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**UTILIZING INFORMATION TECHNOLOGY TO IMPROVE ORDER ENTRY TO  
MANUFACTURING INFORMATION PROCESS FLOWS**

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**A thesis submitted in conformity with  
the requirements for the degree of**

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**in the University of Toronto**

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**DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING**

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## **Abstract**

This thesis revolves around a case study at GE Multilin, a global leader in the design and manufacture of microprocessor based protection relays and the headquarters of General Electric's Power Management Division. The company was in the midst of introducing a new product line that would add enormous complexities to the existing ordering and manufacturing processes. As a part of this thesis, an investigation has been conducted to analyze how information systems and related technology could be implemented to aid in the development and improvement of information process flows that would aid in supporting the introduction of the new product line at GE Multilin. Since this analysis took place at the same time that the company was beginning to establish its order entry to manufacturing processes, to sustain the introduction of its new product line, all information collected and recommendations generated were immediately shared with GE Multilin.

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**ii**

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## **Acknowledgements**

The birth of the idea for this thesis began in the summer of 1997, when I was working as a summer student at GE Multilin. The analysis conducted for this thesis commenced at the end of the summer and continued for six months. Recommendations were provided to GE Multilin throughout the analysis phase and continued for three to four months after the analysis phase was completed. The implementation phase commenced as the recommendations were provided to GE Multilin and was still continuing as this thesis came to a close.

The corporate environment at GE Multilin is one of continuous improvement and total quality. With a progressive company and the encouragement of my professor, Harvey Kolodny, I began to explore ways of streamlining the order entry to manufacturing information processes. With several years of input and support from many people, the results of my endeavor are documented in this thesis.

Throughout this thesis, I have benefited from the input and co-operation of several people at GE Multilin including Jody Grafstein, Karen Winlove-Smith, Nick Gall, the IM/IT team, the Inside Sales team, and the Manufacturing work-cells.

I would like to thank my parents for their unfailing support; my brother Joseph Cagnelli, for his advice; and my friend, Jennifer Doherty, for her encouragement.

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# **Table of Contents**

1.0 Introduction .....	1
2.0 Research .....	3
2.1 General Order Entry and Manufacturing Processes .....	3
2.2 The STS Design & the Organizational Change Process Model.....	6
2.3 Information Systems: Configurators .....	12
3.0 Scan .....	16
3.1 Overview of GE Multinlin .....	16
3.2 History of Formation.....	17
3.3 Organizational Mission.....	17
3.4 Values.....	18
3.5 Customers .....	20
3.6 Organizational Structure .....	21
3.7 Sales .....	21
3.8 Manufacturing .....	21
3.9 Information Management .....	23
3.10 New Product Introduction .....	24
4.0 Technical System Analysis.....	26
4.1 Overview of the Existing Order Entry Process .....	26
4.2 Analysis of the Order Entry Information Process Flow .....	29
4.3 Key Differences between the Existing and New Product Lines.....	34
4.4 Overview of the Manufacturing Information Process Flow .....	37
4.5 Analysis of the Manufacturing Information Process Flow.....	37
4.6 Key Differences between the Existing and New Product Lines.....	48
4.7 Variance Control Analysis .....	49
4.8 Technical Analysis Key Variance Control Table .....	63
5.0 Social System Analysis .....	64
5.1 Quality of Working Life.....	64
5.2 Team Dynamics of the new Work-Cell.....	65
5.3 Goal Attainment .....	66
5.4 Adaptation .....	68
5.5 Integration.....	71
5.6 Long Term Development .....	72
5.7 Rewards and Recognition.....	73
6.0 Recommendations .....	74
6.1 Basic Assumptions: Role of the IM/IT department.....	74
6.2 Identifying Key Areas for Improvement with regards to the current Order Entry to Manufacturing Process Flows .....	74

6.3 Development and implementation of new information processes that will support the introduction of the new product line .....	83
7.0 Post Implementation.....	92
7.1 New Information Process Flow Established.....	92
7.2 Transition Strategy .....	95
7.1 Benefits.....	96
8.0 Lessons Learned .....	98
Appendix 1: Order Entry to Manufacturing Information Process Flow.....	101
Appendix 2: Order Entry Information Process Flow.....	102
Appendix 3: Purchase Order Check List.....	103
Appendix 4: Defects attributed to Data Entry .....	104
Appendix 5: Manufacturing Information Process Flow.....	105
Appendix 6: Auto-Label Example .....	106
Appendix 7: Order Entry to Manufacturing Process Variance Analysis.....	107
Appendix 8: Technical Analysis Key Variance Control Table .....	108
Appendix 9: Interdependencies between Recommendations Suggested and Key Variances Identified.....	121
Appendix 10: Process Flow for Recommendations 26 through 30.....	122
Appendix 11: Configurator Information Process Flow.....	123
Appendix 12: Status of recommendations at the time the new product was released into production.....	124
Appendix 13: New Information Process Flow .....	126
Appendix 14: Recommendations that were translated to other Product Lines .....	127
References .....	129
Bibliography .....	130

## **GLOSSARY OF TERMS**

*Accpac:* refers to the Order-Ship-Billing system used at the time the analysis was conducted

*Auto-label:* refers to the labels placed on the product itself and on the shipping box. An auto-label also contains a job card for that particular unit.

*Auto-label program:* refers to the serial number and label generating system. The output of the program is referred to as an auto-label.

*Convert program:* is used to generate open orders reports in a Microsoft Excel format.

*Foxpro:* a database program used in a majority of systems, usually implemented by consultants for the company. All Foxpro based programs referred to in this analysis were written in version 2.1, the version released after the DOS version.

*GAIL:* the acronym GAIL refers to the four system functions that must be performed for an organization to work effectively: goal attainment, adaptation, integration, and long term development.

*Input:* is the raw material that will be converted into output. Input is only that which is actually transformed or converted into output

*Job Release system:* a Foxpro 2.1 based program used to indicate to the Shipping department when to pick up the finished units from the various work-cells.

*Key Variances:* are those variances which set up long chain reactions of problems which quickly become critical to the system.

*Output:* are exported by the system to the environment. Their values earns an organization access to resources necessary for its continued functioning.

***POURS:*** the point-of-use-replenishment system. Is used to identify at what point the kanbans should be replenished.

***Repair database:*** used to store the various defects identified during the manufacturing process

***Scan:*** develops a system definition of the target organizational unit. It seeks to define the unit's inputs, outputs, transformations, boundaries, technical system, people, purposes, and problems.

***Social System Analysis:*** examines the work-related interactions among the various people in the organization.

***Technical System Analysis:*** is analyzed as a transformation process comprised of a series of unit operations. The process is flow charted from beginning to end providing a map upon which system problems may be identified and located.

***Test-Rig program:*** used to store and retrieve necessary information and to test the unit

***Throughput:*** is the state of the input as it is converted into the output.

***Variance:*** is any disturbance, deviation or unplanned event that can have a negative effect on the throughput.

***Variance Analysis:*** is a chart relating all of the variances so one can see which causes other complications down the line.

***Work-cells:*** a team of individuals, that have ownership over all responsibilities with respect to a particular product line

## **List of Tables**

## **Page**

*Table 2.3.4* : Configurator Features

10

*Table 7.3* : Comparison between the Old & New Processes

97

## **List of Figure Captions**

## **Page**

<i>Figure 2.1a : General Order Entry Processes</i>	4
<i>Figure 2.1b : Basic Manufacturing Processes</i>	5
<i>Figure 2.2.1 : STS Roadmap</i>	7
<i>Figure 2.2.2 : The Organizational Change Process Model</i>	9
<i>Figure 4.1.1 : Order Code table for a MMII relay</i>	28
<i>Figure 4.3.1 : Order Code table for a L90 relay</i>	36

## 1.0 Introduction

In today's competitive business environment, companies across the globe are taking advantage of information technology to improve the manner in which they conduct business. Information technology (IT) has been used in the past to simply automate existing business functions, and thus until recently has not been used to its full potential. Implemented effectively, IT can be used as a tool to streamline business processes and at the same time integrate a business' critical activities. A well integrated information system not only improves overall business performance but can also identify key areas that require further investigation, ensuring continual improvement.

The heart of this thesis is a case study of a project conducted at GE Multilin, the headquarters of General Electric's Power Management Division. GE Multilin, a global leader in the design and manufacture of microprocessor based protection relays, is introducing a new product line. The nature of the new product itself will add complexities in the ordering and manufacturing processes. An investigation will be conducted to analyze how information systems and related technology can be implemented to aid in the development and improvement of business processes at GE Multilin. It is important to note that this investigation will take place at the same time that the company will be establishing its order entry to manufacturing processes to sustain the introduction of this new product line into the organization.

To support the case study, research will be conducted on three main topics; order entry to manufacturing processes, STS methodology, and existing information systems/technology. The first main area of research will deal with defining and describing general order entry and manufacturing information process flows. This research chapter will aid in defining the boundaries and scope of the thesis. The second area of research will describe the methodology that can be implemented in order to bring about information process flow improvement. Sociotechnical systems (STS) design, a methodology that strives for an optimal balance between the social and technical systems, will be described in detail and later applied to the case study. The third area of focus will investigate existing information systems and related technology used to improve information process flows.

The information and knowledge obtained from the research chapters will aid in the analysis of the case study. The case study will consist of an analysis of how information technology can be implemented to aid in the development of processes that will support the introduction of the new product line at GE Multilin. Order entry to manufacturing processes will be the main area of focus. STS methodology will be used in order to analyze the information process flows within the current order entry and manufacturing business processes at GE Multilin. By analyzing and identifying problem areas in the current process, the new process can be developed and implemented ensuring that these and other potential problem areas will be averted. Information technology will play a strong role in aiding in the development of the new processes. Since this investigation takes place at the same time that the company is establishing its order entry to manufacturing processes to sustain the introduction of its new product line, all information collected during this analysis will be immediately shared with GE Multilin. Thus, this will aid in ensuring that GE Multilin will use information technology to its full potential to aid in improving its new order entry to manufacturing processes as they are being developed.

Recommendations will follow the analysis and focus on two key areas. The first area will deal with the development and implementation of the new information process flows that will support the introduction of the new product line at GE Multilin. The second will deal with identifying key areas for improvement with regards to the current information process flows. The recommendations will focus on how to implement IT tools in order to streamline business processes and at the same time integrate some of GE Multilin's critical activities. All recommendations will also be immediately shared with GE Multilin to aid in ensuring the successful introduction of their new product line into the organization. Due to this, an overview of the results of implementing various recommendations will be possible and thus will be provided in the thesis. A conclusion identifying lessons learned will end the thesis.

