Yoke system of error proofing and building quality into the process. Leveling and mixed production are then targeted. The implementation of kanban or a pull system of production lies at the end of the process.

While the model specifies a good amount of detail on the sequence for implementing the basic tools or countermeasures of the Toyota Production System, it seems to be missing essential elements. It does not address the basic rules as identified by Spear and Bowen (Section 3.1). Shingo does indicate that "it would be a mistake merely to imitate the external features of the Toyota production system. The system cannot be applied properly without a thorough understanding of the principles on which it is based...If the production system and the kanban system are adopted without adherence to these precepts, not only will results fall short of expectations but the side effects may induce a kind of addiction that will confuse production and invite undesirable consequences."

Shingo discusses the importance of the principles but fails to recognize the need to alter other company systems to support the lean principles. He seems to focus exceedingly on the countermeasures. His model is most useful as an implementation roadmap and considering the relative sequencing of activities.

Figure 3.3 - Guideline for Implementing the Toyota Production System

Source: Shingo (1989)



3.5.2 Integrated Manufacturing Production System

J.T. Black (1991) has also developed a 10 step process to implement lean manufacturing (Figure 3.4) or what he calls IMPS (Integrated Manufacturing Production Systems). His model focuses on the importance of manufacturing cells in a lean operation. In step 1, Black calls for the formation of production cells where the pace of production is governed by the Takt time:

$$\text{Takt} = \text{Available Work Hours During Week} / \text{Weekly Demand}$$

These cells offer tremendous flexibility because the number of workers in the cells can be varied to either speed up or slow down production. He recommends that setup time reduction be targeted in the second step. These improvements move you closer to the goal of instantaneous responsiveness. Lower setup times decrease lot sizes, thereby decreasing the time for a part to make it through the system. Step 3 calls for building quality into the process. Doing so ensures that waste is not produced and carried

through subsequent processes. Instead of inspecting for quality, quality is ensured at the operation. Step 4 targets increased reliability and predictability.

Note how closely the relative sequencing of the tasks matches Shingo’s model. For example, the creation of manufacturing cells is equivalent to the layout improvement recommended by Shingo. Additionally, both recommend that the implementation of kanban systems occur at the end of the implementation on the premise that they should only be put in place after improvements in setup time, quality and reliability have been made. This is when they are likely to have the biggest impact.

Figure 3.4 - 10 Steps to IMPS
Source: Black (1991)

1	Form manufacturing and assembly cells
2	Reduce or eliminate setup (RETAD)
3	Integrate quality control
4	Integrate preventative maintenance
5	Level and balance
6	Link cells (KANBAN)
7	Reduce WIP
8	Build vendor programs
9	Automate
10	Computerize

Black’s model suffers from many of the same drawbacks as Shingo’s. Additionally, he seems to overemphasize the importance of manufacturing and assembly cells. The purpose of cells is to improve product flow and efficiency. They may not always be optimal or even appropriate for all settings. For instance, if all products flow through a specific process that is very capital intensive, it may not be economically feasible to purchase additional capital equipment to allocate to specific work cells. Shingo defines this first step better as “layout improvement.” This term is much more flexible and allows for improvements in lay-outs that make sense for that particular plant.

3.5.3 Ford “10 Steps” Model

Kowalski (1998) developed a model that he recommended Ford follow in their effort to implement the Ford Production System (Figure 3.5). He states that the order is important but that the elements do not necessarily have to be sequential.

Figure 3.5 – Kowalski’s 10 Steps Implementation Model

Source: Kowalski (1998)

Step	Description	Purpose
1	Improve machine lay-outs	Eliminate waste
2	Develop effective workteams	Ensure bottom-up decision making and the continuous improvement philosophy
3	Standardize Work	Reduce process variability (inventory levels)
4	Reduce Setup Times	Reduce lot sizes (inventory levels)
5	Mistake-proof processes	Ensure quality is built into the processes. Eliminate the waste of inspection.
6	Focus on Preventive Maintenance to Improve Reliability	Reduce process variation and unforeseen machine disruptions.
7	Level Production	Level production volume and mix to reduce variability
8	Implement J.I.T. Production (Pull System)	Eliminate overproduction
9	Minimize Inventory	Each of the earlier steps help eliminate waste and/or decrease process variability. This aids in the reduction of inventory.
10	Reduce Costs	This is a consequence of the successful implementation of the other steps. The earlier steps help the company focus on eliminating non-value added activities and thus reduce costs.

Again, the sequencing of the steps bears tremendous similarities with the Shingo and Black models. This model adds the essential elements of creating effective work teams and standardizing work. Each step has various Ford Production System measurables associated with it (not shown), indicating where these measures fit into the overall implementation. Thus, he indirectly introduces the concept of staggering the implementation of measurables. While all models relay important information on key activities to undertake during a lean transition and their relative sequencing, they are basic roadmaps and fail to address the potential obstacles and disruptions that can occur during the implementation.

3.5.4 Hilbert’s Model

Rather than focus on a roadmap for implementing lean manufacturing tools, Hilbert’s model is broader and ensures the steps are in place to successfully implement change. He states that it is

impossible to separate the social and technical sides of a lean implementation because of the tight interdependencies and identifies seven fundamental issues that must be addressed to ensure a successful transition.

1. Identify a launch team, key leadership, and the production team.
2. A shared vision must be established among the stakeholders.
3. A method of evaluating the change effort should be established.
4. A means of keeping stability in the current design should be designed.
5. There should be a means of simultaneously addressing social and technical issues and their interdependencies.
6. A system design process should be instated that insures that the physical manufacturing system meet the lean design guidelines.
7. There should be safeguards against social or technical surprises that will arise during the launch process.

These issues are insightful and he recognizes that a lean transition can be extremely disruptive to the current system. He recognizes that the lean transformation is a major change initiative that must be continually evaluated and any obstacles removed. Issue #4 is particularly informative as he recognizes that an immediate tension exists between shifting to the new system and meeting current production demand. Hilbert goes on to describe a four-point model for implementing lean manufacturing (Figure 3.6). The sequence of the model is deemed to be very important.

Figure 3.6 – Hilbert’s Four-Point Implementation Model

Source: Hilbert (1998)

Point	Step	Activities/Direction
1	Building a Shared Vision	<ul style="list-style-type: none"> • Proper Team Selection • Benchmarking • Team Building Offsites • Set a clear vision
2	Planning & Designing the Change	<ul style="list-style-type: none"> • Recognize but minimize technical and social variability • Design the system to a specific application (right-size)
3	Managing the Change	<ul style="list-style-type: none"> • Assign roles within the team • Interim Review Processes • Prototype the Design
4	Celebration & Continuous Improvement	<ul style="list-style-type: none"> • Recognize individuals and accomplishments along the way • Set improvement goals to avoid complacency

Hilbert's implementation model focuses much more on the social aspects of change and the need to develop effective work teams to execute the transition. Thus, he captures the more important and difficult elements of instituting and sustaining change that were neglected from the other models. Using a system dynamics perspective, he recognizes leverage points for ensuring that a shared vision is developed. He identifies four activities that are often necessary to get a lean implementation moving because of the delays in seeing the effects of the improvements after making a change. Thus it is important that the following activities be of a sufficient threshold to set a dynamic in place leading to successful change.

1. Level of Training in Business Principles
2. Technical Skill Level of Team
3. Level of Benchmarking Successful Case Studies
4. Level of "Practice Field" Activities

Hilbert's model is insightful because it goes beyond a mere roadmap and focus on the tools to touch on the more important and difficult elements of instituting and sustaining change.

3.5.5 Johnson's Toyota Leadership Model

Johnson (1998) touches on the social side of the Toyota Production System stating that there are three characteristics to the social portion of the Toyota Production System that he terms the Toyota Leadership Model (Figure 3.7).. These principles are not new and have been documented in many leadership texts as fundamental skills that a leader must master. Recognize that the first point is equivalent to Hilbert's point of "Building a Shared Vision." Before embarking on any change initiative it is first necessary to sell the need for the change and to get the organization aligned with the change. If this is not achieved, the odds of success are slim. The second point of removing barriers is also a must in any change initiative if initial problems are to be overcome. Finally, the third point of developing people is necessary if the company is to be aligned with the philosophy of continuous improvement. The model provides a checklist list of items to review periodically to ensure that they are being addressed. The items are very broad and offer no guidance on how to best implement such a system.

Figure 3.7 Johnson's Toyota Leadership Model

Source: Johnson (1998)

Characteristic	Activities
Give Direction	Create a shared vision Develop a yearly Hoshin Give specific direction through master teachers
Remove Barriers	Link problem cost and consequences to root cause Provide visual cues Modularize problem solving Train and transfer training and knowledge Create a safe environment (physically and emotionally)
Develop People	Develop the capability to improve by improving Stewardship delegation of tasks Emergent leadership

3.5.6 Lean Thinking Model

Womack and Jones have developed the model shown in Figure 3.8 to help a company prioritize activities while transitioning toward lean. The model is broken up into distinct phases with different time durations and activities.

Figure 3.8 – Womack and Jones Lean Leap Model

Source: Womack and Jones (1996)

Phase	Specific Steps	Time Frame
Get started	Find a change agent Get lean knowledge Find a lever – seize a crisis to motivate Map value streams Begin kaikaku – start making improvements quickly Expand your scope	First six months
Create a new organization	Reorganize by product family Create a lean function Devise a policy for excess people Devise a growth strategy Remove “anchor-draggers” Instill a “perfection” mind-set	Six months through year two
Install business systems	Introduce lean accounting Relate pay to firm performance Implement transparency Initiate policy deployment Introduce lean learning Find right-sized tools	Years three and four
Complete the transformation	Apply these steps to your suppliers/customers Develop global strategy Transition from top-down to bottom-up improvement	By end of year five

The model introduces a new tool to use in transitioning toward lean manufacturing. Step (4) asks that the entire value-stream of all product families be mapped. This value stream mapping process breaks down the implementation into concrete segments. Rother and Shook (1998) define the value stream mapping process as consisting of the following sequence of events:

- (1) Definition of product families
- (2) Current-state mapping of a product family
- (3) Future-state mapping of a product family
- (4) Creation of a value-stream plan

Rather than focus on implementing specific tools, the intention is to look at moving from the current-state of product flow to a leaner future-state. Thus, once a current-state map is created, a future-state product flow is created that is more geared at continuous flow of the product family through the system. The improvements necessary to move from the current-state to the future-state are then listed in the yearly value-stream plan with assigned improvement deadlines and responsibilities. Kaizen projects are then carried out to make the necessary improvements.

Womack's model is intriguing because of the addition value stream mapping and the applicability of the model for all business systems. He chooses to not focus on the countermeasures and instead places his attention on the fundamental philosophy and principles. Prior implementation models and roadmaps were unstructured and unclear in suggesting when a task was sufficiently complete to warrant the start of the subsequent task. This model addresses this shortcoming by recognizing that the countermeasures are only important in that they help achieve the objectives of lean. Instead of focusing on these countermeasures, Rother & Shook (1998) suggest that solutions should be executed specific to a particular product flow. This focus is much more valuable from an implementation perspective in helping a company make the transition.

3.5.7 Summary

In short, transitioning to lean manufacturing is not easy. Most of the research has focused on a sequenced implementation of an idealized lean manufacturing system separate of the considerations of the existing state, opting instead to focus on the adoption of the countermeasures or tools of lean manufacturing. More critical than this is the need to adopt the fundamental rules or principles and integrate them into an implementation model. Rother and Shook (1998) also show us the importance of creating an implementation model that understands the intricacies of the current-state. With this knowledge of the current-state and the enablers that must be in place to support a lean manufacturing system, such as the measurement system and organizational structure, an improved implementation model can be created addressing these fundamental concerns.

3.6 Lean Research Summary

While each area of research seems to provide important and essential information, the integration of the different areas seems to be weak. Each area has been treated as being independent of the others. In reality, all of the areas are interdependent. Thus, a flaw in one area can weaken the entire system and lead to failure of the change effort. A truly lean system integrates all of the necessary aspects into a comprehensive system. Nonetheless, this chapter has reviewed many pertinent research areas in lean manufacturing. This background is useful to keep in mind as we explore the specific issues facing Intrigue and the adoption of the ILMS.

Chapter 4: Research on Managing Change

4.1 Introduction

It has been said that nature is resistant to change. Indeed, Newton's Second Law of Motion supports this principle by stating that a physical mass will continue traveling along its current path at a constant rate unless it is forced to do otherwise. Thus, nature tells us that a change from the status quo must be forced.

As creatures of nature, human beings are often resistant to change. On a larger scale, organizations are often described as immovable or slow to change. Why is change so difficult to embrace? Even when change occurs, often times it does not persist. Understanding change requires an understanding of the dynamics of change. Much research has been conducted to shed light on these questions and issues. This chapter will attempt to summarize much of the research and will provide a baseline for comparison when the implementation of the ILMS is later examined. Change efforts specific to process improvements will be explored in great depth as it will be extremely important in our later analysis of the ILMS.

4.2 Framing and Understanding Change

Why is it that some companies find it so easy to constantly change while others cannot implement even minor change? Comparing companies who continually transform themselves with ones that are rigidly configured helps to identify elements that must be addressed in a change initiative. Assessing the differences between these organizations has been a standard technique that researchers in the area of change management have used to uncover the essential elements of change.

A helpful framework to understand change and the factors to consider when designing change are the Three Organizational Lenses (Ancona (1999)). Each lens or perspective provides insight to minimize the organizational resistance to change. The strategic design lens suggests that the structures, processes

and procedures of the organization must be designed to ensure alignment with the change. These should serve to enable rather than hinder the changes. For example, measurement systems should ensure that the desired behavior is being gauged. Incentive systems should reward desired behavior, assuring that workers have the incentive to act according to the desired change. An appropriate design recognizes everyone that will be affected by the change and is structured to minimize the resistance within each area.

The political lens allows the organization to recognize everyone who will be affected by the change and understand everybody's motivations to either support or resist the change. It specifies the individuals or groups carrying power within the organization, the forms of power, and also the likely motivation or stance of these power-holders related to the change. The change must be such that it is beneficial to all power holders. Any deviation can render an initiative motionless, stalled by holders who would be negatively impacted by the change. The main barriers to change according to this perspective are due to entrenched interests and resistance to loss of power or influence.

Lastly, the cultural lens attempts to make sense of the culture of the existing organization by defining characteristics or artifacts of the organization. The implicit assumption is that organizations have momentum in the form of existing norms. These norms must be understood in order to understand the meanings that guide the behavior of the group. The perspective emphasizes the difficulty of change and the amount of time that may be necessary for a change to take hold. While none of the lenses is sufficient by itself to uncover all of the issues that may become obstacles in the ultimate success of a change initiative, together they provide powerful insights to consider when designing a transition or implementation plan.

4.3 Leadership and the Structure of Change

Very often the people we honor with the titles of "leaders" are people who have instituted major shifts away from the status quo. Thus, leaders are thought of as being necessary to transition organizations through radical, discontinuous change. Senge (1999) states that "leaders drive change.

That is what is expected of real leaders today.” However, leadership goes beyond a few, and he continues by stating that leadership is “the capacity of a human community-people living and working together-to bring forth new realities.”

A vast field in the area of leadership focuses in on the traits, behaviors, settings and values of leaders. While this research is insightful, the majority of it is not of essential importance here. However, Kouzes and Posner (1995) have developed what they term the “Ten Commitments of Leadership” (Figure 4.1). Although general and basic, when applied to any change initiative, they provide a framework for breaking down resistance to change and gaining commitment from the immediate team and the broader organization.

Figure 4.1 – Ten Commitments of Leadership

Source: Kouzes and Posner (1995)

PRACTICES	COMMITMENTS
Challenging the Process	<ol style="list-style-type: none"> 1. Search out challenging opportunities to change grow innovate and improve. 2. Experiment, take risks, and learn from the accompanying mistakes.
Inspiring a Shared Vision	<ol style="list-style-type: none"> 3. Envision an uplifting and ennobling future. 4. Enlist others in a common vision by appealing to their values, interests, hopes, and dreams.
Enabling Others to Act	<ol style="list-style-type: none"> 5. Foster collaboration by promoting cooperative goals and building trust. 6. Strengthen people by giving power away, providing choice, developing competence, assigning critical tasks, and offering visible support.
Modeling the Way	<ol style="list-style-type: none"> 7. Set the example by behaving in ways that are consistent with shared values. 8. Achieve small wins that promote consistent progress and build commitment.
Encouraging the Heart	<ol style="list-style-type: none"> 9. Recognize individual contributions to the success of every project. 10. Celebrate team accomplishments regularly.

The model is valuable because it describes essential activities to address in a transformation. More formal models on the essential stages and elements of change exist. Most of these models divide up the management of change into finite sequences such as preparing change, beginning change and sustaining change. Each phase includes essential activities. For example preparing change would include

activities such as preparing a vision and strategy, and establishing key leadership. Beginning change would include activities such as redesigning structures, processes, and creating and carrying out an implementation plan. Sustaining change might address systems that should be erected to support continued momentum.