## **2.0 Research**

Research will be conducted on three main topics which include:

1. General Order Entry and Manufacturing Processes
2. Sociotechnical Systems
3. Existing Information Systems

The first main area of research will deal with defining and describing general order entry to manufacturing information process flows. This will aid in defining the boundaries and scope of the thesis. The second area of research will describe the methodology that will be used to aid in bringing about information process flow improvement at GE Multilin. The third area of focus will investigate an example of an existing information system that can be used to improve information process flows.

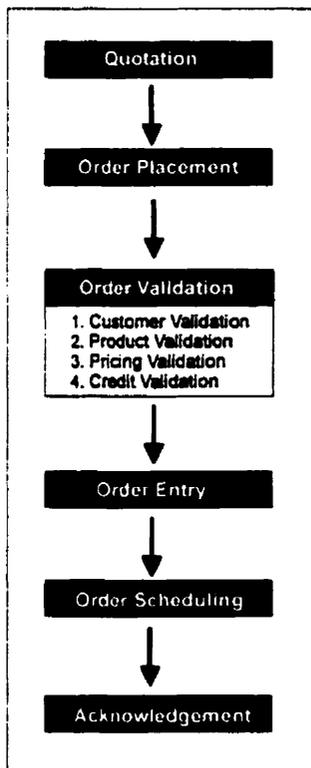
### **2.1 General Order Entry and Manufacturing Processes**

The main purpose of this section is to overview general order entry and manufacturing processes in order to define the boundaries and scope of the analysis with respect to the case study at GE Multilin.

A general order entry process flow can be seen in *Figure 2.1a*. The flow may differ from organization to organization but the general elements are the same. Quotation generation is usually the first step in the order entry process. This is where the negotiations of terms, such as pricing, occurs between the customer and the specific organization's sales force. Once this step is completed one of the possible results may be the customer placing the order on the company, the second step. Once the order has been accepted by the company in question, a validation process occurs, step three in this particular case. In certain circumstances identification of whether the product can be sold to the particular customer may require to take place. This is usually to ensure that the existing sales channels are not bypassed. Thus certain products may only be sold to customers that the organization has an agreement or contract with, this is referred to as "customer validation" in *Figure 2.1a*. Whether the product requested can actually be manufactured and ordered is referred to as "product validation" in *Figure 2.1a*. Pricing validation consists of verifying that the particular

customer is paying the correct amount for the specific products in question. Credit validation and/or authorization of payment aids in ensuring that the organization will collect its payment for the products that will be delivered to the customer. Members of the finance department are usually involved in this process. Once the validation is completed, the order is usually then entered into the organization's order entry system. Depending upon the organization and on the circumstances this may either be a manual or automated process. Once the order has been entered, scheduling usually takes place with the help of manufacturing and a delivery date is issued. The final step is usually an order acknowledgement to the customer acknowledging that the order has been accepted and usually identifies the final price, products ordered, and delivery date for that order. The order acknowledgement may take the form of a fax and/or telephone call, and/or e-mail. (Kalakota & Winston, 1996)

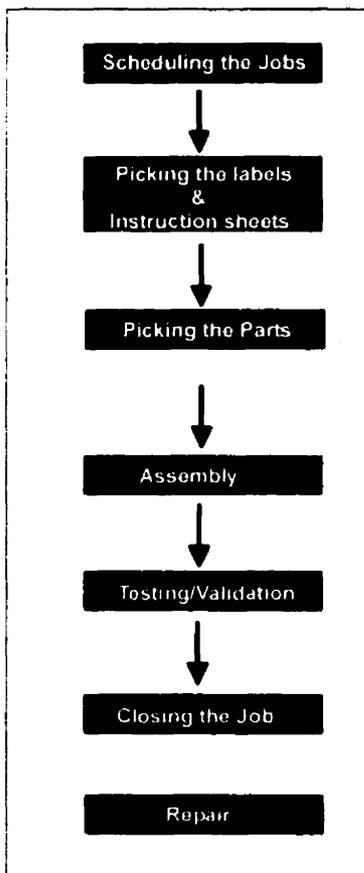
*Figure 2.1a : General Order Entry Processes*



A basic manufacturing process flow, for a “make to order model” can be seen in *Figure 2.2b*. The flow may differ from organization to organization but the general elements are the same. The first step usually consists of viewing the open orders and scheduling the

jobs in order to meet the requested delivery dates. Once a job is selected, the appropriate labels and instructions sheets are selected. Depending on the organization and on the particular circumstance this may either be a manual or automated process. The instruction sheets usually indicate what parts are required to be selected for the particular job in question. Once the correct parts are picked the assembly of the actual product begins. The complexity of the assembly process varies depending upon the product being assembled. Testing usually follows to ensure that the product was assembled correctly and that the product will meet the specifications originally identified by the customer. Once the job is completed, it is usually identified in the particular order-ship-billing system , in order to indicate to shipping that the job is ready to be picked up and to the finance that the invoicing process should begin. If defects are identified during any of the manufacturing steps the product being assembled is usually sent to a repair station until the defects identified are eliminated.

*Figure 2.1b: Basic Manufacturing Processes*



## **2.2 The STS Design & the Organizational Change Process Model**

The Sociotechnical system is a methodology, “an informed approach to organizational improvement”, combining both philosophy and method. As a philosophy “it supports the value of empowerment as well as the systemic focus on product and customer.” As a method it “helps provide custom solutions for performance by design” (Taylor & Felten, 1993).

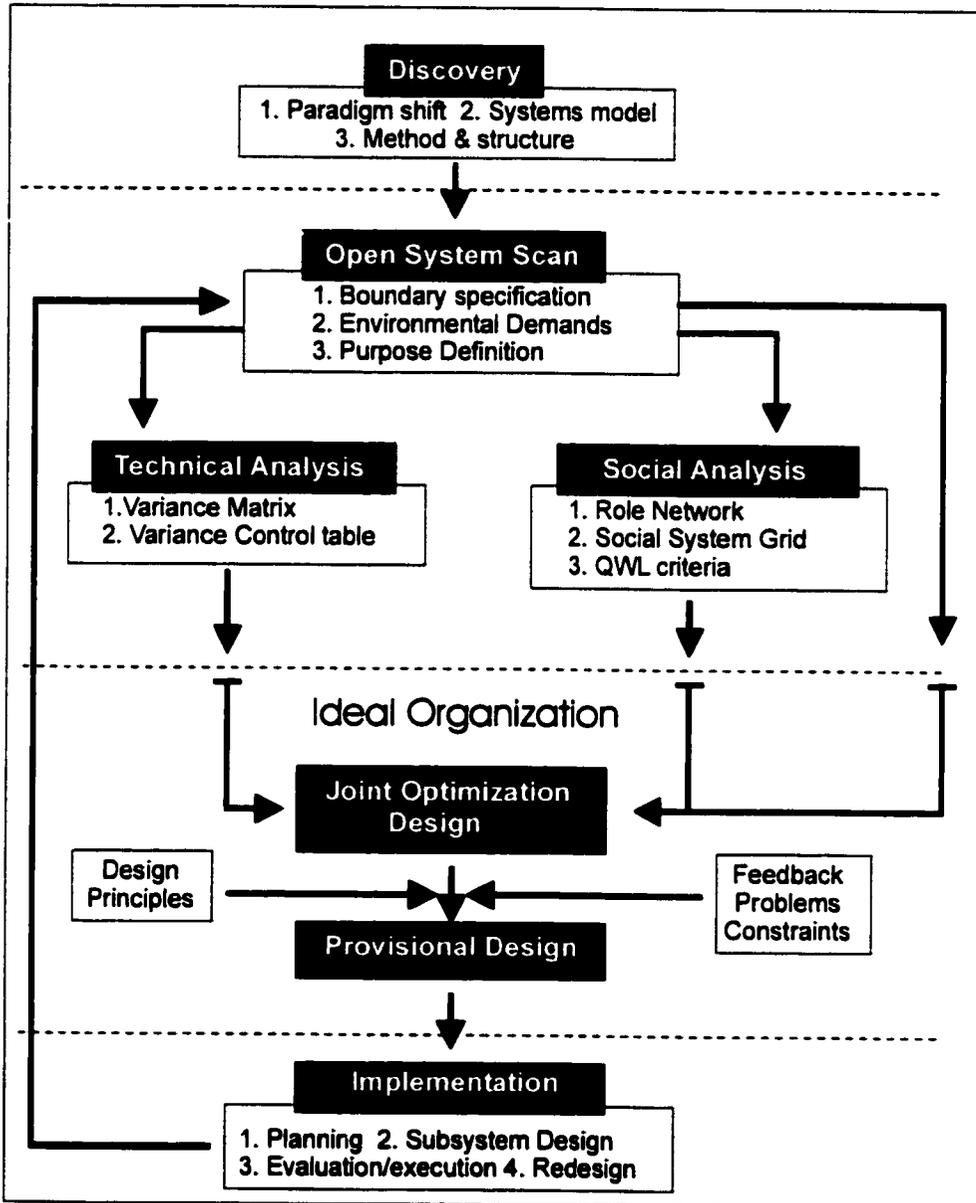
### **2.2.1 The Sociotechnical Process**

A Sociotechnical system analysis of a particular organization or enterprise consists of applying a series of steps in which various system aspects of the organization are examined. *Figure 2.2.1* illustrates the roadmap of the STS process. The roadmap identifies seven major steps in four phases, identified by dashed horizontal lines that are required to implemented to achieve a successful Sociotechnical system. The seven steps include:

1. *Discovery*: “Recognition of the Sociotechnical systems paradigm”
2. *Scanning*: “Is the process of defining boundaries. It is key to understanding the purpose, the process, and the environment of any system”. The scan develops a system definition of the target organizational unit. It seeks to define the unit’s inputs, outputs, transformations, boundaries, technical system, people, purposes, and problems.
3. *Technical System Analysis*: This step employs a methodology “for understanding and then designing the product-creation or transformation process.” The process is flow charted from beginning to end providing a map upon which system problems may be identified and located.
4. *Social System Analysis*: Examines the work-related interactions among people in the organization. The role network, social system grid, and quality of work life criteria is used to understand the relationship among people and the system.
5. *Joint Optimization Design*: Understanding regarding how it all comes together.
6. *Provisional Design*: Understanding how to make the design relevant and realistic
7. *Implementation*: Understanding how to make the recommendations provided succeed and continue to succeed in the far future via continuous improvement.

(Taylor, Felten, 1993)

Figure 2.2.1. STS Roadmap



(Taylor, Felten, 1993)

This roadmap will be applied as much as possible to the analysis conducted at GE Multilin. The scan will begin the analysis, followed by the technical and social analysis. Recommendations will then follow which will encompass step five and six, joint

optimization design and provisional design. The final sections of the analysis will overview the status of the implementation efforts and the lessons learned.