Senge and Käufer (2000) suggest the need for three types of leaders to initiate and sustain change in an organization. *Local line leaders* are critical because “only they can deal with important day-to-day matters like time, help, relevance, and walking the talk.” Because of their focus on a local team or area, they are isolated from other parts of the organization that could also benefit from the changes. *Internal networkers* balance this inward view and spread new ideas to other parts of the organization, moving across functional boundaries. “They serve as guides, advisers, active helpers, and accessors, connecting people and ideas across the organization.” Lastly, *executive leaders* are necessary to redesign and rethink the challenges and direction of the organization.

Charles Colosky (1998) claims that to introduce and sustain a change in daily operations, sufficient underlying capability to support and continue the changes must exist. In cases where the change involves significant change, such as empowering lower levels of the organization, a “development strategy” is ideal. He claims that development needs arise when the social or technical capabilities of the organization are not aligned with or supportive of the change. He claims that many companies are unsuccessful because they follow a try-it-‘till it sticks change philosophy, hoping to find something the company will understand and embrace. He calls this rapid information transfer throughout all levels of the company a deployment strategy.

“Deployment is good for distributing information of a limited and specific nature. While transmission of information is assured, understanding and application is not.” Because of this, ideas that are sensitive to the context they are applied in are not successfully implemented using such a strategy. It is necessary to create the fit between the current business needs and the company’s capabilities. Thus, it is necessary to understand the needs of the different parts of the organization and discover the behavioral gaps to use in planning the development activities to lessen the gap and develop the appropriate and

necessary capabilities. Thus, different parts of the organization will require different amounts and type of support. Maintaining a sufficient amount of support is necessary to have people stay involved and “interested in an improvement process when they know the changes they are making are more than just a passing fad and are a real actor in the organization’s future success.” For a company that is used to doing things a specific way, it is necessary to spend much more effort in gaining support and educating people on the benefits in order to break the ‘if it ain’t broke, don’t fix it’ cultural artifact.

4.4 Process Improvement Initiative Change

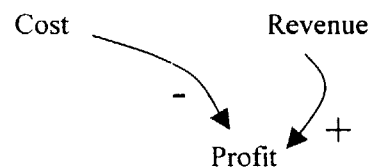
Change is required in today’s evolving world. What many companies are calling the information revolution is forcing many companies to remold themselves to compete in the new environment. This type of change has been what many refer to as discontinuous because it is a radical departure from existing work and processes.

A common change in corporations during the past decade has been in the area of business process reengineering (BPR). Firms have taken on radical projects to transform the way they are structured and carry out business processes. The principle behind it is the elimination of non-value-added tasks or waste. Thus, the implementation of lean manufacturing can be referred to as a form of BPR. Because it requires a fundamental shift in the most basic principles regarding work, it introduces a discontinuous change. However, once implemented, change is the natural state and is continuous.

Because the scope of change evolves within a lean manufacturing system, dynamic models are necessary to explain why some process improvement or BPR initiatives succeed while others fail. Better yet, such a model may help explain why change may initially take hold but cannot endure over time. Repenning (1997) states that “there is a clear need for an interdisciplinary theory that integrates the physical structure of improvement with understanding of human decision making in organizations to explain the challenge and difficulty of organizational change.”

Need for Early Commitment and Success

Repenning (1998) attempts to explain how such change initiatives are thwarted by organizational dynamics using causal loop diagrams. Causal loop diagrams (CLD's) as the name implies attempt to identify the cause and effect relationship between two variables and the interdependence of these with a broader system of variables. For example, consider the following CLD.

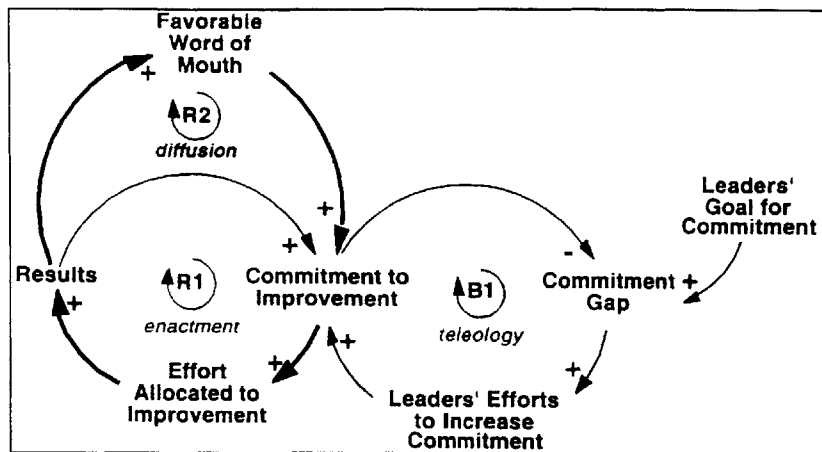


The diagram consists of three variables: cost, revenue, and profits. The direction of the arrows explain the causality between the variables. Here a change in either the cost or revenue will impact the state of the profit variable. The polarity (sign) on the arrow indicates the nature of the relationship between the two variables. A “+” polarity indicates that an increase in the independent variable causes an increase in the dependent variable or that a decrease leads to a decrease. A “-“ polarity indicates the opposite relationship.

Repenning states that “successfully implementing a participatory initiative requires both an effective set of behaviors and tools and an organization that uses them effectively.” Believing that participation in such an initiative cannot be forced, he asserts it must have other sources besides management input. This is indicated by the *enactment* and *diffusion* loops in Figure 4.2. Participants will evaluate the usefulness of the program based on its results. Improvement in results leads to increased commitment or what he refers to as a virtuous cycle because positive outcomes create a process of reinforcement. Positive results lead to increased commitment that encourages greater effort and hence even better results, leading to yet even greater commitment. However, these same dynamics will cause negative outcomes or results to have destructive effects on the commitment level in a vicious cycle. This “enactment” dynamic is further strengthened by favorable word of mouth or “diffusion” loop, as word of

the success or failure will spread to areas that were uninvolved in the change effort. Thus, the push from the leaders and managers, the experience that one has with the program and the thoughts one develops through discussions with other users all play an important role in building the commitment of a person or group to a change.

Figure 4.2 – Building Commitment for Change
Source: Repenning (1998)



Differential equations are used to simulate the system's interdependencies and dynamics.

Repenning finds that there are specific leverage points that can be exploited to improve the probability that an initiative will work. First, management's efforts must provide a strong catalyst so that critical thresholds are met and the enactment and diffusion loops are set in a virtuous cycle. They then dominate the system behavior. When management sets a low target for commitment, the enactment and diffusion loops never reach the required threshold and the system does not grow commitment. Simulation shows that there is a significant delay between the start of the program and the growth in commitment created by the positive enactment and diffusion loops. If managers underestimate the delay required for a successful effort to be implemented, they are likely to conclude that the set of tools do not work and end their support for the effort. Participants seeing the lack of support, and lacking other evidence will also abandon the effort. It is helpful for management to structure a change initiative so that early benefits that can be attributed to the change are apparent. This is why many initiatives often attack the low hanging

fruit early. Summarizing, “the key to sustaining the success of a participatory improvement effort is to create enough initial commitment and results so that the enactment and diffusion processes work in a virtuous direction.”

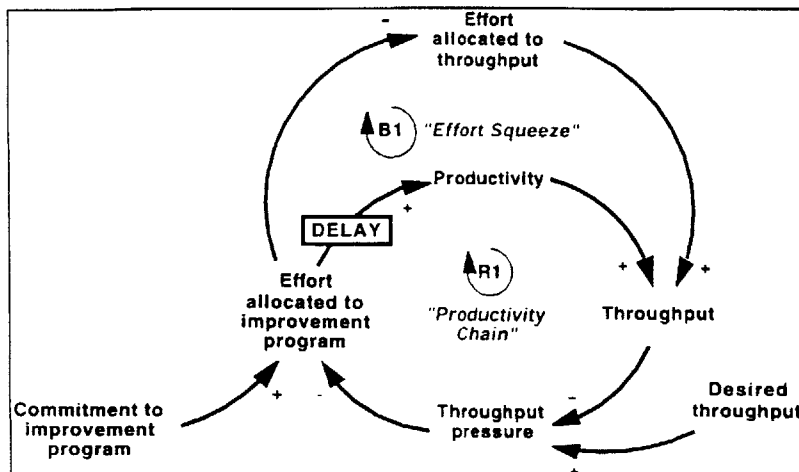
Worse Before Better, Employee Initiative & Evolving Expectations

In a separate study, Keating et. al. (1999) state that “the inability to manage an improvement program as a dynamic process is the main determinant of program failure.” These programs must be recognized as being tightly coupled to other firm processes, customers, suppliers, competitors and capital markets. “Failures to account for the feedbacks among these tightly coupled activities leads to unanticipated and often harmful side effects.”

First, it is necessary to address the fundamental trade-off between current and future performance levels. There is a delay between action and results. To work on improvement initiatives, employees must dedicate less time to meeting throughput. The short run effect is a decline in output, exactly the opposite of the goal. Figure 4.3 indicates that as throughput falls, pressure to work harder builds. Employees faced with this pressure to meet throughput goals are forced to cut back the time allotted to improvement initiatives, meeting short-run production requirements but either stalling or killing the improvement effort. “The delay between allocating time to improvement and obtaining results, combined with the immediate drop in throughput, implies that performance will follow a ‘worse-before-better’ pattern.” This dynamic supports many expert claims that employees should have a sufficient amount of their time allocated to improvement efforts. Managers can reduce throughput pressure by adding resources or capacity, thereby allowing sufficient time for both throughput and improvement activities. Lastly, management can lower throughput pressure by reducing the desired throughput. The authors claim that “many improvement programs fail because management cannot tolerate or understand the initial drop in availability or rise in costs.” Thus, this throughput pressure or pressure to meet daily production goals must be kept low to support the reinforcing nature of improvement.

Figure 4.3 – “Worse-Before-Better” Dynamics

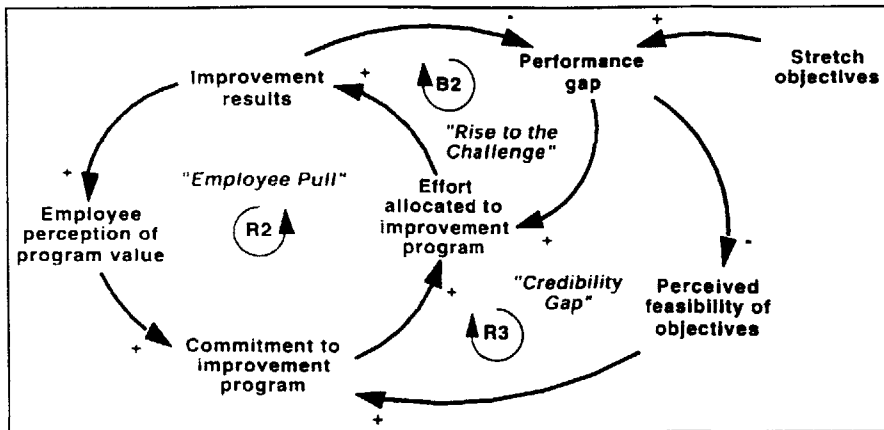
Source: Keating, et al (1999)



The second claim of the study is that commitment to ongoing improvement efforts must shift from managerial actions to employee initiative or what they call employee pull. Employee pull arises when workers come to understand the benefits of improvement and commit themselves to the effort. Similar to the Reppenning (1998) finding, they claim that an initial managerial push is necessary to build an initial commitment level. These activities include but are not limited to training, demonstrating support, providing incentives, clarifying needs and championing. However, they claim that “no amount of management push can substitute for the self-reinforcing feedback created as results motivate more people to participate, thus generating more results.” They introduce the model shown in Figure 4.4 revealing that many factors can interfere with employee pull. In addition to earlier findings, they claim that early effectiveness depends on the scope of the initiative and the adequacy of the chosen methodology. It is thus important to establish a sufficient job security level and develop an adequate training and support infrastructure to accompany the change. “Improvement programs can falter as aggressive push and pull effects that expand the demand for training and support far faster than capacity and support infrastructure – overwhelming the training organization. The initially enthusiastic participants then falter in applying the tools, causing them to question the methodology and, ultimately, abandon the program.”

Figure 4.4 – Generating Employee “Pull” for Change

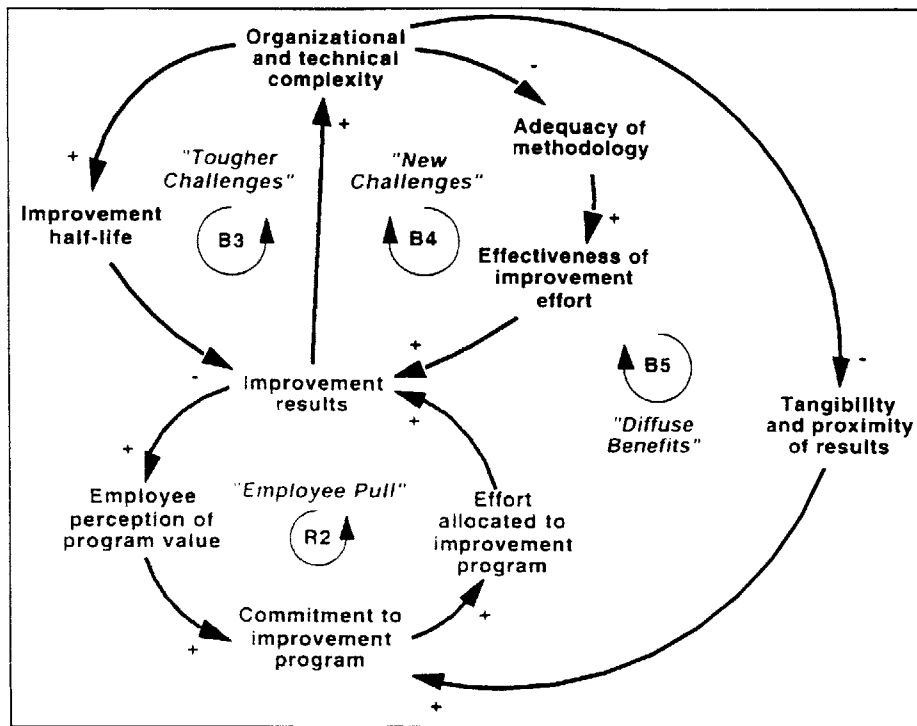
Source: Keating, et al (1999)



Lastly, aggressive objectives can undermine the benefits. The authors claim that a credibility gap can develop that undermines the effort when set too high. People often underestimate the scope and difficulty of tasks. Reasonable estimates of the time and efforts required to make improvements are needed to allocate sufficient resources. Improvement half-lives, the time it takes to make a 50% improvement, grow with the technical and organizational complexity of a process. Early problems focus on simpler problems or ‘low hanging fruit’. Once these opportunities are removed, the problems addressed are more complex, and thus have greater half-lives. The increased half-lives slow the rate of improvement, weakening the self-reinforcing employee pull process. Figure 4.5 shows these dynamics and how they can cause a program to falter.

Figure 4.5 – Growing Complexity of Change

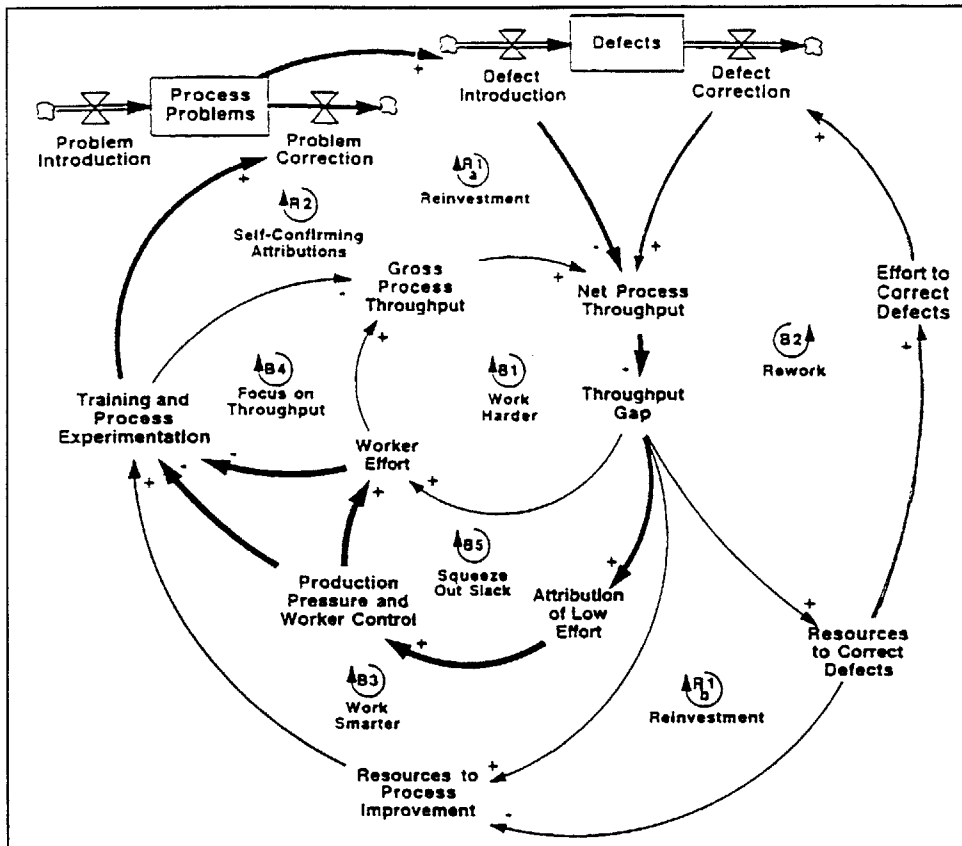
Source: Keating, et al (1999)



Addressing the Root Cause and Preconceived Biases

Repenning (1999) states that the “challenge of process improvement is to shift attention from reducing the stock of defects to reducing the stock of process problems.” Faced with a “throughput gap” as identified in Figure 4.6, he states that best solution is a second order improvement where “process problems” are targeted by increasing the rate of “problem correction”, thereby reducing the pool of process problems. This rate increases via the “work smarter” loop where resources dedicated to improvement activities are increased and training and process experimentation is encouraged. Ultimately, this increases the quality of production, thereby increasing the net throughput or rate of good production. Alternatively, a first order improvement attempts to increase the net throughput by correcting defects. This is accomplished through the “rework loop”. Because of limited resources, the same workers are allocated to both types of improvements. Thus, management must often decide whether to address the throughput gap, or difference between the desired throughput and the actual throughput, by correcting the defects or the source of defects.