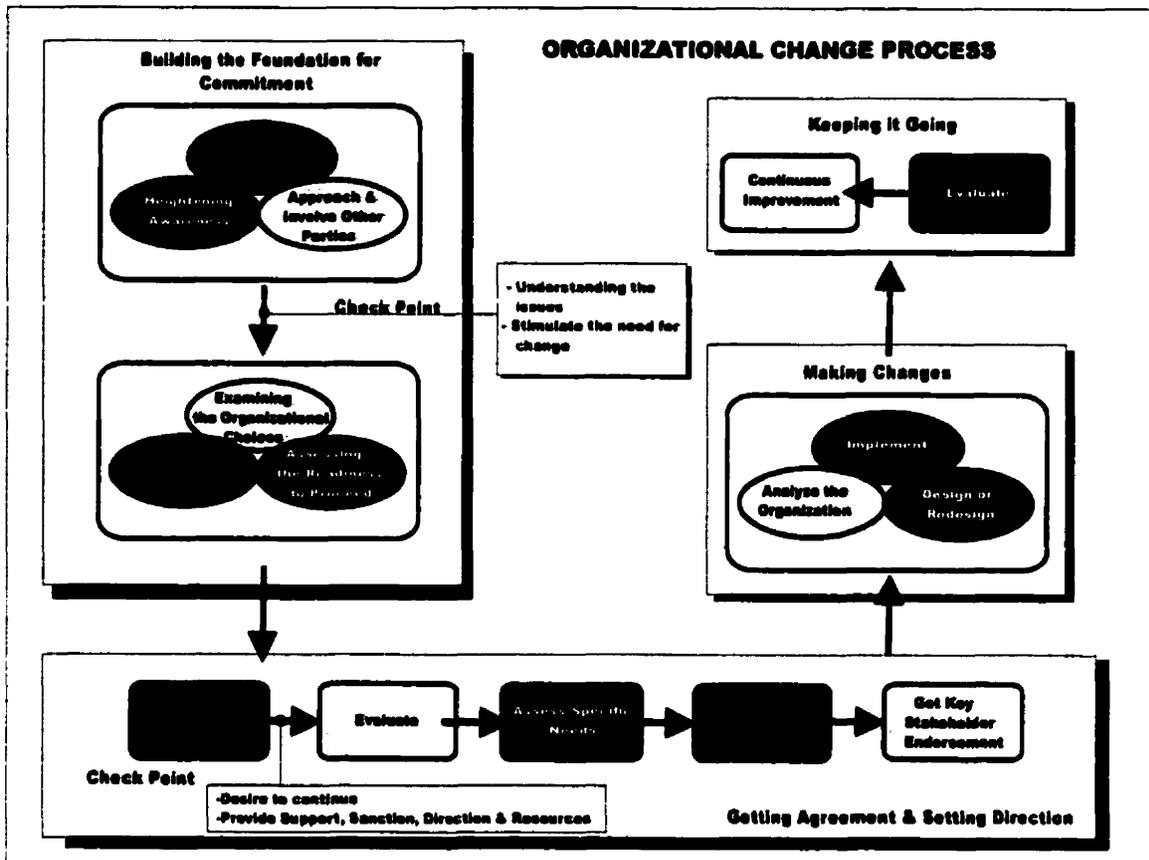
### **2.2.2 Organizational Change Process Model**

Many models of organizational change exist in practice. The change process model was developed from experiences mostly within existing unionized organizations (Kolodny, 1996). In general, the model provides guidance for a wide variety of organizations attempting to proceed with changes in structure, process, and/or services. Each organization is different in size and culture, thus the required timeline for an organization to engage in all steps and stages will vary. Most importantly, every step in the model is necessary and important, and must be followed completely to maximize effectiveness.

Initially, many organizations begin on this journey for organizational change they feel threatened in their current work practices. In essence, “they remain in these final years of the twentieth century, prisoners of a language that has its roots in a way of life and a way of work that are fast becoming obsolete” (Zuboff). As a result, they recognize the need to change which involves a reassessment of their strengths and weaknesses. Thereafter, the next step involves heightening awareness by addressing what needs to change and why there is such a need. Information sharing is an essential step for building trust and acceptance as was evident in our on-going bulletins.

Other parties are approached and involved which includes residents and their families, unions, management and community. Organization choices are examined by identifying and agreeing to the type of direction to take by identifying the values that will become the core of their beliefs which they will continuously test their decisions and actions on (Kolodny, 1996). The next step involves assessing what is in it for the key stakeholders in order to be able to proceed and begin the journey without resistance. The organizational change process model can be seen in *Figure 2.2.2*.

Figure 2.2.2 The Organizational Change Process Model



(Kolodny, 1996)

### Getting Agreement and Setting Direction

Resources to continue the process must be clearly committed. Specific needs are assessed in which gaps between where the organization is now and where it wants to be is stated. A philosophy statement is developed or re-evaluated which is reflective of the setting in study, because it is important to reference a “set of concepts that can provide guidance each time an unfamiliar situation arises” (Kolodny, 1996). In addition, management needs to commit to a continuation of the process.

### Making Changes

Only now can one begin to analyze the organization. An open system which is continuously evolving will require the “participation of those who are most familiar with work” (Kolodny, 1996). Design or re-design is guided by Chern’s principles (1976) and the

values developed. Implementation will involve sufficient detail and keeps in mind future change.

### **Keeping it Going**

The final step involves evaluating and continuous monitoring to avoid falling back to familiar patterns. An open system accepts the need for continuous improvement.

### **Chern's Principles of STS Design**

The design is directly linked to Chern's principles and will not succeed if the design content does not address the following principles. The principles address the best features of Sociotechnical designs in North America and Europe. The principles have been summarized and are intended to help guide the design.

### **Compatibility**

In order to adapt to change, all employees must be given the opportunity to participate in the decision making process by assisting with the design of the jobs that they are responsible for. For this to occur, the organization must encourage employees to be innovative and autonomous. In order to maximize the creative capacities of the individual, employees must be involved from the outset and continue to participate beyond the job design stage.

### **Minimum Critical Specification**

There is far too much specificity in organizations which inhibit adaptation or effective action. Specifying more than is needed may reduce possible options and alternatives. Each design decision must be challenged for simplicity and jobs should be designed dictating only the necessary specifications. As a result, this empowers employees to apply innovative techniques and adapt accordingly.

### **Sociotechnical: Variance Control**

A variance is defined as any deviation from a goal or objective. Unfortunately, traditional methods to control variances such as supervision and inspection aim to correct the actual consequences instead of reducing the number of variances. In a more effective manner, this principle states that if variances cannot be eliminated, they must be controlled as close to their source as possible. For example, an inspection process within manufacturing should be built into each workers job in order to control variances at the source. This design approach reduces the possibility of exporting the variances across the borders to the subsequent steps of the process.

### **Multifunctional Principle (Multiskilling)**

Unlike traditional organizational theories, such as Taylorism, which relied on people to perform highly specialized tasks, this principle emphasizes a worker's ability to adapt and be creative. In addition, this principle encourages an organization to invest in training programs to create a multiskilled environment, which also provides an employee with the opportunity for personal development. In this way, this kind of organization can easily adapt in a turbulent business environment.

### **Boundary Location**

This principle suggests the drawing of boundaries such that variances can be contained within a work group's boundary. Boundaries can be drawn based on time, territory, and technology. In this format, knowledge and expertise can be shared and self-managed, all with a view to achieving a common goal.

### **Information Flow**

Information systems should be designed to provide information in the right place, at the right time, for the right action. Work teams should be supplied with the right amount of information and feedback to control variances, thus creating an environment where employees can respond and act quickly. Information must be available to those who will use

the information first, rather than having delayed information passed down from others who do not need to be involved.

### **Support Congruence**

Systems of social support should be designed to reinforce behaviors that are congruent with the organization's design. Therefore, in a team based organization, which supports and encourages multiskilling, team achievements should be recognized with team rewards.

### **Design and Human Values**

The design objective here is to provide a high quality of work life by designing jobs that are meaningful and challenging for individuals. If implemented properly, information technology can be used to aid in improving the organization's processes, product quality, and quality of work life.

### **Continuous Improvement**

In a STS environment, the design function is never complete. There will always exist changes and improvements that can be implemented to further enhance the organization. The organization must continuously revise their strategies in order to keep up with issues affecting the quality of work life, reward systems, and a team environment.

## **2.3 Existing Information Systems: Configurators**

This section will overview an existing technology that may be of use for organizations using a "make to order" model with somewhat complex products, similar to GE Multilin.

### **2.3.1 What is a Configurator?**

A configurator can be defined as "a rules-based system that allows you to identify and/or configure products from customer-specified requirements" (Tikka, 1997). To add to this definition a configurator can also be described as "a computer program that defines the characteristics of a product and uses this definition to determine if, when and how to produce

it” (Lieberman, 1997). Thus the use of a configurator can aid customers and sales representatives in configuring complex products and services.

### **2.3.2 Benefits of using a Configurator**

The entire organization can reap the benefits from implementing a configurator. To the customer, the configurator plays the part of a personal sales assistant leading them through complex interactions with ease 24 hours a day, if placed on the Internet. Using this tool a product can be accurately configured and priced in minutes, effectively creating a satisfactory and efficient buying experience that may aid in greatly enhancing the company’s customer relationship.

In the eyes of a sales person, by utilizing the configurator they are ensured that the order has been placed according to currently accepted product designs. In addition most configurators enable a sales person to export the ordering information produced, including the order code, to the order entry system, eliminating any potential data entry errors. Furthermore, since the need to contact a product support engineer can be eliminated with the use of a configurator, the order processing time can be reduced from days to minutes.

To the product support engineers, the time that was previously spent validating orders can now be devoted to product improvement and development. The only time the engineer may have to interact with the system is to add product definitions or rules if there happens to be an upgrade or a new release to the product.