Figure 4.6 – Meeting Throughput Dynamics
 Source: Repenning (1999)



He states that systems often fail because management often chooses to make first order improvements. Faced with a large physical inventory of defect parts and a throughput gap, converting the inventory into finished goods seems logical. Thus, resources are dedicated to correct defects, limiting the resources available to address process problems. Thus, defects keep being introduced into the system. Furthermore, improvement activities often require a disruption in production to allow for experimentation. This creates a short run decrease in gross throughput that is immediately evident. Under pressure to close the throughput gap, this decrease is difficult for many to accept.

Another key finding of his study is the self-fulfilling prophecy that is created from a predisposition regarding the cause of low process throughput. He claims that managers will increase production pressure and the strength of process controls if they believe that the low throughput is a result of the lack of worker effort or discipline. This is done through “higher throughput objectives, overtime,

faster line speed, and so on.” This increased pressure will immediately increase the gross throughput, affirming the manager’s beliefs that the workforce was simply lazy. However, this increased pressure will lessen the amount of time available for making improvements, decreasing the rate of process problem correction and increasing the rate of defect introduction. Thus, the net throughput rate drops and a self-fulfilling, self-reinforcing dynamic is set in motion. “Workers may grow to resent the control exerted by management and the lack of trust motivating it, leading to an increasingly hostile and adversarial relationship between superiors and subordinates, workers and management. Workers ultimately have no choice but to evade or subvert management’s controls, play games with performance metrics, and shirk to relieve an intolerable workload. What begins as a false attribution by management that workers are slothful, undisciplined, and untrustworthy becomes reality.”

Although a daunting task, the key is to attempt to understand the dynamics of the system and ensure that the true process problems are identified and addressed. It is important to keep the production pressure under control to allow for sufficient time for addressing these process problems. These second order improvements will increase the rate of process problem correction, leading to decreased defect introduction and ultimately additional resources to dedicate to correcting these root causes.

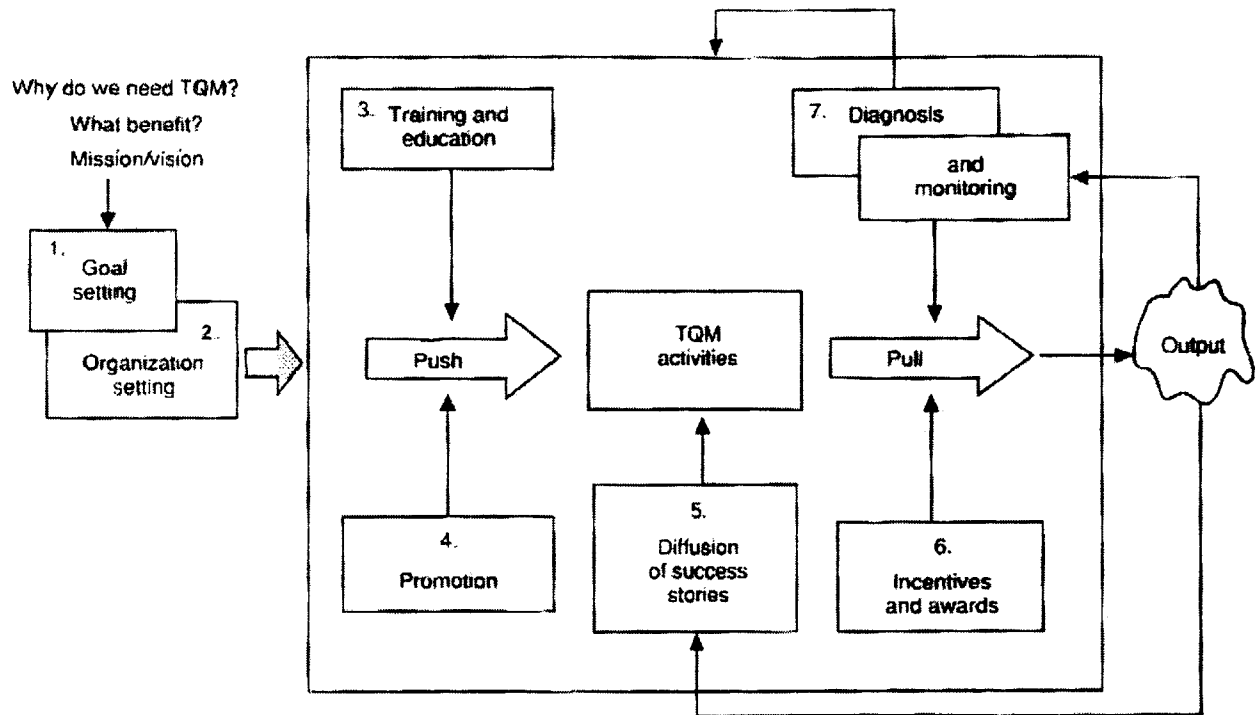
Management Attention

Shiba, Graham and Walden (1993) state that in a TQM movement, a company must first mobilize the organization for the change. This mobilization strategy must have three parts: CEO involvement, strategies for introduction, and organizational infrastructure. The CEO involvement is to ensure that the change gets a sufficient amount of attention and support. This high level support will make dedication and experimentation at the lower levels more likely, ensuring that initial problems are addressed and corrected. The development of the infrastructure should consist of many activities. The authors indicate the existence of seven key elements of organizational infrastructure which are listed in Figure 4.7. These steps indicate the existence of a sequence or phases. An important insight pertains to the indication that in the *orientation* and *empowerment* phases the initiative must be pushed by management. The later *alignment* phase requires that this push for initial participation is transformed into a pull for further action

by employees. This transition from pull to push was discussed in the earlier study by Keating, et. al. (1999). The model also indicates the importance of monitoring the implementation mechanism and improving it as needed. Incentives and rewards must be such that they encourage the desired behavior. Employees must have sufficient training to minimize the early failures associated with the change. As with earlier findings, they define promotion as vital to building early commitment at all levels of the organization. *Word of mouth* of success stories is a key diffusion mechanism to build the level of commitment.

Figure 4.7 – TQM

Source: Shiba, Graham and Walden (1993)



Most of these other studies focus on specific dynamics that may be in place to either support or inhibit change. At any point in time, there are many dynamics occurring and all of them are acting to influence the initiative in either a positive or negative manner.

Common Growth and Limiting Processes

Senge (1999) states that the first principle of leadership is to understand the self-reinforcing process of growth. He claims that these growth processes cannot occur unless the conditions are conducive. Limiting conditions can keep these growth processes from operations, thus "all effective leadership strategies always come down to nurturing reinforcing growth processes and relieving the limiting processes...Effective leaders recognize intuitively the interplay of these forces and learn to work with them." The Society for Organizational Learning (SOL), an organization in Cambridge, Massachusetts (<http://learning.mit.edu>) through research has identified common growth and limiting processes or forces (Figure 4.8).

4.5 Summary

Change can have an impact far beyond the local area where it is implemented. It is necessary to understand how the change impacts the bigger picture. There is no single way to design a change initiative, but the research mentioned in the chapter provides some important tools, lessons and understandings that should be considered during the design of a change implementation. Most importantly, the importance of thinking about change systemically is invaluable. Change by its definition is dynamic, yet too often we plan change as a static process. We must understand the dynamics of change and nurture the growth processes while simultaneously inhibiting the limiting processes. This research was very insightful and will come in very handy as we now turn our attention to Intrigue and the problems it has encountered as it has tried to diffuse the ILMS throughout the company.

The SOL's list of growth enhancing and limiting forces (Figure 4.8) is the most valuable of the studies because it compiles research from many organizational change initiatives and lists the different types of dynamics that were undiscovered. The list is a worthwhile tool that may be continually referenced to manage a change initiative to improve the odds of success.

Figure 4.8 - SOL's Growth & Limiting Processes

Source: Senge (1999)

Growth Processes	Explanation
Business Results	Increases the credibility of the idea leading more enthusiasm and willingness to commit.
Personal Results	People are more committed to changes that benefit them such as work environments where they experience trust.
Peer Influence	If positive results occur in one area, word and experimentation will likely spread to others. This has often been shown to be the primary mechanism of diffusing new ideas throughout an organization.

Limiting Processes	Change Challenge	Explanation	Strategies
Time Flexibility	Initiating	People must have sufficient time for change initiatives.	Trust people to control their own time.
Help	Initiating	People need training and coaching in the new initiatives.	Recognize & invest in needed help early. Create an internal capacity for coaching.
Relevance	Initiating	The need for the change must be made clear.	Build awareness among key team leaders. Explicitly raise questions about the relevance - make the subject open and discussible.
Personal Alignment	Initiating	Managers must be credible and their actions must comply with change.	Build credibility in org. values by demonstration. Cultivate patience under pressure.
Fear & Anxiety	Sustaining	People naturally fear making a mistake or showing ignorance. Deep changes that question accepted long-held beliefs are especially threatening.	Start small and build momentum before conquering difficult issues. Set an example of openness. Use breakdowns as learning opportunities.
Assessment & Measurement	Sustaining	Significant time delays may exist. Will people persist when business results may take months or years to reflect the changes or traditional measures look worse?	Appreciate the time delays that may be involved. Build partnerships with executives around assessing progress. Make assessing progress a priority.
Believers & Nonbelievers	Sustaining	The more time the pilot group spends in isolation, the more they distance themselves. Will the organization deal with the threat of the team and the new behaviors?	Seek mentoring from other leaders, especially those with high credibility in the mainstream culture. Build the group's capability to engage the larger system.
Governance	Redesigning	Innovative groups at some point get caught up in issues of power and accountability. Diffusion and expansion activities will begin to affect other parts of the company.	Pay attention to boundaries and be strategic when crossing them. Articulate the case for change in terms of business results. Deploy new rules judiciously. Make executive leaders' priorities part of your teams.
Diffusion	Redesigning	Concern that new knowledge never escapes local "pockets".	Release information widely about new innovations.
Strategy & Purpose	Redesigning	How do the strategy and organizational values effect change.	Develop stewardship as an organizational ethic and practice. Continually engage people at all levels around the question of strategy and purpose. Test the assumptions behind the current strategy.

Chapter 5: Diagnosing Intrigue's Implementation Issues

This chapter summarizes the actions taken to unveil the issues with the ILMS and its diffusion within Intrigue. Various analyses are explained that were performed to uncover the issues. The findings of these analyses are strikingly similar and are discussed throughout the chapter.

5.1 Introduction

In learning about the ILMS, I traveled to most of the Intrigue North American manufacturing facilities. The degree of success and effectiveness of the system seemed to vary from one manufacturing facility to the next. I also observed that none of the plants were anywhere near operating at levels equivalent to Toyota or other world class lean plants. Additionally, the plants that were more successful in applying the principles were not always more successful from a financial point of view than their counterparts who had not embraced the systems.

Many people seemed fed up with the lean initiatives, particularly the implementation of pull systems. One worker informed me, "Many times it's the system of the week. We have good people leaving because they are fed up with trying to do a good job when they know the system is going to change next week." This response indicated that plant management were not dedicated to continuous improvement and fixing problems when they occurred. Rather, they would treat the occurrence of a problem as a system failure and look for a new and improved system.

How can a consistent message and philosophy from throughout the organization produce such a large variety of results? 'The answer must certainly lie with the leadership within the manufacturing plants', I thought. I could definitely notice that the leaner plants seemed to be led by genuine believers in the philosophy. By contrast, the management in the plants that were not as lean did not believe a lean system was reliable. But beyond this, was there something within the company's implementation structure that inhibited success?

A search of existing documentation yielded the list of problems in Figure 5.1 that employees had identified with the company's pull systems. The list is by no means exhaustive but is very valuable

because it identifies the many of the problems as perceived by the workforce. As discussed in Chapter 4, this perception is often more important than reality as the perception can either act to grow or limit the dynamics of change. Many of the listed issues were identified earlier as crucial to the dynamics of organizational change. Limiting forces can easily be associated with these issues. For instance, *improper managerial support* means that management is not walking the talk, and thus a credibility gap exists. This *personal alignment* dynamic was identified in Chapter 4 as being one potential dynamic limiting the growth of an improvement. This is an observed state and does not identify the true underlying issue as to why this inconsistency is present. It may be due to *assessments and measurements* that are inappropriate and do not recognize the delayed response of the system, or it may be due to *relevance* and the fact that management doesn't truly understand the benefits of the system. Limiting force dynamics can be linked to every other issue. Because we lack the causality to expose the true root causes of the documented issues, further examination is necessary to determine the crucial elements limiting the success of the company's pull systems and more generally the ILMS.

Figure 5.1 – Previously Documented Pull System Issues

- Inadequate management support.
- Lack of attention to intricacies of each system.
- Excessive amount of discipline is required to maintain.
- Lost pull tags (kanban cards).
- No safety or backup system.
- Difficult to implement during start-up due to initial start-up spike.
- Inadequate system maintenance.
- Inadequate training.
- Non-repetitive requirements (service).
- Not enough buffer inventory to handle variation.
- Lack of understanding.
- Lack of confidence in the system.
- Lack of clarity from management – have not defined what a pull system is.
- Lack of quality in the process (low reliability).
- Undefined team responsibility.
- Belief that MRP is needed.

5.2 Ishikawa Analysis

This documentation is helpful in explaining prior issues with the ILMS but a structure is needed to prioritize these issues relative to their importance. A principle of lean manufacturing is that those closest to the work are the most capable of improving the work. This was a principle that Intrigue believed was central to the ILMS. In order to prioritize the issues and find the true root-cause problems with the ILMS, a workshop was held with a broad cross-section of people that were close to the system and the work. Workers from various plants and positions participated in the workshop. The common thread among the group members was that all of these people interfaced with pull systems in their jobs or had been involved in earlier implementations.

The workshop was structured using common TQM root-cause analysis techniques. The theme was first agreed upon by the group as “Why have prior pull implementations not improved plant operations?” The framework of the Ishikawa or Cause and Effect diagram was then laid out as suggested by Shiba, Graham and Walden (1994). Five main categories or branches were selected to form the main structure of the fishbone: People, Machine, Method, Material, and Environment. The next step was the time consuming and value-adding stage of filling in the tree branches with the detail of imaginable causes that could lead to the problem stated in the theme. The result of this analysis is the completed Ishikawa Diagram in Appendix B. The mechanism used to fill in the diagram was the “5-Why?” TQM method of discovering root-causes. The method is simple and consists of repeatedly asking “why?” to uncover the root cause of a problem. This method was chosen because it forced the group to dig down below surface issues that many had thought were the big problems to deeper issues that many of them had not considered or thought of as being relevant.

The analysis reveals many potential problems with prior implementations and why they did not reach the initially desired level of success. It is necessary to narrow down the field of candidates and locate the true culprits. Optimally, objective data should be used to aid in this determination. However, because the theme is more qualitative than quantitative, a voting technique to help people identify the

main issues was used. The reasoning was that since the people contributed and had constructed the diagram, they had thoroughly discussed the issues and the possible underlying causes. This exposure would allow them to make a fairly objective decision. Each person in the workshop voted on three items that they felt were the most important factors that inhibited the success of pull systems. The results of the voting follow.

Issue	Votes
Lack of Training	7
Lack of Human Resources	5
Lack of Discipline (Accountability)	4
Lack of Support	2
Lack of Involvement (Total)	2
Lack of an Understanding of the Benefits	2
Lack of Stability	2
Alignment of Business Goals to Metrics	2
Poor Planning	1
Poor System Management	1

A review of the voting results shows that many of the voted-on items are not truly root causes. In these cases, one can dig to find a deeper cause. Nonetheless, these are the items that the people thought were the most important factors hindering success. Many thought that *Lack of Training* was the main problem. They believed that neither the workers using the system nor management were properly trained in the principles of kanban systems and were unable to develop and implement these systems properly. They also believed that the operators were not trained to handle the different cases they encountered during daily use. Coupled with *Lack of Support*, another issue deemed important, this creates an environment where people are confused and unable to move forward to make the necessary improvements that will allow the system to function. A useful framework to consider these issues is the SOL Growth & Limiting Processes shown in Figure 4.8. These two issues correspond to the limiting force of insufficient *help* identified earlier. The limiting force of time flexibility can explain another item. *Lack of Resources*

is referring to the pressure to meet daily production, thus inhibiting the time available for improvement activity.