To the manufacturing team, the configurator can be used to quickly and easily generate a concise bill of material that aids them in determining how to build the particular product configuration requested. The time saved can now be focused on improving their manufacturing processes. (Tikka, 1997)

In addition to all these benefits the configurator aids the overall business by reducing the cost of sales, increasing revenues, potentially opening new sales channels and decreasing the time to market. The use of a configurator may aid in reducing costs by decreasing the amount of inaccurate orders which lead to higher costs due to the large percentage of returned items. In addition since a configurator guides a customer easily and effectively through a configuration, this reduces the amount of time that a sales representative needs to interact with the customer, again decreasing costs. The use of a configurator may increase revenues

by enabling the sales force to proceed more efficiently, decreasing the sales cycle time, allowing the sales personnel to move onto the next prospective customer. In addition, the use of a configurator may “provide the opportunity to up-sell and cross-sell by suggesting complementary products and options” (Calico, 1998) thus increasing revenue. Furthermore, by using a web-based configurator companies can use the Internet as an additional distribution/sales channel, knowing that their customers will receive correct product information and guidance while purchasing complex to configure products on-line. Lastly, the use of a configurator may aid in delivering consistent and correct information simultaneously to all channels (direct and indirect sales channels) and geographies, greatly improving time to market, and at the same time ensuring consistency of information (Calico, 1998).

### **2.3.3 Types of Configurators**

There are two main types of configurators, add-on configurators and fully integrated configurators. Add-on configurators are typically separate from the production and inventory control system. As a result of this, add-on configurators maintain a redundant database of information required for the order process, such as the customer and part master file. On the other hand, integrated configurators can either use the same master file or can transfer data bi-directionally between the two systems, thus sharing information. Thus the integrated configurator has the advantage of not duplicating data in more than one place which can result in synchronization problems and the need to ensure that each system maintains the same version of common data (Lieberman, 1997).

### 2.3.4 Basic Configurator Functions

Table 2.3.4 illustrates the basic configurator functions for both add-on and integrated configurators:

**Table 2.3.4: Configurator Features**

<b>Function</b>	<b>Definition</b>	<b>Benefits</b>	<b>Add-On Configurator</b>	<b>Integrated Configurator</b>
<i>User defined variables</i>	Allows it to ask questions about the product being ordered and then validates the answer	Independence from programming	Available	Available
<i>Discrete, continuous &amp; text variables</i>	Ability to support different types of variables, i.e. numbers, text, & alphanumeric	Ability to describe all possible products components & options	Available	Available
<i>Configuration code creation</i>	generation of an alpha numeric identifier of the variables selected for a particular product	Permits inventory tracking, retains history, allows sales & financial analysis	Available if interfaced to production system	Available
<i>Rule Creation</i>	ability to capture rules with respect to a particular product definition	Simplicity, ease of use	Available	Available
<i>Vocabulary</i>	The ability to access data from external sources such as the database containing the customer or product master file	Assess all database elements	Not available	Available
<i>Processing Speed</i>	The effective use of design principles enables the program to run more efficiently	Makes efficient use of system resources	Available	Available
<i>Multi-platform capability</i>	designing the program to run on various platforms	Can use different platforms, in local or remote locations	Available	Available

(Lieberman, 1997)

### **3.0 Scan**

Scanning is a process used to describe the workplace and organization in systems terms. It is the key to understanding the purpose, process, and environment of any system. The scan serves as both the guideline to begin the socio-technical design, and is often the most reviewed and revised aspect of the “systems” understanding as the overall process continues. Scanning is used to identify large opportunities for improvement. As an overview of the system, the scan provides an analysis of the general dimensions of the organization as well as the inputs and outputs of the social and technical systems.

#### **3.1 Overview of GE Multilin**

GE Multilin, the headquarters of GE Power Management, is a global leader in the design and manufacture of micro-processor based protection relays for industrial and utility applications. A protection relay can be defined as an intelligent electronic device (IED), micro-controller based, that protects and controls power system elements such as motors, generators, transformers, feeders, and lines against system faults such as short circuits, thermal overloads and other faulted conditions. GE Power Management’s product offerings range from multifunction relays (digital and analog), single function relays (digital, analog, and electro-mechanical), components (such as auxiliary relays and control transfer switches) to complete substation automation solutions. Its products are used in a wide range of applications such as protecting large motors, generators, power feeders and transformers in industrial and utility substations. By taking advantage of resources, both in engineering design and technical support, GE Power Management has become an ideal strategic partner for relays and related systems. Plants located in the US, Canada, and Europe, registered to ISO90001, have allowed the organization to effectively compete in the global market and to meet the rapidly changing customer requirements.

GE Power Management is a division of GE Industrial Systems, created in 1998 by the merger of 2 GE businesses, GE Electrical Distribution and Control and GE Industrial Control. GE Industrial Systems is one of 11 GE businesses which include:

1. Aircraft Engines
2. Appliances
3. Capital Services

- |                       |                         |             |
|-----------------------|-------------------------|-------------|
| 4. Industrial Systems | 5. Information Services | 6. Lighting |
| 7. Medical Systems    | 8. NBC                  | 9. Plastics |
| 10. Power Systems     | 11. Transportation      |             |

### ***3.2 History of Formation***

In 1978, Multilin began its operations with three employees, and a single product, an electronic motor protection relay. From these entrepreneurial roots the organization grew to become a premier supplier of micro-processor based protection relays for industrial applications. The company experienced significant growth throughout the 1980's and 1990's. Multilin has grown approximately 25% annually between 1978 - 1995, followed by a period of rapid growth: 42% in 1996, 54% in 1997 and 32% in 1998. Currently the company has grown to over 250 employees and offers a diverse range of products for motors, feeders, generators and transformers.

In 1995, Multilin was acquired by General Electric and became the headquarters of GE Power Management, a division of the former GE Electrical Distribution and Control, one of the twelve GE businesses at the time. Since 1995, GE Power Management has grown to encompass four sites in its operations located in Ontario Canada, Pennsylvania USA, Bilbao Spain, and Anasco, Puerto Rico.

### ***3.3 Organizational Mission***

Although there is no formal mission or philosophy statement which can be found on walls, pamphlets, or brochures, there is still a common goal which is stressed on almost a daily basis. Whether it be the quarterly communications meeting conducted by the operations manager, or the daily morning manufacturing meetings, the same goal is repeated and reviewed: "to be the number one choice for customers when it comes to quality protection relays and quality service". Another phrase often heard when new projects are being approved is: "What's the impact to the customer?". This philosophy stems from the belief that the customer is ultimately in control of the future of the company. Only by displaying competency in the ability to produce quality products and provide quality service will both the customer base and customer loyalty continue to flourish.

### **3.4 Values**

GE Multilin's culture promotes a strong sense of ownership and autonomy in all the individuals who work there. This is especially evident in the manufacturing work-cells, where the team owns the entire manufacturing process with respect to their particular product line. GE Multilin's employees take pride and ownership in the multitude of projects they willingly undertake, as additions to their regular duties, in order to improve their processes, product quality, and quality of work-life. The culture present at GE Multilin is also reflected in the language that is used on a day-to-day basis. Words such as "stretch goals" and "push back" are often heard being mentioned when projects are being discussed. A "stretch goal" is an objective that is defined at the beginning of a project that exceeds the original purpose and goal of the project. "Push back" is usually used to indicate that it may be time to re-think the decisions that have been made in the past, in order to improve the current situation. This again suggests a culture that promotes its employees to achieve excellence in not only their job functions but also in themselves.

Another important part of the culture present at GE Multilin is the quality initiative. Even before GE acquired Multilin, quality was always identified as being a critical element for success. Total Quality Management (TQM) was used to ensure the highest possible quality of their products. The quality initiative was strengthened when Multilin inherited 6-Sigma from GE, when they were acquired. Unlike TQM which focused on the processes related to the manufacturing of the product, 6-Sigma focuses on reducing the number of defects in the entire organization. GE's quality initiative, 6-Sigma, emphasizes the need to increase quality to meet the ever increasing customer requirements and expectations. Achieving 6-Sigma would translate into approximately three defects/failures in a million products manufactured. The quality initiative has been ingrained in GE Multilin's culture since Multilin was acquired by GE in 1995. A Master Black Belt and various Black Belts lead the quality initiative in each GE business. They are responsible for training others in the 6-Sigma methodologies and also applying 6-Sigma tools on a daily basis in order to improve the overall quality of business processes. Over 80% of the employees have been trained in the quality initiative, over the past four years. More than 50% have been "green belt" trained, which means that the individuals

trained are now capable of not only applying the techniques learned in day-to-day activities, but are also capable of leading a team to improve processes and overall quality. GE expects that every employee will be green-belt trained by the year 2000. In addition, every “green belt” trained employee must complete at least one project per year contributing at least \$25,000 in saving or revenues per project.

Also present in the culture that evolved at GE Multilin is the sense of belonging to a team. A list of team values was created to clearly identify the key elements of GE Multilin’s culture and is used to guide actions, behavior, and decision making within and among the teams. The team values are as follows:

**Integrity**

- Conduct yourself with the highest standard of ethics personally and professionally.
- Conduct open and honest dealings inside and outside the company.
- Conduct fair and equitable treatment of employees, customers, suppliers, and all members of the community.

**Objectivity**

- Ask probing questions and investigate the issues to gain a thorough understanding of the matter at hand.
- Make a clear-eyed assessment of the facts, in a candid way, based on real data and information.
- Face up to difficult issues and act in a timely, appropriate manner.

**Communication**

- Engage in accurate and complete dialogues with all parts of the business involved in your decisions.
- Communicate in a timely fashion and maintain an open mind to all points of view.
- Encourage and support open and honest multi-directional communications.
- Encourage communication as a tool for conflict resolution and lead by example.

- Ensure your communications have an appropriate business focus, are clear and concise and are easily understood.

#### **Teamwork**

- Work together to reach common goals, believing that your individuality will add value to the team.
- Be responsible for your actions and relationships both within your core team and externally.
- Remain flexible and open to change, taking pride in everything you do.

#### **Innovation**

- Bring new methods and ideas forward to achieve more with less effort
- Maximize your creative thinking through involvement of others, diversity and experience.
- Use Six Sigma tools and simple processes to lead us to lasting solutions.

#### **Fun**

- Achieve a sense of accomplishment from achieving goals, as a team.
- Make a positive contribution to your team and recognize others for their contributions.
- Balance the demands of work with social, family, and community activities and involvement.

#### **High Performance**

- Produce consistently strong results through a focus on our customers and quality
- Constantly raise the bar on everyday performance, with a passion and quest for excellence.

### **3.5 Customers**

GE Multilin has a global customer base which varies from end users, Industrial or utility companies and organizations, to consultants working on behalf of the end-user. The particular customer's applications/requirements can range from protecting a hundred thousand dollar motor, to protecting power feeders and transformers in industrial and utility substations. A large majority of the customer base have engineering backgrounds

and are very knowledgeable in particular applications that the product will be used in, and can easily identify the specific requirements/functions needed. However, determining which product line and then selecting a particular configuration which best meets their requirements is a daunting task for many.