Both of these items also relate to *Lack of an Understanding of the Benefits*. The benefits are not always transparent. To make people understand these benefits, theory is generally not enough. People usually have to see the difference between a system operating efficiently on kanban and their factory as it exists. Thus, for a company starting off, a benchmarking visit to an external facility can be extremely valuable. Interestingly, we can also relate this back to the *relevancy* limiting force described earlier. It is vital to address this issue in order to control the dynamics limiting the growth and diffusion of the ILMS throughout the corporation.

Also deemed important was the *Lack of Discipline* that seemed to surround the operation of the pull systems. This is not a root cause and might be attributable to several main sources. One path in the Ishikawa diagram explains that employees don't buy into the system because they fail to understand the benefits of the system. In this case, a lack of training and support would be a fundamental cause for the problem. Another scenario explains that employees fail to buy-into the principles because a continuous improvement environment is not established where the workers are truly empowered and involved. Potential causes for this are that *Business Goals and Metrics are Misaligned* or that *Management Lacks Training* and thus doesn't understand the necessary culture that is required to support such a system.

All of the listed items can be grouped into *Poor Planning*. Because of poor planning, enough resources weren't allocated to support and train the plant personnel in the implementations. Because of poor planning, the company failed to involve important users (*Lack of Involvement*) in the design of the system. This lack of planning can be thought of in terms of the *strategy and purpose* and *diffusion* limiting forces. It must be addressed in any improvement effort.

After significant exposure to the workshop and other encounters with personnel, I believe that there are also other issues of great importance that must be addressed to improve future implementations. The most important of these are:

Management Doesn't Understand Necessary Culture – Not enough energy is being spent in transforming the culture. This is due mainly to a lack of understanding how the current culture and lean culture differ from each other. The differences must be made clear so that an action plan can be developed to address these differences during implementation.

Business Goals and Metrics Misalignment – Many workers identified that the metrics the plants work to optimize are not aligned with a lean philosophy. Lean stresses employee empowerment and the elimination of waste. However, often times the positive results do not show up on the more important financial measures immediately. Thus, often times, the companies are more concerned with optimizing the short-term financial figures. A greater in-depth analysis of the company metrics will follow later.

5.3 KJ-Analysis

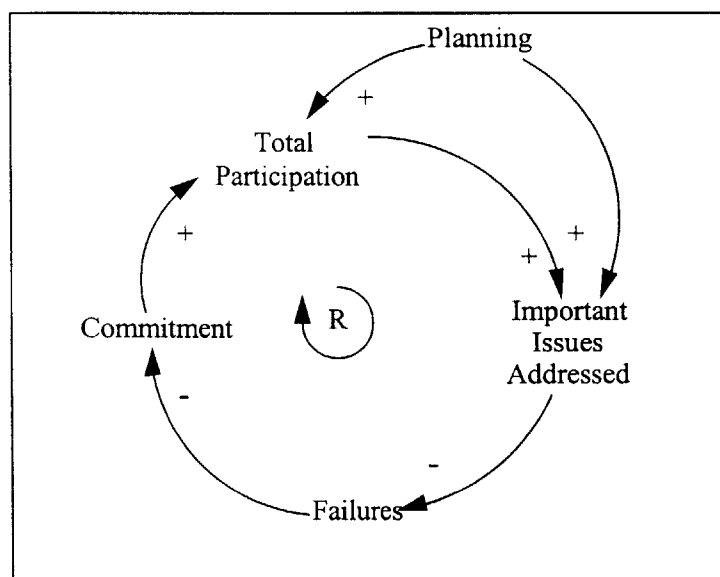
The workshop revealed items that acted/interacted to keep the ILMS from taking root. However, causality and prioritization of the issues was incomplete. To supplement the root cause analysis, the participants were asked to fill out a questionnaire (Appendix B) prior to workshop. The intention was to extract valuable qualitative data that would complement the root cause analysis. The questionnaire elicited valuable response data that was used to construct an affinity diagram (a.k.a. LP-Diagram or KJ-Diagram).

Affinity diagrams (see Shiba, Graham and Walden (1994)) are useful tools to organize qualitative data to identify main causes related to a theme. The theme is phrased in a negative manner so that it identifies an existing problem. The same theme as the root cause analysis was used to focus the analysis. Next, verbatim quotes related to the theme were selected from the questionnaires and written on post-it notes. Similar quotes were grouped together in sets of two or three and given a new head title summarizing their information. This process was then repeated and the new titles were grouped and titled until only a few main titles were left. The process recommends that a voting technique be used at this

point to identify the three most important elements on the diagram. A concluding title should then be formed to respond to the question posed in the theme. However, since I performed the analysis alone, I felt it most effective to construct a title using the remaining main titles. This was done to eliminate any preconceived bias I may have carried into the analysis regarding fundamental problems.

Appendix B shows the completed product. The conclusion states that “Because implementation leaders failed to involve all of the important people and address all of the important issues, many crucial factors went unaddressed and led to early problems that created a resistance to change.” The conclusion startled me at first because my preconceived notion was that the title would be more in-line with the key issues pointed out in the root-cause analysis. However, further reflection indicates that the results are not that far off from each other. The key to the conclusion is that a lack of planning on the part of the leaders carrying out the implementations is critical. This can be seen in the failure to realize the importance of several issues related to both the technical and social sides of the implementation. The conclusion hints that their failure to address these issues led to early problems that reinforced the beliefs of those that had been neglected. This reinforcement led to increasing resistance. Thus, the concluding title itself describes a dynamic inhibiting the success of the pull system implementations (Figure 5.2).

Figure 5.2 - KJ-Analysis Conclusion



The figure clearly indicates that initial planning is essential in building participation and identifying issues prior to implementation. Fewer failures will result, building greater commitment and participation. This high level of initial planning sets a reinforcing dynamic in place leading to even greater commitment to the change.

Hilbert (1998) agrees that the initial planning process is vital, stating that “American firms tend to start the whole process with a mandate for change and proceed directly to the implementation stage. They ultimately take longer to implement change because there was no clear vision set.” Various employees within Intrigue that were critical to its operation were left out of the system development process. Coupled with the lack of training and support during the implementations, employees found it difficult to take ownership of the change. This was true of both plant management and the shop-floor personnel. Further reinforcing the negative effects was the lack of enforcement of the system. People were not held accountable to using the system, so people were reluctant to take ownership of a system that was pushed on them. Further degrading the success of the implementations was the fact that the failure to get everyone involved in the design and planning process led to early problems that may have been avoided. These problems were not caused by the system itself, however they were often attributed as being the fault of the system design. Rather than wanting to improve the system and eliminate the problems, many of the people affected by the change just wanted to wash their hands of them. Thus, these early problems ultimately led to a great force resisting change.

5.4 Personal Observations and Interviews

Certain themes repeated themselves in my encounters with the Intrigue employees. The SOL framework is very helpful in making sense of many of these themes. The analyses identify many factors that interacted to limit the growth of change in the initiation stage. There are also examples of several plants that were initially successful. Over time these systems collapsed and the changes could not be sustained. The previously discussed forces limiting growth are useful in describing these failures. The

limiting force of *fear and anxiety* seemed to be powerful in certain instances. System failures were not viewed as learning opportunities. Rather, failures were attributed to the manufacturing system as mentioned above. These failures would halt production and lead to a pressure to meet production similar to the dynamics in the Repenning (1999) study. Faced with this pressure, workers would side step the system, choosing to focus on meeting throughput instead of correcting the underlying problems.

The limiting force of *assessment and measurement* exacerbated the problems and the focus on throughput. The measurement system was very short-term focused. Working on correcting problems would pull valuable resources away from throughput. Because of the inherent system delays, any improvements would not become evident for quite some time. Thus, there was no short-term benefit to making the improvements. This behavior prompted managers to focus on the short-term measurements because they received much greater emphasis and were seen as being much more relevant and important.

One woman told me that “many times the machines are left running longer than they should just because they are running. They (supervisors) then let them run until they go down. This is because the company doesn’t take the time to determine the root cause of the problems. They put band-aids on the failures to get them back and running.” This message was expressed by several others. Problems were just not always addressed directly and hence occurred repeatedly. The negative effects of this dynamic were explained in Chapter 4. By never addressing the root-causes of the problem, they become even more difficult to address in the future because of a continuing accumulation of defects. This dynamic seems to be at play in several Intrigue plants. It was common for many products to go through a rebuffering operation. This operation was performed because of defects in the painting process. Rather than address the true causes leading to the failed quality, the correction of these defects had become a standard processing step. Thus, the pressure to meet production creates this limiting force of *time flexibility*. Intrigue needs to address this dynamic and ensure that workers have sufficient time to correct root-cause problems. Otherwise, the viciousness of the dynamic will lead to greater underlying problems that will lead to an increasing number of defects.

Another common message in my conversations was the following. “Many times it’s the system of the week. We have good people leaving because they are fed up with trying to do a good job when they know the system is going to change next week.” A different individual told me “Here we go again, something new that's not going to work anyway.” These statements signify an underlying problem with the credibility of the change initiatives. This cynical atmosphere inhibits the process of generating employee pull as workers don't believe the initiative is truly relevant and is destined to fail. This preconceived bias has a way of become self-fulfilling similar to the way that Repenning stated that managements' preconceptions that employees may be underachieving ultimately become true through the inherent system dynamics. Intrigue must be aware of these dynamics and make the ILMS initiatives surrounding it credible. This *personal alignment* limiting force must be addressed in a redesign of the system.

Another individual told me “Yeah they’re doing workshops but Betty, the Continuous Improvement Coordinator, has her favorite group of 5 people that always do them.” This message conveys the possibility that not all workers are truly involved in improvement efforts and that this form of empowerment is the privilege of a lucky few. The basic philosophy of lean manufacturing is the involvement and development of all employees. This is fundamental in order to build commitment to the ILMS and to make the system *relevant* to everyone involved in its operation. Recall the total participation dynamic discussed in Figure 5.2. The importance of this dynamic cannot be overemphasized.

Another worker explained to me that “Don is the only one that understands the system. What would happen if he left the company? All that the operators know is that they need to check the sheets. They don’t understand the requirements. They don’t understand how the system is affected if they fail to check the sheet.” This again reinforces the idea that control of the manufacturing system is not in the proper hands. All of the power over the operation rests in the hands of a few, suggesting a command and control atmosphere. Intrigue must address the organizational structure and the roles and responsibilities of the workforce so that they are more aligned with a lean and change-ready organization.

One worker described the following situation when implementing a pull system. “I ran like a crazy woman looking for pull tickets that got lost, thrown away, shipped, etc. Everything was always in the red (high priority) on the pull boards. so we had to call customers, make excessive mold and color changes. They (workers) thought we were nuts for ruining a good thing and running around like crazy.” Repenning explained the important role that positive results play in building commitment. This is the same dynamic playing itself out as a viscous cycle. Improved planning is necessary to limit the problems early in the process. Furthermore, the change should be structured to elicit positive results and build this necessary early momentum.

The same worker went on to say “People need to be rewarded for their improvements. You learn by doing not pushing. In our case learning came after the hard part, and the rewards were never received. The pull system went away and people came up with other ways to keep customers happy.” This example shows the short sighted nature and management's failure to understand the ‘worse-before-better’ dynamic. The failure to recognize the dynamics and time delays led to the early discarding of the system.

When commenting on the efficacy of the present pull system, another worker commented “Some people did not understand the importance of each tag (kanban card)...We would find people hiding tags in the belief they could have the weekend off.” The statement reveals that the workforce didn't truly understand the system itself and its benefits. Thus, there was a *relevancy* dynamic limiting the success of the pull system. Workers must understand how the system is benefiting them. This is important in any change initiative. Intrigue must make the case for change clear to all employees.

5.5 Organizational Assessment

Armed with research findings on how lean and change ready organizations should be designed, a comparison between the research and the current Intrigue organization reveals shortcomings or areas that are inhibiting the success of the ILMS.

5.5.1 Strategic Design Analysis

In viewing the organizational structure and linkages between the roles and responsibilities within the organization and those of a lean organization, several discontinuities are evident. As described earlier, the structure should be such that decision making is pushed down via empowerment. Most of the shop floor employees, or lower level as described in Chapter 3, at Intrigue manufacturing facilities have little control over their work output. Instead, supervisors generally instruct them on what to produce and when product is poor enough to warrant halting production. They meet as a team periodically to discuss current issues, but rarely work together during production to solve problems as they arise.

The executive-level are the trend setters of the organization. Much of the organizational tension with regard to lean manufacturing begins with this group. Most of the group supports the principles of lean manufacturing. However, they have not made the effort to ensure the design of the organization is such that it supports a lean organization. Mr. Cramer is the leader and is a firm believer in the principles. After observing a two-day meeting to review the company's 5-year strategic plan, his conviction in the principles was unquestionable. However, his focus is still very much on the short-term, overemphasizing the current year's financials. This attention seems warranted based on the company's sluggish recent performance, but he sets the tone for the entire organization. He should not stress the short-term to the detriment of long-term objectives. Much of this focus is a carry over from the company's early days when failure to achieve short-term performance objectives may have very well meant insolvency. With the recent growth and expansion, however, the company is in need of greater structure. This is in direct conflict with the history of the company and the entrepreneurial spirit that it is based on.

The middle-level also needs to reshape itself to align itself with the objectives of a lean manufacturing organization. Presently, most of the decision making occurs at this level. It was also at this level that there appeared to be the greatest number of skeptics who were unsure of the efficacy of the principles. Again, many of the individuals at this level are plant managers with profit and loss responsibility. With many of their evaluation and reward structures based on short-term metrics, the early problems encountered are often viewed as an unwelcome disruption damaging the bottom line.

Local line leaders are present in the form of plant continuous improvement coordinators. Their main responsibility is to ensure that the lean principles are diffused throughout the plant. The Intrigue Lean Group is the company's lean manufacturing corporate support group. They can best be defined as the company's internal networkers. Their main purpose is to offer help to the plants and to periodically assess their progress in accepting and operating according to the ILMS. They are the knowledge workers tasked with transferring best practices between different plants.

Summarizing, an improved structure would greatly enhance the rooting of the ILMS. Measurement systems and other interdependent systems must be analyzed and altered to ensure their consistency and alignment with the ILMS.

5.5.2 Political Analysis

A political analysis recognizes the main parties affected by the ILMS. To the extent that a change in the manufacturing system affects the roles and responsibilities of different power sources or holders, people will either support or oppose the change. It is important to understand who the political supporters and opponents are to leverage the positive support while addressing the concerns that may inhibit the diffusion of the ILMS. Figure 5.3 lists the main power holders and their concerns as they relate to the ILMS.

A review of the figure reveals that performance is a major motivator and mechanism for gaining and maintaining power within Intrigue. Metrics are central in determining who the performers are. Thus, a misalignment between the metrics and the desired behavior can create a large force resisting the acceptance of the ILMS. These metrics will be discussed in greater depth in Section 5.6. The supervisors seem to have the most to lose under the ILMS. Thus, gaining their participation early in the initiative is vital to limit their resistance.

Figure 5.3 - Political Power Holder Motivations

Power Holder	Motivation
Shop Floor Employees	Back up principles as a means of gaining power. Empowerment creates uncertainty and tension. May desire union backing to safeguard against future employment, compensation uncertainties.
Supervisors	Empowering the shop floor to make decisions dramatically alters their role. They may view this decision making as a power source and resist the change initiative. Additionally, they are concerned about how the change will impact their measurables: cost, quality, utilization, etc.
Plant Manager	Concerned mainly with meeting the yearly budgeted scorecard performance. Will support initiative if it helps him/her extend their power by achieving these goals.
SBU Director	Same concerns as the plant manager but on a larger scale. Will support if they help improve the entire SBU scorecard.
Intrigue Lean	Concerned with helping plants diffuse principles. This aid is limited by the responsibility threshold.
Suppliers	Will support initiative but not at the sake of the NPV of their own profits.
Customers	Will support initiative but not at the sake of the NPV of their own profits.
Owner	Rationally concerned with maximizing the value of Intrigue which relates to his own personal value. Value is based on maximizing the net present value of the firm's future cash flows.

5.5.3 Cultural Analysis

Every plant has its own unique atmosphere and culture. The plants that seemed to have had greater success with the principles had leadership that was much more focused on the principles. The workforce also seemed to be much more open and confident in their systems within these plants. The plant manager seemed to define the tone of the entire plant. If he or she supported the principles then their subordinates saw their conviction and were also dedicated to the cause. In this sense, the plant manager was the model of the corporation. Failing to live according to the principles led to a *personal alignment* limiting force that gave the ILMS initiatives no credibility.

As previously noted, the CEO set the overall tone for the company and was the dominant figure that everyone looked to for guidance. He continuously voiced his support in the lean principles. Again, his focus on the scorecards seemed to take precedence. If a facility performed well on the scorecard, they felt it didn't matter how they achieved the results. In general, this description was the reality within the company.

Mr. Cramer had diffused a philosophy of evaluating leaders within the organization. He claimed that there were three classes of employees within Intrigue. 'A employees' were those that embraced the IOS and achieved acceptable results. 'B employees' achieved acceptable results but failed to do so using the IOS. Lastly, 'C employees' failed to achieve results and thus had no future with the organization. Although not a formal evaluation technique, this philosophy was very widespread and almost every person in the corporation knew of it. The philosophy suggests that using the IOS would lead to acceptable performance, this is why there is no classification for using the IOS but failing to achieve results. While an interesting philosophy, reality failed to reflect this. The most distinguished plants in the company did not seem to be great supporters of the ILMS, but because they were the highest performers financially, they were recognized and praised. Thus, the model lacked credibility in building support for the IOS and the ILMS.

Because of the time delays and immediate resources required, lean implementations generally lead to decreased performance in the short-term exhibiting the 'worse-before-better' behavior. Because of this behavior and the short-term nature of the scorecard, many aspects of the ILMS were never fully adopted. The sacrificed performance seemed too steep a price to pay. As noted earlier, this misalignment dynamic is a large reason for the failure of the ILMS.

The workforce was skeptical about the ILMS and many didn't understand the principles. The culture identified by Spear and Bowen (1999) was not present. Problems were not viewed as learning experiments allowing for the improvement of the system.

5.6 Analysis of Performance Measures

Intrigue has two basic forms of measurement systems. The first is the Scorecard method used to evaluate individual plant and SBU performance. The basic measurements in the Scorecard are summarized below.

- Customer Complaints
- Delivery Rating: % of Shipments Made
- Satisfaction Rating
- Safety: Consecutive Days Without an Accident, Accidents, Days lost
- Headcount
- C.I. Projects
- Suggestions/Employee
- % of Suggestions Implemented
- % Employees with suggestions
- Turnover Rate
- Inventory Level & Turns
- Scrap Costs
- Revenue
- Material Costs
- Plant Wages
- Factory Operating Costs
- Contribution

These are elements that the CEO has defined as being essential to current and continued profitability. The main goal is for each plant or SBU to achieve a contribution margin of 35%. This is the bottom line of the Scorecard and all of the other financial measures factor into this figure. Scorecards are filled out monthly by the plants and reviewed within their individual SBU's. Quarterly scorecards are completed by the SBU director and reviewed with Mr. Cramer. The goals and stretch goals for these figures are determined annually. I had the pleasure on sitting in on the setting of these goals for the 2000 fiscal year in a two-day offsite meeting. The algorithm for calculating these goals is not public knowledge. Bob Cramer crunches numbers and relays them back to plant and SBU management. After a brief bargaining exchange, the numbers usually stand and are considered fixed. Not a single individual asked to see what his logic was in determining the figures. Rather, the logic was that he was the owner/CEO and was thus entitled to set whatever goals he wished, however unrealistic they may really be. There was open exchange from plant management to surface the difficulties and resolve any constraints that presented major obstacles in achieving the objectives.

In addition to the Scorecard, individual plants were assessed on their ILMS implementations. Each plant was assessed quarterly by the Intrigue Lean Group on how well they were applying the different elements of the ILMS. The results of this assessment (Appendix C) were relayed to the plant

manager, SBU director and the owner. Mr. Cramer then reviewed the results in conjunction with the plant Scorecard to evaluate the plant's performance according to his A-, B-, C-employee philosophy. An example of the assessment is attached in Appendix C. Each element had questions the company deemed critical to gauging the acceptance of the element. For example, the Elimination of Waste section had a series of questions that would indicate how well a particular plant or area of a plant was employing this principle. These questions would be equally weighted in determining the overall score for the element. If multiple areas assessed, the areas were also equally weighted in determining the overall plant's score on the ILMS element. Each question was graded as being either red, yellow or green. These colors corresponded with scores of 1,2 and 3, respectively. When averaged, a score of 1.6 or less was given a red for the element. A score of 2.4 or greater was given an overall green rating. Any score in between was given a yellow rating. The idea was that the higher the score, the better the plant was in applying the lean principle in question. Thus, a score of 3 on an individual question indicated that the plant was performing as expected in all areas of the plant. A score of 1 would indicate noncompliance in nearly all areas.

Earlier research pointed out that a tiered measurement system is needed for each appropriate level of work. No such system exists at Intrigue. There are some measurements that some areas keep track of, but supervisors seem to be more concerned with the Scorecard. Most of the measures on the Scorecard are financial and not process-focused. These are not adequate for controlling the processes that drive the costs on the Scorecard. An improved measurement system must be put in place that is adequate for the various levels in the ILMS.

5.7 Intrigue Lean Manufacturing System Implementations

The company did not have a common sequence model for implementing the ILMS in new plants. Several basic events were common to most implementations, however. A continuous improvement coordinator was first assigned to watch over the initial implementation and continued operation of the

ILMS. The Intrigue Lean Group would create an implementation schedule for training management and other leadership within the plant. Those exposed to the initial training were to be the mechanism for diffusing the principles within the plant through formal training sessions or informal conversations. Thus, the training mechanism was a tiered system where management was trained by the corporate support group and expected to pass on the ideas to those below them. The plants seemed to generally focus in on the easier to grasp ideas and would immediately try to implement the ideas of workplace organization, visual management, identification and elimination of waste. More complex elements that often required intrafunctional involvement were either not addressed or were addressed by the continuous improvement coordinators or plant schedulers separate from the shop floor level.

The plants were immediately introduced to the ILMS assessment process and encouraged to explain the system to their employees and periodically self-audit their areas. The company allowed the plants the flexibility to focus on elements they deemed important. The ILMS assessment also served as a guide to prioritize the improvement efforts of the plant. Red elements were the poorest and where the plant could show the most dramatic improvements. Plant continuous improvement coordinators were responsible for the diffusion of the ILMS within the plant. They coordinated all activities and set up kaizen workshops when they deemed it necessary to make improvements. Additionally, all employees belonged to work teams who would periodically meet to discuss improvement ideas. Employees were encouraged to suggest improvement possibilities. The continuous improvement coordinator then reviewed all suggestions and would periodically set up a workshop to address various issues.

While, flexibility is in general good, the company could greatly benefit from increased structure in their implementations of the ILMS. A common model should be formed to address the growth and limiting dynamics of change described earlier. This model should be detailed enough to provide valuable guidance but general enough to adapt to the intricacies and strengths and weaknesses of each plant.

5.8 Summary

This chapter identified many factors that led to the difficulties in various ILMS initiatives. The dynamics of change first examined in Chapter 4 were especially insightful in analyzing the ILMS. Many issues were identified that will later be addressed in the formation of a structured implementation model. Many of these issues cannot be specifically pinpointed as the ultimate reason for the failures. Because of the complex dynamics involved, this is a difficult task, and any limiting force can become the dominant mode of failure at a point in time. Thus, it is more important to understand these dynamics over time and react accordingly to mitigate a dynamic that may limit the successful diffusion of the ILMS. Correspondingly, the growth dynamics should be visible and leveraged to ensure successful diffusion.

Chapter 6: Altering the ILMS

This chapter explains the redesign of the ILMS and how it relates to the issues identified in Chapter 5. The implementation of these changes in the manufacturing plants is also discussed.

6.1 Background: Recognizing the Need for Change

Over time, Intrigue realized that the present manufacturing system was not ideal and could use a makeover. This realization process took some time. My internship was initially focused on the company's failure with implementing and sustaining pull systems. Thus, there was an initial awareness that at least this element of the system needed rework. One key event occurred during the internship to refocus the company on altering the entire ILMS.

Recent measurements of a particular plant had showed improving ILMS assessment results coupled with slowly deteriorating financial performance. This forced the CEO to call into question the present assessment process. He wondered if it was actually measuring lean manufacturing the way he envisioned it should. After seeing the plant operate on several occasions, he knew that the plant was not embracing the ILMS. He thus viewed the Scorecard as being more indicative of the state of the plant than the ILMS assessment. Finally, he decided it was time for a change. The major event that occurred was a rehauling of the plant's leadership. A credible Continuous Improvement Director was named to spread the ILMS throughout the plant. This individual was a strong believer in the principles and was being promoted from the Intrigue Lean Group. In addition, a plant manager and general manager were brought in from the outside. Both of these individuals came in from similar level positions and had experience running operations using similar lean manufacturing concepts. The failure of the current system to indicate the true state of the plant, coupled with the CEO's observations of the diffusion of the ILMS in various other plants, prompted him to request that the system be redesigned.

6.2 Redefining the Intrigue Lean Manufacturing System

6.2.1 Altered Intrigue Operating System

The Intrigue Lean Group was tasked with making improvements to the ILMS. The CEO stated that no plants were embracing the principles to the extent that they should be. The shake-up received everybody's attention. Mr. Cramer heightened this attention at a two-day, 5-year strategic planning meeting. He began the meeting by introducing his updated version of the IOS (Figure 6.1). "It took me over 200 hours to do this (refine the IOS)...It has to be done. This is the way I want the company to run...If its too complex, make it more simple so you have something you will work with." This started quite a rumble among all of the leaders of the different plants. He was telling them that this was the guideline yet providing them with the flexibility to alter the system to their liking. He further emphasized the importance of lean manufacturing. "You've refused to understand what lean is. You've concerned yourself with more important things. The customer is not going to pay for your waste."

A review of the new IOS shows a simplified operating model when compared to the earlier version (Figure 2.3). A careful review reveals the presence of two core processes: Intrigue Lean, the company's lean business system, and the Product Development Process. Attempting to shed light on this, Mr. Cramer commented "o you realize there are only two processes in this entire system?" Intrigue Lean expanded the ILMS to other business processes. Thus, this indicated that he wanted the Intrigue Lean System to be general enough to apply to all processes.

The new focus on these processes is excellent. During the internship, it was evident that these two processes are the most essential to Intrigue. The Product Development Process has had an even more difficult time gaining acceptance within Intrigue. With the company's increasing competition, this process will become even more important. Furthermore, the company has gained a reputation for being late at launching new projects for customers. This new limited focus on these two processes, along with critical organizational design changes should greatly improve their effectiveness and help them understand overall priorities. However, Mr. Cramer's quote criticizing plant management for their failure

Figure 6.1 – Altered Intrigue Operating System

STAKEHOLDERS	BUSINESS GOALS	SYSTEMS and PROCESSES	SBU EXECUTIVE RESPONSIBILITIES	PLANT MANAGEMENT RESPONSIBILITIES	Results
CUSTOMERS	CUSTOMERS' SATISFACTION	<ul style="list-style-type: none"> •Customer Business Team Executives •Program Launch Live Plan •Global R & D Process •Advanced Systems Marketing Group •Business Leadership Team Process •Global Engineering Processes •Prod. Eng. Design, Prototype Tooling, Validation 	<ul style="list-style-type: none"> •Supplier of Choice •Lean Cost Reduction •Provide Value to Customer •Program Launch •Product Development Process •Performance to Scorecard (Customer Section) •Innovative Manufacturing Processes •Focus CBT's ASM's R & D for growth of SBU 	<ul style="list-style-type: none"> •Products and systems to specifications with "0" % scrap goals •100% On-Time Shipments •Successful Launches •Total Lean Operation •Quick Problem Resolutions 	<ul style="list-style-type: none"> •Growth Oriented •World Class •Preferred Supplier
EMPLOYEES	EMPLOYEE EXCELLENCE	<ul style="list-style-type: none"> •Employee Development and Education Plan •Work Team Empowerment Process •Health & Safety Plan •Recognition and Reward •Global Employee Opportunities •Total instant communication through WEBB Site Technology 	<ul style="list-style-type: none"> •Employer of Choice •Provide Leadership for Learning Improvement and Development with 100% •Employee participation •Provide Leadership in creating a safe and healthy work environment 	<ul style="list-style-type: none"> •Lead Plant Employees in Lean Projects •Train and assist employees in improving Venture's work life •Lead in providing a safe and healthy workplace •Create an environment in which all can grow and be successful 	<ul style="list-style-type: none"> •Work Quality of Life •Having Fun •Being the Best!
SHAREHOLDERS	OPERATIONAL EXCELLENCE	<ul style="list-style-type: none"> •Product Development Process •QS-9000 •Intrigue Lean System •Lean Manufacturing Operating Plan •Manufacturing Eng. Launch Process •Internet speed flow of information •Scorecard 	<ul style="list-style-type: none"> •Remove Obstacles to Lean Manufacturing •Provide Direction for Meeting Data Card Goals •Foster Lean Mfg. Environment •Share Successes with Other SBUs •Provide Leadership for Low cost Quality Products 	<ul style="list-style-type: none"> •Lead in efforts to meet Business Plan items by items noted on Data Card •Lead the Plant to be Lean •Insure plant has sound leadership, supervisory and technical roles that will promote Intrigue Lean •Keep clean, organized, well maintained plants 	<ul style="list-style-type: none"> •Job Security
	PROFITABLE GROWTH	<ul style="list-style-type: none"> •Five Year Business Planning Process •New Business Development Planning Process •Activity Based Accounting quoting process •Marketing Plan for company and products 	<ul style="list-style-type: none"> •Responsible for meeting Business Plan •Establish and Lead plan to meet Stretch Goals •Provide Plan for 15% per year growth •Lead Service Groups in providing excellent support for plants (Finance, H.R., Eng., Sales, Etc.) 	<ul style="list-style-type: none"> •Use our Lean Manufacturing process to create floor space, and improve productivity •Lead employees to create a plant that is preferred by your customers •Lead SBU Executive's plan to meet Stretch Goals 	<ul style="list-style-type: none"> •Growth and Opportunity
	FINANCIAL RESULTS	<ul style="list-style-type: none"> •Scorecard •Capital Planning •Intrigue Lean System •Entrepreneurial Process •Product Development Process 	<ul style="list-style-type: none"> •Establish and Lead Plan to insure a 35% minimum contribution •Plan for minimal use of capital •Stop waste through Lean 	<ul style="list-style-type: none"> •"Stop Scrap!" •Reduce use of materials, paint, energy, and indirect costs •"Attack Waste!" through "Lean" Intrigue Lean 	<ul style="list-style-type: none"> •Company Success
COMMUNITY	CORPORATE CITIZENSHIP	<ul style="list-style-type: none"> •Good Citizenship Policies and Practices •Public Relations •ISO-14001 certified 	<ul style="list-style-type: none"> •Positive community image and citizenship •Provide for civic involvement •ISO-14001 compliance 	<ul style="list-style-type: none"> •Volunteer in Community activities •Secure our future through competitive quality products 	<ul style="list-style-type: none"> •Help make our community a better place

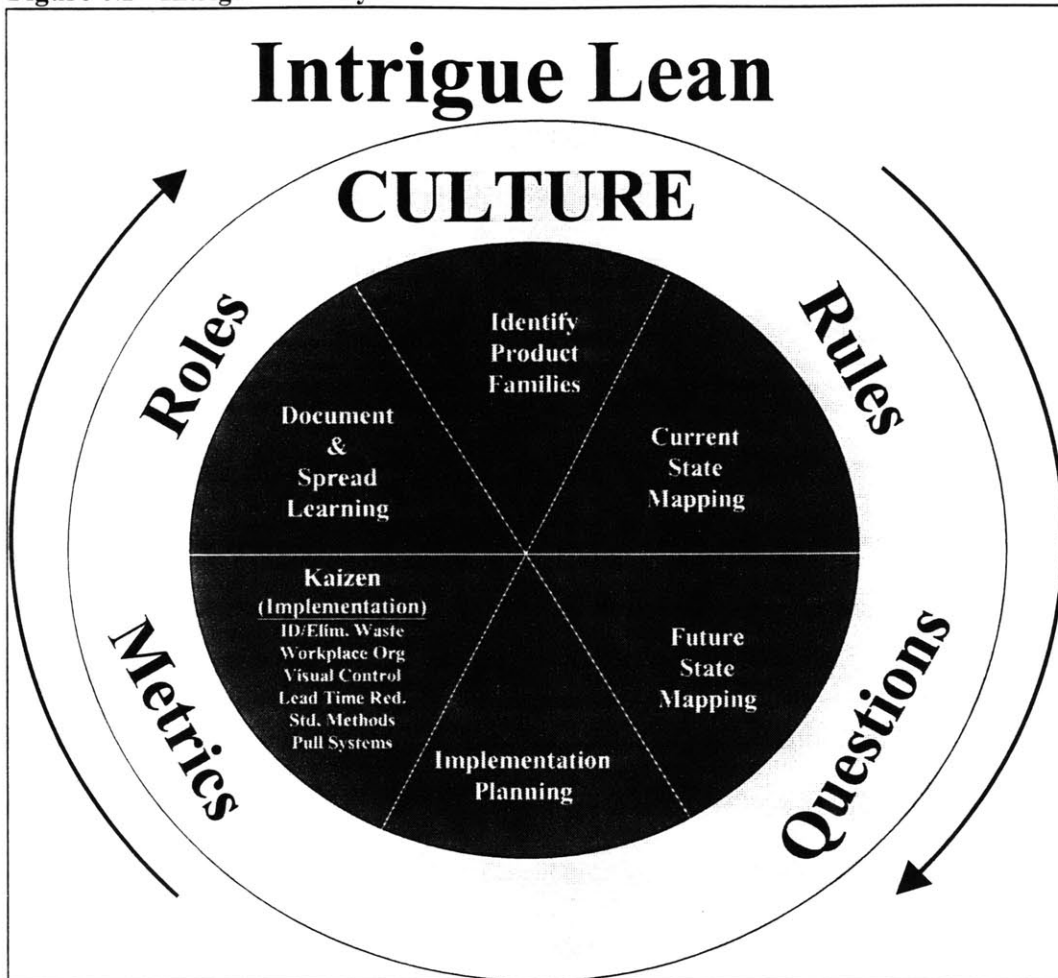
to adopt the ILMS is uncalled for. Their behavior is quite rational when the incentives, metrics and other limiting forces are considered. This lip service is good for gaining people's attention but is insufficient if it is not accompanied by the redesign of the existing system to enable success.