### **3.6 Organizational Structure**

To best meet the needs of its customers, GE Multilin's over 250 employees are divided between 9 main departments. Each department has its own team leader, with separate budgets and profit targets. The departments include:

- |                    |                                |              |
|--------------------|--------------------------------|--------------|
| 1. Administration  | 2. Engineering/Technology      | 3. Finance   |
| 4. Human Resources | 5. Information Management (IM) | 6. Marketing |
| 7. Sales           | 8. Service                     | 9. 6 Sigma   |
| 10. Manufacturing  |                                |              |

GE Multilin is managed overall by a President/Chief Executive Officer, who resides at the Markham location.

### **3.7 Sales**

GE Power Management's Sales Team is divided into two main areas: the internal inside sales team and the external sales team located across the globe. The inside sales team's main functions are to respond to inquiries from both customers and external sales representatives, generate quotes and process orders.

To support its large customer base and to promote continual growth, GE Power Management has established over 200 sales representatives located across the globe. With close ties to the Inside Sales team, the sales agents offer customers assistance in tailoring the implementation of GE Power Management's product line to their particular needs and requirements. The sales agents aid the customer in configuring the product to meet their particular needs and also partake in the quoting process.

### **3.8 Manufacturing**

Manufacturing's vision statement for the year 2000 and beyond is as follows:

*"To become the supplier of choice globally, as a result of our innovative and versatile products, which are defect free and reliable, delivered on request and supported by teams*

*of people who own their product(s) and care passionately about their customer's success".*

In order to achieve this vision, Manufacturing has put in place the following mission:

- to deliver perfect products
- to provide continued support of customer needs
- to meet customer request dates for delivery and support
- to operate effectively and deliver a competitive total cost
- to continuously improve its capabilities to support the business and all its customers
- to support our "team values" and take on rewarding challenges that develop excellence in ourselves

GE Multilin embraces a focus factory manufacturing model, which fosters the creation of self-managed work-cells, a team of individuals that have ownership over all responsibilities with respect to a particular product line. To meet each particular customer's needs/requirements, a make-to order model is used where each product is assembled and configured as per the customer's request. There are currently twelve work-cells at GE Multilin, with approximately 10-15 members per team. All members of the team are cross-functionally trained with regards to the various processes that are involved in the manufacturing of the particular product. Members of a work-cell include assemblers, technologists, product support engineers, and a work-cell leader. The assembling of the actual product is the main responsibilities of the assemblers, while the testing and inspection aspects of the process are the main duties of the technologists. The technical competence to support the product is a strength based on the individual knowledge and commitment of the product support engineer. The values, goals, and overall leadership that is instilled upon the team is the responsibility of the work-cell leader, who is also responsible for a wide range of duties such as scheduling, the creation of performance metrics, and customer relations. In addition to their every day duties and tasks, each and every work-cell member is also responsible for the continual improvement of the overall team performance. Thus, all members are encouraged to suggest, and aid in implementing, ideas that may increase productivity and work-cell performance.

### **3.9 Information Management**

The Computer Services department was founded in the early 90's in order to aid the growing staff with their computer needs and was later replaced by the Information Management Department in 1998. The Computer Services department was strictly focused on meeting user's requirements with regards to hardware and software needs, such as upgrading and servicing. Other responsibilities included policing user licenses and managing the Novell network structure from a centralized server room. As user numbers increased, it became increasingly difficult for the department to keep abreast of the ever changing user requirements. As a result of this, users both in the manufacturing work-cells and in the offices created and/or purchased their own programs/databases to aid them in their day-to-day jobs. The autonomous nature of the work-cells promoted a non-standardized approach of implementation with respect to the various databases and programs implemented.

As a result of increasing user requirements with respect to both computer related needs and information gathering, the Information Management/Information Technology department was formed in early 1998. The focus of the department was to be proactive with respect to user needs, rather than using a reactive mentality that was used by the Computer Services department. In addition the newly formed department would venture forth in areas where the previous department could not. The newly formed department was divided into 5 main teams: End-User Computing, Core Applications, Infrastructure, Special Projects, and Application Development.

The End-User Computing team uses a call-center approach to aid users in their day-to-day needs with respect to computer usage. Software and hardware upgrades are handled quickly and effectively. Unlike the Computer Services department, computer related repairs are handled off-site by a third-party company. The End-User Computing team is also responsible for policing user licenses across the over 550 computers located in the building. The Core Applications team is responsible for maintaining and supporting the core user applications such as Accpac (the order-ship-billing package used), and Clarify (the call center package used). The Infrastructure team is responsible for

maintaining and supporting the network structure. Currently the team has just completed migrating the Novell structure to Microsoft NT. The Special Projects team is mainly focusing on the Y2K issue and other miscellaneous projects. The Application Development team is mainly responsible for developing applications that streamline business processes. Projects undertaken include automating the order entry to manufacturing process, eliminating duplication of data entry in the business processes, and standardizing the many databases located in the work-cells. In addition, the team is also responsible for developing and maintaining both the company's Intranet and Internet sites.

### **3.10 New Product Introduction**

To meet the ever increasing requirements of a global market, GE Multilin is continuously developing new product lines by: improving upon previous product offerings, adding new capabilities and features, and taking advantage of the latest breakthroughs in technology. Their latest offering in product lines not only provides the customer with added features and functionality but also allows the customer to configure the product like never before. Previous products could be potentially configured in 8,000 possible manners, while the new product offering has more than 16,000,000 possible configurations. The benefit to the customer is that he/she will only be paying for the features and functionality that they actually require. Previously, the customer would purchase a product that usually had much more functionality than would ever be utilized. Thus, the customer would be paying for features that would never be used. Customers complained about this fact and GE Multilin listened when introducing this product line. The entire design of this new product revolves around the fact that it can be configured in a multitude of different manners in order to meet the specific user requirements. However, this amount of flexibility brings to light obstacles that were not encountered before. They include:

- the customer now must be more knowledgeable in selecting which configuration most suits his/her needs

- the Sales team must be knowledgeable in the multitude of possible configurations and their potential usage in order to aid the customer in selecting a product that most meets his/her needs
- the processing of an order will be more complex since the multitude of configurations being ordered must first be verified to ensure that they are indeed valid configurations that manufacturing can build
- The manufacturing of this product will be infinitely more complex than anything in the past

In order to overcome these obstacles the Sales, Manufacturing and Information Management departments have begun to work together. Their objective is to deliver a product that can be easily configured and manufactured, and that meets and/or exceeds customer expectations/requirements and is delivered on time.

## **4.0 Technical System Analysis**

The Technical Analysis will focus on the order entry to manufacturing information process flows at GE Multilin. In order to develop information process flows that will support the introduction of the new product line at GE Multilin, the current order entry to manufacturing information process flows will be analyzed in detail. In addition, key differences between the existing and new product lines will be identified and analyzed. The result of this analysis will lead to the identification of defects that may occur throughout the processes. A Variance Analysis Grid will then be generated and the key defects/ root causes, will be identified and analyzed. The results produced will aid both in the development and implementation of the new processes and aid in improving the existing ones.

It is important to note that all current products that can be ordered and manufactured at GE Multilin share the same information process flows. Although the manufacturing processes may vary depending on the product being manufactured, the information flows do not. All products share common information systems in both the order entry and manufacturing processes, and thus the information flows between systems are common for all products. Therefore a generic analysis will be conducted for both the order entry and manufacturing areas, with respect to the existing product lines. An overview of the information flow for both order entry and manufacturing, detailing the information systems used, can be seen in *Appendix 1*.

### **4.1 Overview of the Existing Order Entry Process**

The status of the current quoting and ordering processes have been identified by GE Multilin as being the third largest factor contributing to product returns and rework. Although the make-to-order model enables the company to meet the ever increasing user requirements, the current process also results in opportunities for error for both the customer and the company. The over 150 products offered by GE Power Management can all be configured in a multitude of combinations, sometimes ranging in the tens of thousand. This complexity can confuse the customer with respect to selecting/configuring the product properly to meet their particular needs. In addition, this complexity may also cause difficulties for the sales force in the quoting and ordering processes. The current process of

configuring a unit consists of either using the product catalog, product CD, or the Web to select the appropriate product and properly interpret a table describing the potential options that can be selected. An order code, an alpha numeric string, is manually generated by interpreting the table. Each character of the order code represents an option selected, and depending on the product, some options restrict the selection of other options or components. The order code is used to indicate to Sales what exactly the customer requires and at the same time indicates to Manufacturing how to build the product, i.e. how to configure the product. Since the order code varies in length and may range from 8 to 20 characters in length, manual data entry becomes a difficult task. If only 1 out of the 20 characters is incorrectly typed into the order entry system, the product will be configured incorrectly by manufacturing and will result in a product return, and thus customer dissatisfaction. In the current order entry process the order code is manually typed at least twice, at least once in the quoting process, and at least once in the order entry process.

#### **4.1.1 About the Order Code**

The order code generation process is a fundamental factor in the sales process. The order code tables are used by the customer, and the Sales and Manufacturing teams to aid them in the process of configuring the selected unit in the best manner possible to ensure that the customer's specific needs and requirements are met. The order code table displays the various options and configuration rules that pertain to each product. The tables are displayed in various documents which include the product catalog, the product manual, the product brochure, the product CD, documents on the intranet and on the Internet. The product support engineer is the "owner" of the order code table, since he/she is the only individual that can authorize a change to the order code. However, each document that contains the order code may be maintained by a different individual. For example the product catalog is created and maintained by the marketing department, while the product manual is created and maintained by the product support engineer. Another factor to note is that the frequency that the document is updated depends directly on the document itself. For example the product catalog is only updated once a year while the product manual can be up-dated at any time. This adds further complexity when attempting to synchronize the order code tables. The current process of updating the tables involves manually duplicating the original order code

table created by the product support in the various documents. It is important to note that the order code table cannot be easily ported over to the various documents due the fact that each document may be created in a different program. For example the product manual is created in Microsoft Word on a PC, while the product brochure is created in Quark on a Macintosh. This also increases the opportunities for error caused by manually re-creating the tables and related data. An example of an order code table is as follows:

**Figure 4.1.1: Order Code table for a MMII relay**

<b>MMII</b>	-	*	-	*	-	*	-	*
<b>MMII</b>								<b>Basic Unit</b>
	PD							Panel Mount with Display*
	P							Panel Mount without Display
	C							Chassis Mount (Black Box)
		1						<b>Option 1</b> : Process control, process input
			2					<b>Option 2</b> : Enhanced protection, power (kw)
				120				Control Voltage 120 VAC
				240				Control Voltage 240 VAC

Note: \* only available when both options are available

*Figure 4.1.1* illustrates the order code configuration for a MMII, an intelligent motor control center. An example of a MMII order code that can be generated with the use of *Figure 4.1.1* is: MMII-PD-1-2-120. The order code is made up of various sections separated with dashes. The first section represents the model type, in this case a MMII. The next section represents the panel types available. Three different panel types are available; a panel mount with display identified in the order code as a “PD”, a panel mount without display identified as a “P”, and a chassis mount identified as a “C”. The “\*” located in the description field beside the “PD” indicates that special rules/restrictions are required to be abided by in order to configure the unit properly when selecting “PD”. In this case the “\*” signifies that the “PD option is only available when “option 1” and “option 2” are both selected. This particular rule is explained at the bottom of the order code table, seen in Figure 4.1.1. The next section describes an option that can be selected if required. In this case it is a “process control” feature, represented by a “1” in the order code. If this option is not selected this section is left blank in the order code. Thus an example of a MMII order code without option 1 is: MMII-P-2-120. The next section represents the second option available, in this case an

“enhanced protection” feature. As in the previous section, since this is an option, if not selected this section is left blank in the order code. An example of a MMII order code without option 2 is: MMII-C-1-120. The last section represents the various control voltages that are offered. In this case there are only two.

Other product order codes may have more complex rule sets associated to them. These rules are usually represented by a brief description located underneath the order code table.

It is important to note that the manner by which the order code is generated with the use of the table is a very manual process. Usually a customer or sales agent has a copy of the order code table in one hand and the brochure/product catalog in the other. As the order code is being created, conforming to the standard displayed in the table, the brochure or catalog is used to aid the selection of various options by reading the detailed descriptions. Thus, generating a valid order code that meets specific customer requirements may be a difficult and time consuming task.

## **4.2 Analysis of the Order Entry Information Process Flow**

To thoroughly understand the inner-workings of the information flow with respect to the order entry process at GE Multilin, an information process flow diagram must be created and analyzed, as shown in *Appendix 2*. By analyzing the system, key factors contributing to defects/errors can be identified and later improved. The information process flow of the order entry process is as follows:

1. Quotation Requested & Generated
2. Customer submits Order
3. Order Received & Information Verified
4. Order Entered into Order entry System
5. Confirmation of Order

### **4.2.1 Unit Operation 1 - Quotation Requested & Generated**

#### **Input**

The customer can use a variety of methods to gather the necessary information that can then be used by the sales team to generate a quote. The customer can either use the

product catalog, the product CD, visit the Web Site, or speak to a sales agent to collect the necessary order code information. Depending on the knowledge that the customer has with respect to the product and the application that the product will be used in, the customer can configure the product his/herself and produce an order code. Otherwise the customer can either call or e-mail Inside Sales or a sales representative in order to receive help in configuring the product to fit their particular needs/requirements. Nevertheless, the input is the information required by the sales team to generate a quote, which includes a valid order code, quantity, and required ship date. The information can be sent to either a sales representative/agent or to Inside Sales by fax, e-mail, or phone.

### **The Process**

Once a customer requests a quote, the Inside Sales team or a sales representative ensures that the order code is valid, signifying that the configuration request can be built by Manufacturing. Occasionally this requires a phone call to be placed to a Product Support Engineer who can verify that the configuration is indeed feasible. Once this is determined an Excel spread sheet, located on the network, is used to determine the correct pricing for the particular configuration requested. A sales member manually compares the order code sent by the customer to the breakdown listed on the Excel spreadsheet and manually adds the necessary options to the base price. Depending on the customer, a discount schedule may be used in the quoting calculation. If a sales agent is quoting the customer, an old version of the Excel spreadsheet may be used, thus requiring the Inside Sales team to re-check the quote once it is sent in. An Inside Sales personnel then evaluates whether the ship date requested is feasible. This is performed by identifying how many orders for that specific product are currently requested for that particular ship date. This process involves analyzing a calendar placed in a central location and manually writing the number of units/products required for that particular day and the product type. If the orders for that particular day exceed the capacity indicated by the work-cell leader for that product line then another ship date must be provided to the customer. A Word document is then used to generate the quote and it is then sent to the customer. The format of the quote sent to the customer is not standardized, thus the look and feel of the quote may change depending on who generates the quote.

## **Output**

The output is a quote that is sent to the customer.

### **4.2.2 Unit Operation II - Customer Submits Order**

## **Input**

The primary input is the information contained in the quote that the customer receives and approves.

## **Process**

The customer reviews the quote and then determines whether to proceed to the ordering process. If the customer does decide to order the product then the customer can either acknowledge and approve the quote or make modifications to the original quote and resend it in for verification. The customer must also select a method of payment, either via P.O. or credit card. If the customer is a “first time buyer” then a credit check is necessary if the payment method chosen is via P.O.

## **Output**

The output is all the necessary order information, including payment method, that is sent to Inside Sales, or a sales agent who will then route the information to Inside Sales.

### **4.2.3 Unit Operation III - Order Received & Information Verified**

## **Input**

The primary input is the ordering information that is sent to Inside Sales either by fax or letter, by either the customer or a sales agent. To begin the order process, the order request must contain all required pieces of information. Examples of required information include “bill to” and “ship to” addresses, date required, full order code, quantity, and price. A “GE Multilin Purchase Order Checklist” identifying the required information, shown in *Appendix 3*, can be downloaded from the Web site and can aid in ensuring that the purchase order/order request sent in contains all the essential pieces of information.

## **The Process**

All purchase orders sent to GE Power Management are routed to the Inside Sales Department at GE Multilin. Purchase orders are verified by an Inside Sales person by manually checking whether or not all required pieces of information have been delivered. If information is missing or incorrect, the respective customer or sales agent is contacted in order to complete the purchase order. For example if an order code is invalid, signifying that the configuration ordered does not exist, the inside sales team contacts the agent/customer and aids them in creating a valid order code. Again a Product Support Engineer may be required to intervene in order to verify the validity of the particular configuration. The method of payment is then verified and a credit check may be required. This process usually involves contacting a member of the Finance Department. If the purchase order is complete, the sales agent or customer is usually contacted to verify the order. Instances where the order code is valid but not necessarily what the customer actually intended to order are usually identified with this final call to the customer/agent.

## **Output**

The output for this unit operation is the information contained in a verified order request. All order requests are then given to the appropriate Inside Sales personnel to start entering the information into Accpac, the order-ship-billing system.

### **4.2.4 Unit Operation IV - Order Entered Into Order Entry System**

## **Input**

The input to this unit operation is the information contained in the hard copy of an order request that has been verified by the Inside Sales team. All hard copies of the order requests are given to the appropriate person to await manual entry into Accpac.

## **Process**

The information contained in each order request is manually typed into the order entry system. If the customer has never previously conducted business with GE Power Management before, all customer information is required to be entered into the Accpac customer master file. In addition, a reference and credit check are required to be performed before the order is entered into the system. There are three main screens in Accpac that Inside

Sales uses to enter the order related information. The first screen provides the user with the ability to enter the specific customer number, which is then used by the system to reference the information contained in the customer master file. Thus all customer related information such as company name, address, and contact information is automatically filled out by the system. Ship to, ship via, and other shipping information is entered into the second screen, while all product information, such as order code, quantity, and item number, is entered into the third screen.

Certain pieces of information are more complex and are potentially prone to more opportunities for error than others. For example, compare entering the ship date to entering an order code. The ship date is entered in the following format m/dd/yy, such as 1/25/98, while the order code can be more than 15 characters in length, such as 269-PLUS-W-100P-120VAC. Due to the amount of characters and complexity of the order code, it is one of the pieces of information more prone to error. This point is illustrated clearly in the pareto chart , *Appendix 4*, illustrating defects attributed to data entry on the behalf of the sales team. The more complicated and lengthier pieces of data are the ones more prone to data entry errors. Once all the information has been entered, a job number is automatically assigned by the system uniquely identifying the order.

It is important to note that once a job has been entered into the order entry system, there is no mechanism stopping someone else from entering the same job again. Thus, the job can be entered again by another sales personnel, not knowing that it has already been entered, thus duplicating the job. This sometimes occurs when the sales agent sends in a job request and the customer that the sales agent is representing also sends in the same job request. Duplicating a job in the order entry system may result in manufacturing duplicating the order.

Also important to note is that occasionally customers and/or sales agents contact the Inside Sales department to make changes to an order that was recently submitted. By providing the Inside Sales team with the corresponding Job number, Manufacturing is contacted to ensure that the order has not been already completed, and to advise them that changes are being made to the specific order. A special code is then entered into Accpac by the Inside Sales team, which is used by manufacturing to identify “changed” orders.

## **Output**

The output is the order related data stored in the order entry system. The data resides in the Accpac system and can be retrieved by either the Sales or Manufacturing team in electronic or hard copy format.

### **4.2.5 Unit Operation V - Confirmation of Order**

## **Input**

The input is the order related data that has been entered into Accpac. Reports can be created from the data entered through the use of the reporting function found in Accpac.

## **Process**

An Inside Sales person prints an order confirmation report which contains all the order information entered previously. This is then faxed to the customer/agent to again verify the order and to signify that the order was successfully processed. If the customer does not respond back in a certain amount of time, the order is automatically deemed correct and passes the order entry stage. The order is then flagged as being entered completely into the system, thus allowing Manufacturing to view the order.

It is important to note that once a sales person is in the process of printing or viewing the order confirmation report in Accpac, they are locking out everyone else from viewing the job in Accpac and from exporting the details of that job from Accpac. Thus, it is important for anyone printing the order confirmation report to understand this fact and quickly exit the details screen once their task is completed. This makes it necessary for new employees using the system to be trained in the proper usage of the system.

## **Output**

The output is an order request that has passed the verification stage and is entered into the order entry system allowing it to be viewed by the respective work-cell.

### ***4.3 Key Differences between the Existing and New Product Lines***

There are three main differences between the new product line and the existing product lines worth noting with respect to the order entry process.

The first main difference between the existing and new product lines is the length of the order code itself, as seen in *Figure 4.3.1*. The length of the new product line may range from 35 to 70 characters in length in comparison to the existing product lines which range from 8 to 20 characters. Thus it is apparent that manual data entry becomes an even more difficult task since the number of characters that must be correctly typed has more than tripled. Again it is important to note that even if just one of the 35 to 70 characters is incorrectly typed into the order entry system, manufacturing will be building a product that does not meet the customer's needs and specifications.

The second main difference is the number of possible configurations, with respect to the order code, between the existing and new product lines. For the existing product line, the average number of configurations per product are in the hundreds. For the new product line the number of configurations per product may range from just over a million to over eighteen million unique configurations. With respect to the order entry process, this increases the already existing problem of validating whether or not the order code submitted is indeed a configuration that Manufacturing can build.