6.2.2 - *Intrigue Lean*

The Intrigue Lean model was created to address all business processes. The model's structure, shown in Figure 6.2, serves as an umbrella to guide the execution of all lean business processes. In fact, the model also represents the new ILMS. In order to address the lack of structure in implementing the ILMS, the model defines a definite sequence to aid in the focusing of company activities. The uppermost Intrigue 'V' is where the process begins. The first activity requires that all products be grouped into product families. The characteristics to guide this process are numerous. Products that undergo similar operations in a similar sequence should be grouped into families. However, other variables come into the fray. Processing time differences, process quality differences between products, and various other factors may require that similar products be in different product families (Rother & Shook (1998)).

The next step in the sequence is current-state mapping of individual product families. This was briefly described in Section 3.5.6 and consists of mapping the material and information flow of the product family from raw material delivery to finished goods shipment. Once complete, the next step targets the waste in the current-stream in the creation of a future-state map. This mapping process is undertaken by a mix of employees that are involved with that product flow, from operators to continuous improvement coordinators. Often, this is the first time that many of these workers have seen the entire flow of product and the massive waste involved. This experience allows them to see how they can enhance the flow and move closer to the goal of continuous flow. Thus, the key to the entire process is that these employees generate the improvement ideas and create the future-state map, which is a snapshot of the product flow in the future.

Figure 6.2 - Intrigue Lean System



This leads into the next step - the creation of an implementation plan to move from the current-state to the future-state within an adequate time period. Future-state improvements are not massive breakthroughs that will require years to implement. Rather, the focus is on continuous improvement. The employees break down the tasks that must be done and assign responsibilities amongst themselves. This is the most important element and allows the workers to own the effort. They not only determine the scale and scope of improvement but also the sequence of improvement activities and those responsible for ensuring execution. Because the decision is theirs, they are more aware of the benefits behind the changes and committed to meeting the agreed upon dates.

The next phase is the longest and is where the workers turn their vision into a reality by executing and applying the different elements of the ILMS. For example, if the implementation task is to put in a pull system between an upstream and a downstream operation, the responsible person will interact with these areas to set this up. This will require the use of the ILMS elements of work place organization, standardized work methods, visual controls, and of course pull systems. The use of these principles is still encouraged outside of the scope of making specific value stream improvements. The value stream implementation, however, designates higher priority to the initiatives.

To ensure that activities are progressing, plant wide value stream review meetings are to be held to review the progress of the implementation plans. Off-track items will be reviewed and obstacles preventing their completion will be addressed. These items will be given high priority and exposure to ensure they are addressed and put back on track. Upon completion of the transition to the future-state, the knowledge will be transferred to the remainder of the plant through these same value-stream review meetings. The meetings will have representation from all product families. Thus, the issues, execution and solutions will be discussed openly and also benefit the other product families.

The attainment of the future-state designates a completion of a cycle. It is in no way an end. This is the signal to repeat the process. The former future-state becomes the current-state for the product family, and the cycle is begun anew. At this point, the workforce should congratulate themselves for a job well done and move on to greater improvements feeling renewed and confident.

The value of the Intrigue Lean Model is that it provides a rigid yet flexible structure. In other words, it is rigid enough to provide guidance by stressing that each product family cycles through the process with a certain frequency, yet provides the flexibility to empower those working with the products to define and commit to the scope of change. Those committing to the change become the local leaders guiding the implementation. Thus, the process is ideal for building commitment, a dynamic that has been a major limiting force in the earlier ILMS efforts. This worker involvement will ensure that all affected areas are involved (recall Figure 5.2). Total participation of the workforce is vital in eliminating

problems that may spring up early in the implementation. The model addresses the global aim of a lean manufacturing by enabling employee driven change.

Another important improvement in the new model is the guidance that it provides. No longer is the system to function as a loosely defined set of principles that are addressed arbitrarily by the plants. Rather, the sequence is transparent. The elements in Figure 2.3 are not the focus of the ILMS. The attention is on making improvements to the product flows. The elements are only important in the sense that they make such improvements at the lowest possible cost.

The Intrigue Lean Model illustrates this structure submerged in a cultural pool. It is this integration of the structure and culture that enhances the system. The structure is valueless without the accompanying cultural elements of roles, rules, metrics and questions. Greater explanation of these elements follows.

6.2.3 Culture

The culture of the company was in need of a major makeover. In order for the system to operate effectively, enabling systems were needed to encourage the development of an empowering culture. What were the high leverage systems? Every system in some way or another influences the culture of the company. Thus, there is not a single system that could be revised to automatically alter the culture so that it is more aligned with Intrigue Lean. It is much more complex and changes are necessary in all of the current systems to ensure alignment.

As discussed in Section 5.5, the organizational design and roles within the hierarchy need a makeover to fit with the company's lean manufacturing strategy. Worker empowerment is not currently a fundamental element of the system and the roles need to be revised to develop this culture. Each hierarchical level must have a new set of questions that they consciously ask themselves regularly. During a brainstorming exercise, the Intrigue Lean Group identified a new set of roles (Appendix D) and responsibilities for the manufacturing organization and the fundamental questions that must be asked. The roles were renamed to correspond with athletics. This clearly communicates the responsibilities behind the specific roles in a manner that most everyone can relate with and easily remember.

The rules that were chosen are those recommended by Spear and Bowen (1999) and reviewed in Section 3.1.

Rule 1: All work shall be highly specified as to content, sequence, timing, and outcome.

Rule 2: Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.

Rule 3: The pathway for every product and service must be simple and direct.

Rule 4: Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

The rules interact to create an experimental problem solving culture where the operation of the system is an experiment. To develop this scientific community, it is first necessary to specify all activities according to a standard work method (SWM). These SWM's then serve as the foundation that is improved. The rules ensure the continued operation of the system no matter what event may occur. This scientific approach assures that when a disruption occurs the root-cause is immediately located and addressed. Thus, this directly addresses the root-cause problems that arise and lead to second order improvements (Section 4.4).

The questions that a supervisor or manager asks the employees on the floor are pivotal in communicating priorities and creating the culture on the manufacturing floor. The traditional questions that one would hear on the shop floor of Intrigue were focused on learning what the variance between the scheduled and actual production was, why the employee had ceased the operation of a machine, etc. A more appropriate set of questions was created to ensure the workforce understood the design of the system and the value that they presented to Intrigue. The questions are simple but a conscious effort to use these in conversations with the workforce can be of benefit in shifting the manufacturing priorities from simply attaining results to focusing on improving the process through the empowerment and development of the workforce. The questions follow:

1. Do you know why your job is important?
2. How do you do your job now?
3. How do you know you're doing your job correctly?
4. How do you know the outcome is free of defects?
5. What do you do if you have a problem?

By now it should be transparent that a discontinuity between any of these portions of the system's operation can lead to the collapse of the entire system.

6.2.4 Intrigue Lean Metrics

Measurements also aid in the definition of the culture. They seemed to play an even greater role of shaping the Intrigue culture. A tiered measurement system was developed in order to shift the focus from the results to the process. The Scorecard was valuable and conveyed valuable information pertaining to a plant's performance. It was determined that this detail was adequate at a plant manager/general manager level and above. It was insufficient for the other levels of the company. In order to find adequate measures for lower level employees in the plant, drivers impacting the metrics on the Scorecard were determined and listed at a process level. The new measures are listed in Figure 6.3.

The methodology used to design the measurements was quite simple. For example, one of the data card measurables is delivery rating. It is essential to understand what drivers impact this rating that employees in lower levels of the plant can control. These drivers should define the metrics at the appropriate control levels. Several elements interact to produce the end delivery rating. First and foremost, on-time delivery is essential and factored into the rating. Inventory cost is one factor that is indirectly related. Having a large inventory of finished goods on hand can ensure an appropriate amount of parts to service the customers needs. This, however, is wasteful but it should be understood that the variability of demand may make this a necessity. Lead time also effects the rating. If the lead time is short enough, finished goods inventory may not be necessary so long as the manufacturing system has the capacity to meet this demand. This would require the lead-time through the process to be shorter than the required delivery time. First time quality (FTQ) is also a driver of the delivery rating. Processes with low first time quality may be more prone to slip defective products through to the next process undetected. These defective products may be shipped to the customer. Additionally, low FTQ processes are often the bottleneck operations. Therefore, large amounts of downtime may lead to incomplete deliveries.

Figure 6.3 - Improved Intrigue Measurement System

Shop Floor	Supervisor, C.I. Director, VSM Manager(s)	G.M.
*FTQ (First Time Quality)	*FTQ *Error Proofing Mechanisms Installed	Customer Complaints
*Build To Cust. Instruction *Setup Time *Batch Size *Unplanned Downtime *On-time Delivery (downstream) *FTQ	*Lead Time *On-time Delivery *Inventory Cost *FTQ	Delivery Rating: % of shipments made
Same as above		Satisfaction Rating
Same	Same	Safety: # accidents, days lost
*Unplanned Downtime *MTBF (Mean Time Between Failures) *FTQ	*Absenteeism *Labor Productivity	Headcount
*# Suggestions	*Kaizen Projects	C.I. Projects Suggestions/Employee % of suggestions implemented % employees with suggestions
	*Average Skills per Employee	Employee Development
*Absenteeism *# Suggestions	*Absenteeism *Morale Survey *Turnover Rate	Turnover Rate
*Setup Time *Batch Size *Inventory Level	*% VSM Action Items Complete	Inventory Level & Turns
*FTQ *Inventory Level	*FTQ *Error Proofing Mechanisms Installed	Scrap Costs
		Revenue
*FTQ	*FTQ *Error Proofing Mechanisms Installed	Material Costs
*Setup Time *Batch Size *Inventory Level *Build To Cust. Instruction	*Inventory Level	Inventory Holding Costs
		Plant Wages
*FTQ	*FTQ *Error Proofing Mechanisms Installed	Factory Oper. Costs

6.2.5 Lean Manufacturing Assessment Process

In addition to the other metrics, the lean manufacturing assessment was also revised to better correspond with the Intrigue Lean System. The new assessment is very similar to the original Appendix C). Value stream mapping was a key addition to the assessment. The questions themselves were altered

to ensure the truly desired elements were being addressed. Mr. Cramer places particular importance on this assessment process. The plants use a similar scoring method as before with red, yellow, and green denoting the state of the plant on the question and more broadly, the overall lean element. The process, however, has not been drastically altered because it is a good methodology that draws attention to the areas that need improvement. The importance placed in the use of the process is what must be changed. Thus, the assessment cannot be low priority if the plants are to alter their activities to be in accordance with the ILMS. Management must walk the talk and assure that plants using the process and showing improvements are rewarded, while those neglecting it are penalized. This credibility is the main focus that must be addressed so that Intrigue can break the *personal alignment* limiting force and gain commitment from all plants.

6.3 Implementation of the ILMS Changes

Once designed, the changes in the ILMS had to be deployed. The focal point of the changes was speed. Mr. Cramer wanted to see the plants embracing the system as soon as possible. Thus, the mechanism used to communicate the ILMS changes ensured that speed was the top priority. The basic Intrigue Lean backbone was deemed critical in shifting the plant's focus from individual work areas to product flows. This was a major change in direction and deemed of necessity to put into operation early in the transition. Execution of the revised lean assessment process would facilitate the acceptance of the process.

Training material was created to convey the structure of the Intrigue Lean System and the value stream mapping process. An interactive training workshop was held to convey the principles to the individual plants. Attendees at the session included the plant general manager or plant manager, the Value Stream Mapping Champion, and a shop-floor machine operator. Value Stream Mapping Champions were defined for all plants. These were generally selected as being the current plant Continuous Improvement Coordinators. The operator was to be someone well respected in the plant. The

training was set up to convey the benefits and mechanics of the process. The aim was that the operator would see the benefits of the process and return to the plant and serve on initial value stream mapping teams. Her support and informal social network in the plant would be a valuable way to spread positive word of mouth about the process, thereby building commitment for the change as discussed earlier and shown in Figure 4.2. It is wise to exploit this dynamic by ensuring an adequate level of planning to improve the probability that the training session is well received. If successful, the training will be a success and the word of mouth generated will create a pull for the change throughout the organization.

The training took place approximately five weeks prior to the end of the internship. At that time the plants were tasked with spreading the word of the new Intrigue Lean System. They were to classify all of their products into specific product families. Upon completion, they were to select four product families and initiate the value stream mapping process. Over the next five weeks, they were to complete steps one through four of the process (create an implementation plan) and report on their adventures with the new system.

The training was successful in building commitment for the new initiative. However, the agenda was a bit rushed and therefore the concepts did not completely sink in. The Intrigue Lean Group had to spend much of the next few weeks visiting the plants, assisting them with the execution of the process and answering questions about the ILMS. The plants seemed to enjoy the concepts behind the process but it was evident that they were uncertain about the future of the initiative as they frequently grumbled about lacking the necessary resources to perform the mapping exercises. Thus, the initiative didn't seem to do much in the way of building a 'we can do it' attitude. There was still a major obstacle present that inhibited the growth of the change initiative.

A little thought reveals that the obstacle is the limiting force of *time flexibility*. There is still sufficient production pressure that makes it difficult to remove workers from production work and have them work on improvement work. This is a difficult issue for the plant management to resolve. A plant manager must perform in both the Scorecard and lean assessment. Unfortunately, the two are still contradictory because the budgeted level of workers in the plant is proportional to the dollar revenue that

passes through the plant. The number of workers are initially too low to meet daily production requirements while simultaneously having free time allocated for making value stream improvements. The budget is inflexible and doesn't understand the initial 'worse-before-better' dynamic. The budgeted Scorecard value must be set so it recognizes this dynamic and minimizes the production pressure, allowing the improvements to begin and setting the reinforcing cycle in motion. Until the owner allocates these budgets so that initial resource constraints are freed up, a misalignment will exist that may make it difficult to set the reinforcing growth forces into motion.

As revealed earlier, the initial concentration was on the structure of the Intrigue Lean System. Unfortunately, the cultural aspects of Intrigue Lean were developed but not explicitly rolled out in the plants with the exception of the lean manufacturing assessment process. In order for the system to take hold, the essential cultural elements cannot be ignored and must consciously be developed. Thus, the roles, rules, questions and metrics must become an important part of the future implementation.

6.4 Summary

This chapter described the activities that occurred and led to the redesign of the ILMS. It relates the redesign to the earlier findings on the factors that inhibited the acceptance of the ILMS. While many steps have been taken moving Intrigue closer to operating under the ILMS, many more steps remain to ensure that all company systems mesh smoothly and interact to exploit the growth dynamics of change. Recommended future activities are explained in the closing chapter.

Chapter 7: Conclusions and Recommendations

7.1 Short-Term Recommendations

Intrigue has improved the ILMS but drastic changes are still necessary to address the forces limiting its acceptance described earlier. Namely, the culture still serves to inhibit the positive changes from deeply rooting and bettering the organization. The dynamics and the effects that an ill-suited culture may have on the system can be enough to halt these early successes. It is vital that Intrigue addresses the culture of the company and the roles, rules, questions and metrics described earlier.

This effort must start at the top. A major force limiting the success of prior attempts has been the inconsistency of the top leadership's support. In order for the changes to persist, the owner and other executives must continually show their support for the ILMS and Intrigue Lean. Their actions are pivotal in gaining acceptance. It is first necessary for Mr. Cramer to slacken the resource constraint limiting the growth of many of the change efforts. By freeing this production pressure, workers and managers will be much more aligned with the principles of the ILMS. Tied back to this personal alignment dynamic, Mr. Cramer must begin to truly enforce the A-, B-, and C-Employee Philosophy. Paying attention to this and rewarding those plants that are performing commendably in using the ILMS will shatter the existing cynical culture who believe that the philosophy is nothing more than lip service.