The third main difference is regarding the modularity between the products in the new product line. Existing products are very much different from one another. A power supply for one product in the existing product lines may not be compatible with another product. However the new product line is modular based, thus signifying that the same power supply, CPU, digital input outputs, digital signal processors, analog input/outputs, and communication modules are compatible within the various products. This causes added complexity in ensuring that the order code tables are up-to-date when portrayed to the customer. With over 10 different products in the new product line, changing one module description requires manual changes to ten order code tables. Instead of just changing one description, which would be the case in the existing product lines, 10 descriptions must be changed and ensured that they are accurate. It is also important to note that the order code table may be recreated manually several times, once in the product catalog by a marketing person, once in the product manual by a product support person, and once in the product CD, Intranet and the Internet by an IM person. Thus the opportunities for error with respect to updating the new order code increases dramatically.

### 4.3.1 About the Order Code

An example of a product that belongs to the new product line being introduced is an L90, a Line Differential relay. The order code structure can be seen in *Figure 4.3.1*.

**Figure 4.3.1: Order Code table for a L90 relay**

<b>ORDERING</b>		<b>L90 - *00 - HCH - F8A - H** - L** - N** - S** - U** - W**</b>									
Base Unit	L90										Base unit
CPU	A C D										RS485 + RS485
Software Options	00										RS485 + 10BaseF (MMS/UCA2 and ModBus <sup>®</sup> TCP/IP)
Mounting		H									RS485 + Redundant 10BaseF (MMS/UCA2 and ModBus <sup>®</sup> TCP/IP)
Faceplate			C								No software options
Power Supply				H							Horizontal
CT/VT					8A						Faceplate with keypad and display
Digital I/O						6A	6A	6A	6A	6A	125/250V
						6B	6B	6B	6B	6B	Standard 4CT/4VT
						6C	6C	6C	6C	6C	2 Form-A, 2 Form-C, 8 digital inputs
						6D	6D	6D	6D	6D	2 Form-A, 4 Form-C, 4 digital inputs
						6E	6E	6E	6E	6E	8 Form-C outputs
						6F	6F	6F	6F	6F	16 digital inputs
						6G	6G	6G	6G	6G	4 Form-C, 8 digital inputs
						6H	6H	6H	6H	6H	8 Fast Form-C outputs
						6K	6K	6K	6K	6K	4 Form-A, 8 digital inputs
						XX	XX	XX	XX	XX	6 Form-A, 4 digital inputs
											4 Form-C, 4 Fast Form-C
Inter-Relay Communications:											No Module
											7A 820 nm, multi-mode, LED, 2 Terminal
											7B 1310 nm, multi-mode, LED, 2 Terminal
											7C 1310 nm, single-mode, ELED, 2 Terminal
											7D 1310 nm, single-mode, LASER, 2 Terminal

*Figure 4.3.1* illustrates the order code configuration for an L90, a line differential relay. An example of an L90 order code that can be generated with the use of the table is: **L90-D00-HCH-F8A-H6B-L6G-N6D-S6K-U6B-W7A**. The first three characters indicate the product type. The next character, “D”, indicates the CPU type which in this case is an RS485+Redundant 10BaseF. The next two characters, “00”, indicate the software options. The next three characters, “HCH”, indicate the mounting type, faceplate type, and power supply type respectively. The rest of the order code describes the particular modules selected and the particular slot where they are located in the chassis. For example “F8A” refers to an 8A module, in this case a particular digital signal processor, located in slot F of the chassis. The “H6B” refers to a 6B module, in this case a particular digital input output, that is located in slot H of the chassis. The rest of the modules can be interpreted in the same manner.

#### **4.4 Overview of the Manufacturing Information Process Flow**

The manufacturing environment at GE Multilin consists of twelve work-cells, with approximately 10-15 members per team. With the exception of the new product line being introduced, whose work-cell will eventually be responsible to produce over 10 different products, each work-cell manufactures/assembles approximately one to two different products each. Thus, although the Manufacturing processes will vary between work-cells due to the fact that the products vary, the information process flow will not. Each existing work-cell shares a common information process flow and thus also shares the same information systems, which include Accpac: the order-ship-billing system, Convert: the job reporting system, Auto-label: the serial number and label generating system, POURS: the point-of-use-replenishment system, the Test-Rig software program: used to store and retrieve necessary information and to test the unit, the Repair database: used to store the various defects identified during the Manufacturing process, and the Job Release system: used to indicate to the Shipping department when to pick up the finished units. Thus the flow of information between these systems is common for all work-cells and this is the area of analysis which the next section will focus on.

#### **4.5 Analysis of the Manufacturing Information Process Flow**

To thoroughly understand the inner-workings of the information flow with respect to the manufacturing processes at GE Multilin, an information process flow diagram must be created, as shown in *Appendix 5*. By analyzing the system, key factors contributing to defects/errors can be identified and later improved. The information process flow of the Manufacturing process is as follows:

1. Generating the Orders Report
2. Scheduling the Orders
3. Generating the Order Confirmation Report
4. Generating the Auto-label
5. Auto-label Verification Process
6. Assembling the Unit

7. Testing the Unit
8. Closing the Job
9. Repairing the Unit

#### 4.5.1 Unit Operation I - Generating the Orders Report

##### Input

The input is the order related data that has been entered into Accpac by the Inside Sales team.

##### Process

Every morning and every afternoon a work-cell member runs the “orders” macro in Accpac, which exports all open order information entered by the Sales team into a text file that is accessible through the network by all work-cells. The text file is comma delimited and contains all the open orders for the entire company. To properly run the macro, no other user can be viewing any of the particular work-cell’s open order details in Accpac. If someone is viewing the details of an open order, for example a Sales member, the text file generated will not contain the order information being viewed. It is important to note that once the text file is generated, it replaces the previous file located on the network.

The next step involves running a Fox Pro program, called “Convert”, that parses the “orders” text file and creates a report for each of the individual work-cells. The report contains all of the open orders for each of the respective work-cells and can be customized to highlight late shipments, shipments due today, new orders entered since the last printout, and any orders that have been edited/changed. Once the report is generated it is then printed so it can be used for scheduling purposes. If the macro is not run properly, the resulting report will not display all the jobs for the particular work-cell. In addition, not all work-cells are under the impression that running the macro on a daily basis is necessary, although they do run the Convert program regularly. This may be due to the fact that the Convert program does not indicate to the work-cells that the text file being used does not contain the latest up-to-date information. Therefore, the relationship between the macro and the Convert program is not well understood. If the text file is not updated by running the macro, the program will use the previous file and will generate an out of date report, unknowingly, to the work-cells.

### **Output**

The output is a hard copy report detailing all the open orders for a particular work-cell.

### **4.5.2 Unit Operation II - Scheduling the Orders**

#### **Input**

The input is a hard copy report, generated by the Convert program, containing all open orders for the particular work-cell in question.

#### **Process**

The information contained in the printed hard copy of the open orders is the primary aid in scheduling jobs. The open orders report is analyzed to provide the following information: jobs that are due in the near future, jobs that are late, and new jobs recently entered into the system. This information provides the work-cells with sufficient information to make pertinent decisions with regard to kanban sizes, the need to schedule overtime, regular reporting information and more importantly scheduling the jobs to be completed by the end of the day/week. In order to make proper decisions, it is highly essential that the information presented in the report be accurate. Jobs that are selected to be completed are usually manually highlighted and finally crossed off the report when the Manufacturing process has commenced. Missing information can easily lead to late jobs, ultimately leading to a decrease in customer satisfaction.

#### **Output**

The output is the selection of jobs that are deemed to be high in priority to be completed.

### **4.5.3 Unit Operation III - Generating the Order Confirmation Report**

#### **Input**

The input is the information regarding the jobs that were identified as having high priority to be completed.

## **Process**

Once the jobs have been selected to be worked on, an order confirmation sheet, the same that the customer receives, is printed from Accpac and provides the work-cells with all the information required to start the manufacturing process. To print the report a work-cell member must perform the following steps in Accpac: select order invoice menu, select print order confirmation, select edit, enter the Multilin job number twice, and modify the last job number entry field. This process must be completed in order to print each order confirmation report.

The report contains essential information such as ship to and bill to addresses, customer P.O., payment terms, order date, ship date, item number, accessories, comments, quantity, and the full order code. The report essentially informs the work-cells with regards to what exactly they are building and who they are building it for.

## **Output**

The output is the information pertaining to what exactly is required to be built in order to fulfill the order.

### **4.5.4 Unit Operation IV - Generating the Auto-label**

#### **Input**

The input is the order related information contained in the order confirmation report.

#### **The Process**

The order confirmation report is used to identify which product type will be built and also aids in entering data into the Auto-label program. Depending on the product type, the user selects which Auto-label form to use. This is a manual selection which is directly dependent on the product type selected to be manufactured. Once the proper form is selected the information contained in the order confirmation report is entered manually into the system, such as Multilin job number, customer name, customer P.O., scheduled ship date, tag #, quantity, order code and options. The order that the information is presented in each order request does not necessarily match the order in which the information is entered into the system. Therefore this entails that some time must be spent searching for the information before it is manually entered. Once the information is entered, an Auto-label is produced for

that specific product type being manufactured, as seen in *Appendix 6*. The Auto-label consists of three major components, the labels that are placed on the unit, the shipping labels, and the “job card”. The information that was manually entered is used to fill out the information on the labels. The Auto-label program also stores all the information entered into the appropriate database and provides each Auto-label created with a unique serial number, thus each unit manufactured will have a unique serial number. It is important to note that the user has to manually check whether the serial number has been incremented correctly. No automatic check exists to verify whether the serial number created is unique. For a large number of orders the data is entered once and the program increments the serial numbers for each subsequent unit in the order, maintaining the same order related information for all the Auto-labels produced thereafter. Thus for an order of a twenty units that are configured exactly the same and contain the same customer information, the order related data must only be entered once.

It is important to note that each work-cell has their own Auto-label program, their own forms, and their own databases to maintain. Although the information that is stored in the databases are very similar from work-cell to work-cell, the database format has not been standardized. Therefore, work-cell A may name the serial number field in their database “sn” while work-cell B may call it “serialnum”. The importance of this fact is that performing reporting functions from several work-cell databases becomes a difficult task due to a lack of standardization in their database field names. Also the databases created do not all follow normalization rules and are not indexed properly making querying a time consuming process. Also, there is no documentation regarding how and why a particular form was created in a specific manner. Therefore duplication in the form calculations may occur when a work-cell member inherits the form from someone else.