One of the most important systems in shaping the culture of a company is the measurement system. While an improved measurement system has been designed, it has yet to be implemented in the plants. This tiered measurement system should be transferred to all manufacturing plants in order to enable the workforce to have information that will enable them to improve the processes they are most familiar with.

The roles within the plant need to be applied as designed earlier (Appendix D). They are defined in such a way that those doing the job make improvements to their own processes. This is the ideal state and the easiest way to get employees committed to making improvements. The roles drive the central

idea of empowerment. The questions are complementary in making the roles obvious and driving the necessary cultural change.

The rules need to be deliberately driven. While somewhat addressed by the assessment questions, a greater effort must be made in standardizing all plant work processes. This standardization creates a starting point allowing for further improvements and developing the scientific community desired by the Intrigue Lean and ILMS. These are only a starting point and must be improved when it is evident that inefficiencies exist. In order to allow this scientific community to cling and flourish, the production pressure must be eased to ensure that time is available to address a problem when a problem initially appears. Not addressing the problem immediately can create a heap of defects that make the problem even more difficult to address afterward.

Beyond these implementations, it is important to ensure that an adequate training staff is available to address the needs of the workforce. As change spreads beyond a local area, companies often underestimate the magnitude or infrastructure of support that is necessary. This falls back in the planning category mentioned throughout the document. Superior planning is necessary to execute the ILMS and the broader Intrigue Lean System acceptably.

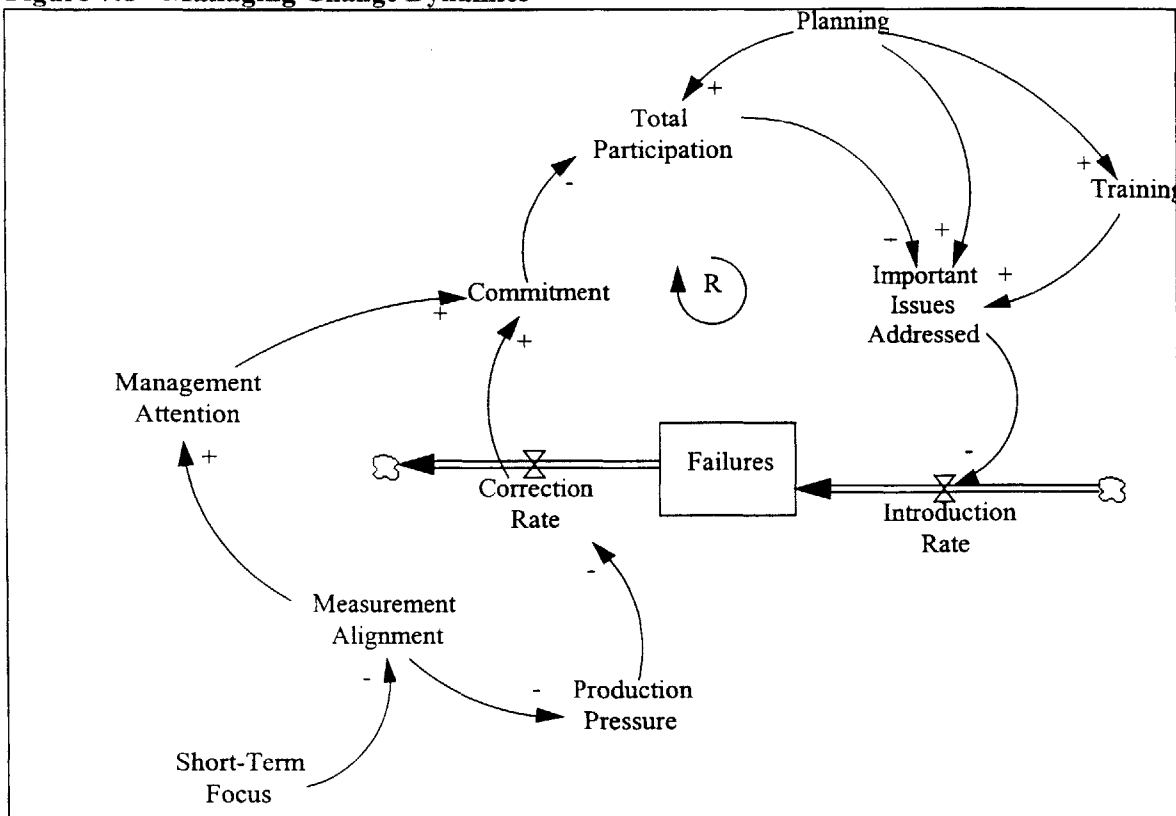
Communication is vital in any change. The workforce must continually be encouraged to ask questions and voice their concerns. This open dialogue is healthy and will expose many deeper problems that may hinder success and must be addressed. This communication will clearly explain the benefits of the ILMS and help people to mentally understand the system and how it will benefit them and Intrigue. This contributes to another main growth dynamic, *personal results*.

7.2 Long-Term Recommendations

Many issues were uncovered about the difficulties with prior ILMS implementations. All of these issues interacted dynamically and may have been dominant in causing failure at any point in time. More likely is the idea that a combination of these issues caused the collapse of the ILMS. Initially, it

appeared that creating a causal loop diagram to show the interaction of these issues (Figure 7.1) would be a useful tool to evaluate the present status of the ILMS or any other company change initiative. However, attempting to capture all of the dynamics broadens the model to where it turns valueless. It is the lower level dynamics that are not apparent that drive the variables in Figure 7.1. Thus, a more useful structure to use in evaluating the company's status with a change initiative is the SOL's Growth & Limiting Forces Model (Figure 4.8). By periodically reviewing each process and how the dynamics of the initiative are playing out, it is possible to understand which dynamics are dominant at a single point in time.

Figure 7.1 - Managing Change Dynamics



Examples have been cited showing that many of the listed limiting forces were operating during the ILMS implementation. However, it is unlikely that all forces were the cause of the prior failures. The workers identified many issues, all of which are very important in understanding the acceptance of the initiative. *Time flexibility, assessment & measurement, and personal alignment* were three especially damaging limiting forces. As repeated several times, the resource allocation formula was insufficient to

allow the company to overcome the 'worse-before-better' dynamic. The measurement systems failed to address this and plant management chose to focus on optimizing the short-term measurements. Thus, management failed to free up workers to address improvement activities, instead choosing to apply production pressure. This failure to understand the nature of change destroyed the credibility of the effort, and management and lower-level employees failed to acknowledge the change.

The SOL structure is very helpful as a tool for examining how change is occurring with regards to the major growth and limiting modes. Intrigue should use the model to identify the major limiting forces. These identify leverage points that the company should then address to help the change grow. This same approach was used in the redesign of the ILMS described in Chapter 7 and can help Intrigue as the ILMS progresses and evolves.

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Appendix A - Lean Manufacturing Glossary

Source: Revised from Milby (1998)

Autonomation: Means the autonomous check of abnormalities in a process. An automatic stopping device is attached to the machine. The worker selects an appropriate solution and executes it.

Balanced Production: All operations or cells produce at the same cycle time. In a balanced system the cell cycle time is less than takt time.

Capacity: the highest sustainable output rate that can be achieved with the current product specifications, product mix, workforce, contractual agreements, maintenance strategies, facilities and tooling, etc. (e.g. Maximum number of units/year).

Cell: A cell groups together operations according to the product flow. Each cell produces a family of products and is designed to meet the needs of its customer. In manual cells the interface between the machines and the worker loop is critical.

Customer: Receiver of a product. This can be a person, an organization or the subsequent operation within a system (internal and external customer).

Demand Interval: This is how often the subsequent process picks a standard container. The subsequent process can be external (customer) or internal (next operation). The time is correlated to how long it takes the subsequent process to consume a standard container quantity.

Flexibility: The ability of a manufacturing system to respond quickly, in terms of range and time, to external and internal changes.

Flexibility – Volume: The ability of a manufacturing system to cost effectively vary its output within a given time interval.

Heijunka Box: A level scheduling tool that is loaded with Type “A” and Type “B” Kanban cards. The Heijunka box controls the pace of demand placed the production system.

Jidoka: Autonomation

Just-in-Time (JIT): Manufacturing method where downstream operations pull required parts needed from upstream operations at the required time. This process is paced by customer demands. The implementation of JIT requires almost all features of lean manufacturing.

Kaizen: Continuous overall improvement effort. Kaizen has a focus on one problem, which may be eliminated by small incremental improvements.

Kanban: Kanban means card. The Kanban contains information about the product, the quantity to be made, the “supplier” and the “customer”, etc. Distinguish between different kinds of Kanban: Production Ordering Kanban, Withdrawal Kanban.

Leveled Production: All operations make the quantity and mix of products demanded by the final customer within a given time (demand) interval. The production run size is greater than one unit, but equal to the quantity pulled by customer during the demand interval.

Machine: A semi-automated or fully automated station, which performs one or more operations.

Man – Machine Separation: The worker is not bound to the machine. E.g. the worker is not watching the machine but performing another task, while the machine is processing.

Manufacturing System: The series of operations performed upon material to convert it from raw material or a semi-finished state to a state of further and/or final completion (see also operations).

Mixed Model Production: Mixed model production means the production of different products every day referring to the daily demand. Mixed model production avoids the accumulation of demand over several time periods.

The realization of mixed model production needs the ability to produce in small lots. It should be pointed out that mixed model production has its best results, if the shipment dates are linked to the production schedule (see leveled production). The ultimate mixed model production would be to produce to the mix and run size of the customer (synchronized production).

Multi Functional Worker: A worker, who is able to handle different machines and operations. Operating a cell definitely requires this kind of skilled worker.

Multi Machine Handling: One worker operates several machines. The worker is separated from the machine performing another task, while the machine is processing.

One Piece Flow: Producing one unit at a time, as opposed to producing in large lots.

Operations: A specific work element required in the production of a product. All processes can be divided into four basic operations (see Shingo, 1989, pp.5)

- Processing
- Inspection
- Transport
- Storage

Poka-Yoke: Device, which prevents defects from being made.

Production System: The entire collection of functions required to design, to produce, to distribute, and to service a manufactured good. The Production System may include more than one company (e.g. an automaker, its component suppliers and dealers). The production system supports the manufacturing system.

Pull-System: Information system in which the information is flowing the opposite direction of the material flow. In that way material is “pulled” from downstream processes. “Daisy chain” manufacturing technique that allows material to flow in logical sequence, being “pulled” from one process to another as opposed to being “pushed” from order entry. The goal of the pull system is to eliminate speculative production and to provide the ability to produce to actual demand.

Push-System: Information system in which information is flowing in the same direction as the material.

In that way the next operation receives materials and production requirements according to a plan.

Thus, the material is “pushed” through the system.

Rate - Demand Rate: The rate at which customers demand products (e.g. demand of 100 parts per week.)

Rate – Production Rate: The output of a machine or manufacturing sub-system per unit time (e.g. parts/hour). Analogous to frequency.

Size – Lot Size: Number or quantity of parts moved between operations.

Size – Run Size: For discrete products, the batch is the number of units made in one setup. One batch can consist of several lots, which are transported to the next operation.

Standard Work Methods: Clearly defined operations and standardized steps for both, the workers and machines.

Station: A physical location and required facilities and tools at which one or more operations are performed.

Sub-System or Cell: A collection of machines and stations required to perform a specified set of operations on a product or group of products. Examples: an engine block machining transfer line; a vehicle assembly line; a Flexible Manufacturing System (FMS) for machining jet engine turbine blades.

Synchronized Production: All operations produce exactly the same sequence of parts demanded by the customer (e.g. same mix, rate, and quantity). The production run size and lot size is truly one unit.

Time – Cycle Time: The time interval between the production of two sequential parts by a machine or sub-system. The production rate is the inverse of the cycle time.

Time – Manufacturing Throughput Time: The time required for a part to pass through the manufacturing system. Measured from the time processing begins on the raw material to the time the processed product exits the final operation.

Time – Order Lead Time: Time interval from order input to shipping of finished good. Order lead time consists of administrative time and throughput time. (See Response Time.)

Time – Processing Time: The time during which material is being changed, whether it is a machining operation or an assembly.

Time – Setup Time (or changeover time): The time required to changeover a machine, resource, work center, or line from the last good piece of part type A to the first good piece of part type B.

Distinguish internal setup (all activities, which require the machine to be shut) from external setup (activities, which do not require the machine to be shut down).

Time – Standard Time: The length of time that should be required to run one part through an operation by a worker. Standard time assumes an average worker following prescribed methods and allows time for rest to overcome fatigue.

Time – Takt time: Takt time defines customer demand cycle time. It is the quotient of available time per shift (day) to average demand per shift (day).

Time – Throughput Time: refers to the length of time from when material enters a production facility until it exits.

Waste: The Toyota Production System defines seven wastes:

Overproduction means to produce more than demanded or produce it before it is needed. It is visible as storage of material. (it is the result of producing to speculative demand).

Inventory or Work In Process (WIP) is material between operations due to e.g. large lot production or processes with long cycle times. (e.g. EDM at Palmer)

Transportation does not add any value to the product. Instead of improving the transportation it should be minimized or eliminated (e.g. forming cells).

Processing - The waste of processing itself anticipates the question why a specific processing step is needed and why a specific product is produced. All unnecessary processing steps should be eliminated.

Motion - Waste of motion relates to the motion of the workers, machines, and transport; e.g. due to inappropriate location of tools and parts. Do not automate wasted motion, but improve the operation itself.

Waiting - The worker should not wait for the machine. The principle is to maximize the utilization/efficiency of the worker instead of maximizing the utilization of the machines.

Making defective products is pure waste. Prevent the occurrence of defects instead of finding and repairing defects.

Work-In-Process: (WIP) The total inventory existing within a manufacturing system. Does not include raw materials and components prior to the first operation in the system or finished goods after the final operation.

Appendix B - Miscellaneous Analyses

- ✓ Voice of the Customer Questionnaire
- ✓ Ishikawa / Root-Cause Analysis
- ✓ KJ-Analysis

Voice of the Customer Questionnaire

Explain to me what your role was in the pull system implementation?

What training was provided to you related to pull systems?

Explain to me your understanding of the system and what its purpose was?

How did the new system alter the work environment?

How was the new system embraced by the workers?

by management?

What outcomes that resulted from the implementation did you see as positive?

What outcomes did you see as negative or destructive?

Explain to me what benefits of the new system were communicated to you?

Was this method of communication effective? How would you have communicated the benefits differently?

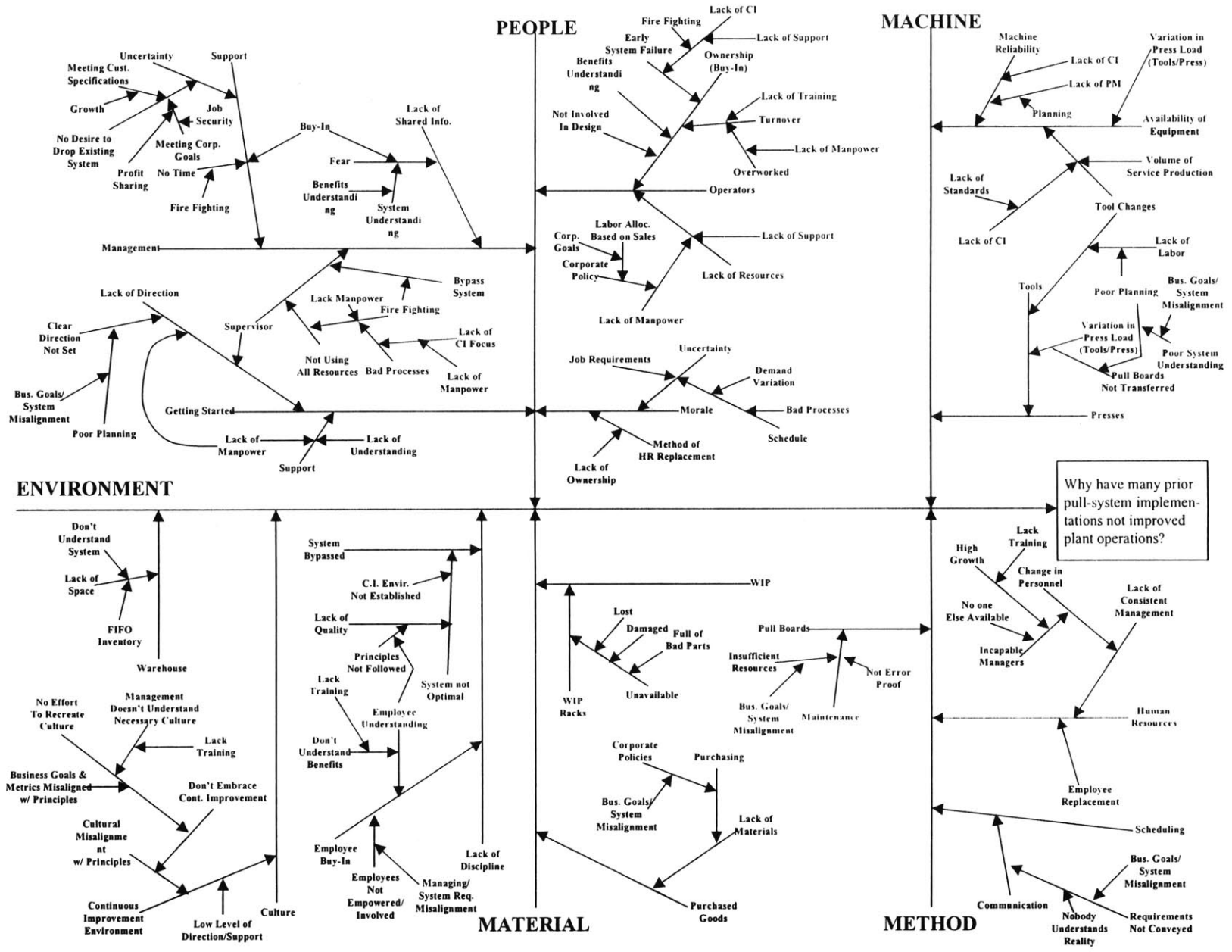
Explain to me what you believe your superior's role was?

What do you think could have been done differently to make the design / implementation more successful?

What should a manufacturing system include to make your job easier?

(ex: If theme was 'Why am I not saving the \$100/week I intended?', an observation might be 'I spend \$50/week at the bar' or 'I spend \$50/week on car improvements').

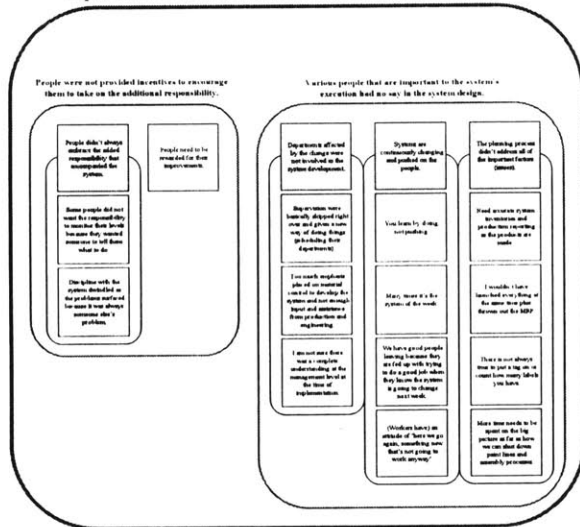
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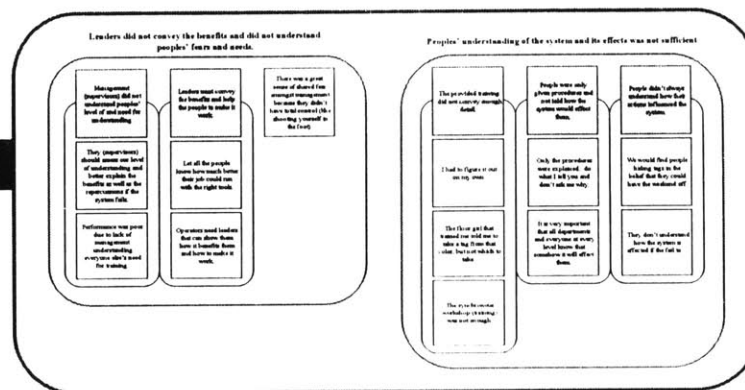
WHY HAVE PRIOR PULL IMPLEMENTATIONS NOT IMPROVED PLANT OPERATIONS?

BECAUSE IMPLEMENTATION LEADERS FAILED TO INVOLVE ALL OF THE IMPORTANT PEOPLE AND ADDRESS ALL OF THE IMPORTANT ISSUES, MANY CRUCIAL FACTORS WENT UNADDRESSED AND LED TO EARLY PROBLEMS THAT CREATED A RESISTANCE TO CHANGE.

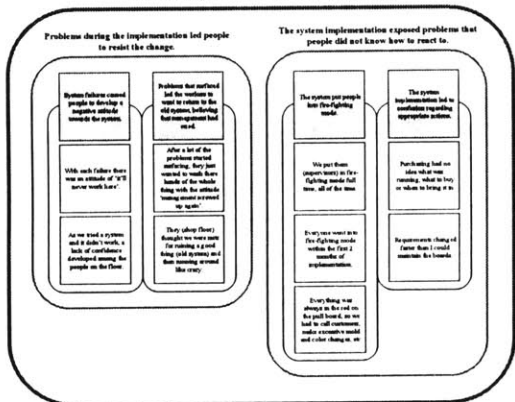
Many people and factors that are crucial to a successful implementation were not involved in or addressed in the change.



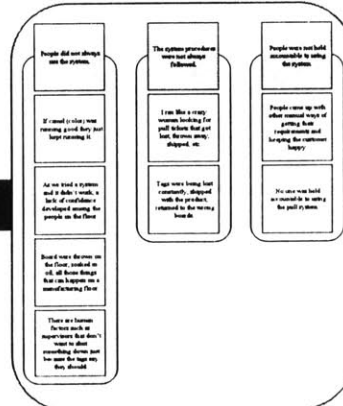
Leaders failed to understand peoples' needs and to help them understand the system and its benefits.



Problems encountered during the implementation led to confusion, uncertainty and a resistance to change.



The system was not enforced.



August 26, 1999
Germany
Mark Lulguraj

Leaders failed to understand peoples' needs and to help them understand the system and its benefits.

Leaders did not convey the benefits and did not understand peoples' fears and needs.

Management (supervisors) did not understand peoples' level of and need for understanding.	Leaders must convey the benefits and help the people to make it work.	There was a great sense of shared fear amongst management because they didn't have total control (like shooting yourself in the foot).
They (supervisors) should assess our level of understanding and better explain the benefits as well as the repercussions if the system fails.	Let all the people know how much better their job could run with the right tools.	
Performance was poor due to lack of management understanding everyone else's need for training.	Operators need leaders that can show them how it benefits them and how to make it work.	

Peoples' understanding of the system and its effects was not sufficient.

The provided training did not convey enough detail.	People were only given procedures and not told how the system would effect them.	People didn't always understand how their actions influenced the system.
I had to figure it out on my own.	Only the procedures were explained: do what I tell you and don't ask me why.	We would find people hiding tags in the belief that they could have the weekend off.
The floor girl that trained me told me to take a tag from that color, but not which to take.	It is very important that all departments and everyone at every level know that somehow it will effect them.	They don't understand how the system is affected if the fail to ...
The synchronous workshop (training) was not enough		

Many people and factors that are crucial to a successful implementation were not involved in or addressed in the change.

People were not provided incentives to encourage them to take on the additional responsibility.

People didn't always embrace the added responsibility that accompanied the system.

People need to be rewarded for their improvements.

Some people did not want the responsibility to monitor their levels because they wanted someone to tell them what to do.

Discipline with the system dwindled as the problems surfaced because it was always someone else's problem.

Various people that are important to the system's execution had no say in the system design.

Departments affected by the change were not involved in the system development..

Systems are continuously changing and pushed on the people.

The planning process didn't address all of the important factors (issues).

Supervision were basically skipped right over and given a new way of doing things (scheduling their departments).

You learn by doing, not pushing.

Need accurate system inventories and production reporting as the products are made.

Too much emphasis placed on material control to develop the system and not enough input and assistance from production and engineering.

Many times it's the system of the week.

I wouldn't have launched everything at the same time plus thrown out the MRP.

I am not sure there was a complete understanding at the management level at the time of implementation.

We have good people leaving because they are fed up with trying to do a good job when they know the system is going to change next week.

There is not always time to put a tag on or count how many labels you have.

(Workers have) an attitude of 'here we go again, something new that's not going to work anyway'.

More time needs to be spent on the big picture as far as how we can shut down paint lines and assembly processes.

Problems encountered during the implementation led to confusion, uncertainty and a resistance to change.

Problems during the implementation led people to resist the change.

System failures caused people to develop a negative attitude towards the system.

With each failure there was an attitude of 'it'll never work here'.

As we tried a system and it didn't work, a lack of confidence developed among the people on the floor.

Problems that surfaced led the workers to want to return to the old system, believing that management had erred.

After a lot of the problems started surfacing, they just wanted to wash their hands of the whole thing with the attitude 'management screwed up again'.

They (shop floor) thought we were nuts for ruining a good thing (old system) and then running around like crazy.

The system implementation exposed problems that people did not know how to react to.

The system put people into fire-fighting mode.

We put them (supervisors) in fire-fighting mode full time, all of the time.

Everyone went into fire-fighting mode within the first 2 months of implementation.

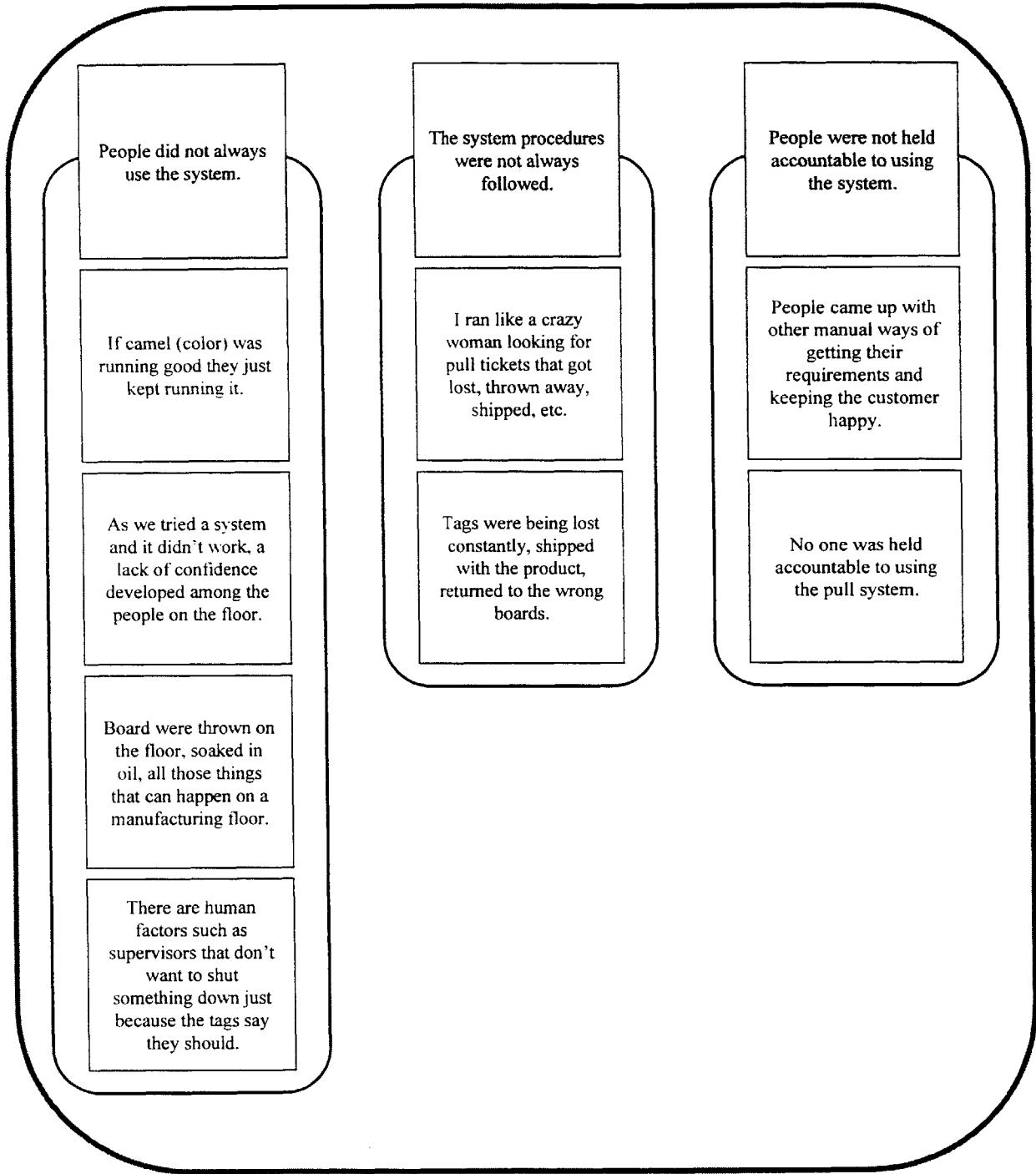
Everything was always in the red on the pull board, so we had to call customers, make excessive mold and color changes, etc.

The system implementation led to confusion regarding appropriate actions.

Purchasing had no idea what was running, what to buy or when to bring it in.

Requirements changed faster than I could maintain the boards.

The system was not enforced.



Appendix C – Initial Intrigue Lean Assessment

Initial Lean Assessment

Rating Date	Today's Rating	Last Rating		2
ITEM	Color	Color	CRITERIA	Sm
Identification/ Elimination of Waste	0.0		Has obvious wasted movement been minimized?	
			Has excessive waiting been minimized?	
			Has redundant inspection been minimized?	
			Are operators involved in efforts to reduce scrap?	
Work Place Organization	0.0		Is the work place neat, clean and organized?	
			Is there a formal housekeeping procedure in place?	
			Is housekeeping audited routinely?	
			Are resources easily accessible to operators?	
			Is everything kept in it's proper place?	
			Do processes and products flow smoothly? Is work designed ergonomically?	
Visual Control	0.0		Are visual controls simple and easily understood?	
			Are visual controls convient to the operators?	
			Do visual controls contain all pertinent data?	
			Is FTQ charted by those doing the work?	
			Is scrap charted by those doing the work?	
			Are productivity Indicators charted?	
			Is downtime tracked and charted? Are quality concerns made visible?	
Pull Systems	0.0		Are purchased goods ordered by pull signals?	
			Are products produced to pull signals?	
			Do operators understand productions requirements?	
			Are production/work priorities obvious to everyone? Is inventory FIFO?	
Standard Methods	0.0		Are job instructions & procedures readily accessible?	
			Do operators know how to change work methods?	
			Are operators cross-trained?	
			Are safety practices observed?	
			Are safety concerns/issues visually displayed?	
			Is there a procedure to stop out of control processes?	
			Is the procedure easily understood by everyone?	
			Are operators aware of customer concerns? Do operators self-inspect product?	
Lead Time Reduction	0.0		Is there timely notification of the need for change over?	
			Do operators react appropriately to that notification?	
			Are there on-going efforts to reduce downtime?	
Employee Involvement	0.0		Are teams meeting regularly (weekly)?	
			Are minutes kept of meetings?	
			Do teams identify opportunities and pursue them?	
			Are employees delegated responsibilities?	
			Is progress tracked and measured? Are employees involved in new program planning?	

Appendix D – Altered Intrigue Employee Roles

KEY ROLES:

Player	=	Employee
Leader	=	Supervisor
Coach	=	Manager
Head Coach	=	General Manager

Players

- ✓ Understand they are part of a high performance work team (HPWT)
- ✓ Recognize the mission (reason for being) of the HPWT
- ✓ Know in very specific detail what their job is
- ✓ Understand how important their job is to the success of their HPWT
- ✓ Know what to look for to be sure they are doing their job correctly
- ✓ Insure that only defect free parts leave their work station
- ✓ Realize they have the authority to stop a job for any problem they deem significant
- ✓ Know exactly how to seek for help to resolve any problem
- ✓ Are comfortable with the 5-Why process for determining root-causes of problems
- ✓ Utilize the PDCA method for making improvements
- ✓ Understand the benefits of the ILMS and embrace the principles so that all of their actions are aligned with the system
- ✓ Understand how their products are used both upstream and downstream in the product flows
- ✓ Understand how the performance of their HPWT impacts the larger plant-wide team
- ✓ Celebrate accomplishments

Leaders

- ✓ Understand they are responsible for the success of a group of HPWT's
- ✓ Understand and communicate the importance and impact of the work their groups do to the overall success of the plant
- ✓ Are goal directed and are always aware of the results but are primarily process-focused
- ✓ Are effective listeners, facilitators, conflict resolvers, consensus builders, and feedback presenters, and employee developers
- ✓ Protect and defend the actions of their employees but hold them accountable for their behavior
- ✓ Are comfortable with the 5-Why process for exposing root-causes
- ✓ Understand and use the rules of ILMS
- ✓ Administrate the daily details of their job in an error-free way that sets an example for their people
- ✓ Know exactly where to go and how to seek help for all issues and problems
- ✓ Are honest, principled, ethical and reliable.

Coaches

- ✓ Understand and articulate the mission of their department and its importance and impact to the plant's overall mission
- ✓ Thoroughly understand the roles and responsibilities of the Players, Leaders in their department and support and assist them to fulfill these
- ✓ Teach the 5-Why, PDCA and the principles of the ILMS to groups throughout the plant
- ✓ Are responsible for the thorough implementation of the Product Development Process for any new business coming into their departments
- ✓ Are aware of and understand the daily results but are primarily process-focused
- ✓ Are responsible and accountable for all activities in their department

Head Coach

- ✓ Is a long-term thinker who sees beyond the daily crisis and the quarterly report
- ✓ Knows how all company plants affect one another and are constantly reaching beyond his/her specific area of influence
- ✓ Puts heavy emphasis on vision, values, and motivation
- ✓ Has strong political skills to cope with conflicting requirements of multiple constituents
- ✓ Never accepts the status quo
- ✓ Grows and develops his/her people and realizes that this is the most important goal