The job card, a component of the Auto-label, is used as a record for the work-cell containing pertinent information such as the job number, order code, firmware revision, serial number, and customer information. Other pertinent information is manually recorded on the physical job card throughout the manufacturing process.

### **Output**

The output is a completed Auto-label which contains all the unit and customer related information and also contains the job card which is essential in the manufacturing process. In addition, the output is also the related unit information that is stored in the database. The unit information can be extracted by querying on the unique identifier which in this case is the unit serial number.

### **4.5.5 Unit Operation V - Auto-label Verification Process**

#### **Input**

The input is the Auto-label itself containing the unit specific information and the job card.

#### **The Process**

The first Auto-label of each order is printed and then inspected for validity by comparing it to the information presented in the order confirmation report. Information such as order code, job number and customer information is manually inspected to ensure that they are identical. The order in which the information is presented in the Auto-label does not correspond to the order that the information is presented in the order confirmation report. Therefore this entails that the user must search for the information when attempting to compare the two. In addition to data verification, the print out is also checked to ensure that the actual labels are free from defects. Occasionally the text that is printed is outside the actual label boundaries, and is one example of a defect. The entire verification process is handled by visual inspection. If a defect is discovered, the defect is corrected. If the defect is an incorrect piece of information, the data can be retyped and a new Auto-label can be generated.

#### **Output**

The output is a verified Auto-label and verified information related to a specific unit that is stored in the database.

#### **4.5.6 Unit Operation VI - Assembling the Unit**

##### **Input**

The input is a verified Auto-label and verified information related to the specific unit which is stored in the database.

##### **The Process**

It is important to note that there are multiple of manufacturing processes within this unit operation. The manufacturing processes vary depending on the work-cell and the product being manufactured. However, the information process flows for “assembling the unit” remain consistent between work-cells and is the focus of this analysis. Therefore the manufacturing processes within this unit operation will only be highlighted to aid in providing clarity and understanding to the information process flows for this unit operation.

Since the work-cells follow a “make to order” philosophy, the order code is essential in indicating what exact configuration of the unit is required to be built. The Auto-label provides this information. Depending on the configuration, the particular process sheets are selected to aid in picking the correct parts and in properly assembling the unit. Since each work-cell contains multiple work stations that are specific to each task, with regards to building the unit, the process sheets specific to each task can be found at the respective work stations.

The Auto-label travels with the unit as it is being assembled from workstation to workstation. To thoroughly understand the process lets take a look at a real-life example: building a 269 unit. Once the Auto-label has been generated it is then given to the personnel responsible for the next manufacturing process, which in this case is the “preparation for calibration” stage. There the individuals responsible for this task identify the particular configuration required and select the proper process sheets to aid them. Using the correct process sheets, they then pick the corresponding parts and assemble the components that are identified. The Auto-label is used twofold, to provide the necessary labels for this stage that are placed on the parts assembled, and to record the full name of the individual that completed this process step and the individual that inspected the work performed. The date that the work was performed and inspected is also recorded on the job card. The next process step, for building a 269, is “assembling the faceplate”. The Auto-label for this particular unit,

containing all the information manually recorded on the job card from the previous stage, is then given to the personnel working at this workstation. Using the information present on the Auto-label the appropriate process sheets are selected, the correct parts identified and picked, and the faceplate is assembled as indicated from the process sheets. The required labels are peeled off the Auto-label and placed on the unit as specified by the process sheets. Once the faceplate is assembled correctly the individual(s) record their name(s) and date on the job card. The individual responsible for inspecting the work performed also records his/her name and the date inspected. This is then repeated for the other process steps until the testing process is reached. It is important to note that the Auto-label, including the job card, travels along the various process steps, collecting the necessary information regarding who was responsible for each step and who inspected the corresponding work.

It is important to note that there may be multiple units flowing through the work-cell at any point in time. Each unit is accompanied with its corresponding Auto-label. However, there is a potential for Auto-labels to be misplaced, thus an Auto-label intended for unit A may be accidentally placed on unit B. Depending at what process stage this occurs, the unit may be incorrectly built. Although these errors are often discovered at the testing stage, the time required to repair the unit may delay the shipment, thus resulting in unsatisfied customers. The work-cells use a kanban system to replenish the parts used. All parts used in assembling the units are picked from shelves located at the perimeter of each work-cell. The parts are stored in bins which each contain a removable identifier, containing the part number and bar-coded part number. A trigger to replenish the bins is sent to the Warehouse department when the bins reach a certain level, with respect to the parts they contain. Once a bin reaches a certain level, the identifier is used to scan the part number into the Warehouse system, which is in the form of a mobile bar-code reader. The bar-code reader saves the part number into memory, and twice a day the part numbers are downloaded to the POURS (point of use replenishment system) located in the warehouse department. Suppliers utilize POURS in order to know when to replenish the various parts they supply. Once the parts are received from the supplier, the bins are then brought to the respective work-cell.

## **The Output**

The output is an Auto-label containing a job card with additional information recorded on it, detailing work-cell members responsible for the various processes completed. The unit is now ready for the testing stage.

### **4.5.7 Unit Operation VII - Testing the Unit**

#### **Input**

The input to this stage is the unit itself, and most importantly the information contained on the Auto-label, and more specifically on the job card.

#### **The Process**

The individual responsible for testing the unit examines the job card to ensure that the unit is ready for testing by determining whether the previous processes have been completed. Once the unit has been deemed ready the unit is placed in the Test Rig. Depending on the type of Test Rig, the individual either manually types the necessary information into the software program or uses the serial number of the unit to extract the information from the Auto-label database, thus automating the data-entry process. Key pieces of information necessary include the serial number itself, order code, date manufactured, and firmware revision. The Test Rig programs the corresponding unit with this information. This allows the end-user to determine the configuration of the unit without disassembling the unit. Once the information has been entered, the unit is tested. The various tests performed on the unit directly depend on the product type. At the end of the test, the test-rig prints a test sheet which identifies which tests the unit has passed and failed. If the unit passes all the necessary tests, it continues to the next manufacturing stage which is pack-up, if not the unit is sent to the repair station. The name of the individual(s) that performed the tests and the date the tests were performed are then recorded on the job card.

#### **The Output**

The output of this unit operation is the Auto-label, containing information regarding who performed the test and when, and the test sheet, containing information regarding the tests performed.

#### **4.5.8 Unit Operation VIII - Closing the Job**

##### **Input**

The input to this unit operation is all the information collected throughout the manufacturing process with respect to the particular unit being built. The Auto-label database, the job card, and the test sheet contain the majority of the information collected throughout the process.

##### **The Process**

Once the unit has passed the final manufacturing process, the “pack-up” stage, where the unit, instruction manual, and necessary software are placed in a shipping box, the last of the labels from the Auto-label are placed on the shipping box. The job card is then peeled away from the Auto-label and placed on the back of the test sheet, creating a report containing all the information collected from manufacturing the unit. This is then stored in a filing cabinet within the work-cell. The Auto-label itself is then considered scrap. The serial number of the unit, which can be read from the shipping label placed on the box, is manually entered into Accpac, to indicate that this particular unit has been completed. The serial number of the unit is also manually entered into the job release database indicating that the unit has been completed. By entering the unit into Accpac, Accounting uses this as a trigger to invoice the customer. By entering the information into the Job Release database the Shipping department uses this as a trigger to know when to pick up the unit(s) from the work-cell. In addition the information entered into both systems is used to perform various reporting functions.

It is important to note that for both the Accpac and Job Release system, an individual from the work-cell must type the serial number of the unit into both systems. A tendency occurs to enter all unit serial numbers into both systems only once the entire job has been completed. Only once all the units for a particular job have been completed do either the Shipping or Accounting departments perform their respective duties. Since some jobs may contain over 200 units, over 200 serial numbers must be manually entered into both systems. No verification regarding whether the serial numbers have been entered correctly occurs in either systems. In addition, no verification regarding whether all necessary serial numbers have been entered ever occurs. If all the serial numbers have not been entered, both systems

do not consider the jobs closed since they compare the number of serial numbers entered to the number of units that were ordered for that particular job. Thus this will delay both the invoicing of the job and the shipment itself.

### **The Output**

The output to this unit operation is the information contained in the Auto-label database regarding the unit itself, the information contained on the test sheet and job card regarding the tests performed and individuals that were involved in the manufacturing process, and the information contained in both the Accpac and Job Release System indicating that particular job has been closed. The data stored may be used for reporting functions and may also be invaluable when and if the unit returns from the field for upgrades or for repairs.

### **4.5.9 Unit Operation IX - Repairing the Unit**

#### **Input**

The information contained on the Auto-label and the Auto-label database is the input for this unit operation.

#### **Process**

During any of the processes involved in manufacturing the unit, the unit may be required to be sent to the repair station. This may be due to the unit failing visual inspection, due to damage to components during assembly, or the unit failing the tests conducted. Once the unit is brought to the repair station, a non-conformance tag is issued. The non-conformance tag is brightly colored, and placed on the unit making it easily distinguishable from working units. A repair person copies several key pieces of information from the Auto-label to the non-conformance tag such as job number, order code, ship date, type of problem discovered, date the problem was first identified, and by whom the problem was identified by. The unit is then placed on the repair shelf until a repair personnel decides to investigate the issue further. Once the problem is investigated further and a solution is determined the information including the solution itself and the individual responsible for repairing the unit is either entered manually in the repair database or stored on a repair sheet and filed in a cabinet.

A majority of work-cells have abandoned the use of the repair database since they claim “it takes too long to enter all the information it requires, and most of the information it requires is irrelevant and redundant”. Therefore the majority of work-cells manually record the information on a repair sheet and then file the information in a filing cabinet. This method has certain constraints since it becomes very difficult to answer questions such as how many units have failed test A, or how many units have failed due to irregularities in parts C and D. Storing the repair information on sheets of paper eliminates the possibilities of finding patterns in failed units and also makes reporting a very manual, and time-consuming task. The use of a database would allow users to query on the data stored and could automate the reporting functions. However, since the current database requires the user to re-enter most of the information stored in the Auto-label database plus extra information, and its reporting and querying features are limited and difficult to use, most users have deemed it as “not a worthwhile tool to use”.

#### **Output**

The output of this unit operation is the information pertaining to the root cause of the failure and how the problem was solved. The information may either be in electronic or hard-copy form, depending on the specific work-cell.

#### ***4.6 Key Differences between the Existing and New Product Lines***

There are three main key differences between the new product line and the existing ones worth noting, with respect to the manufacturing information process flow.

The first main difference is the number of products that the new work-cell will be responsible for manufacturing and assembling. The average number of products per work-cell for an existing product line is one to two. The new work-cell will be responsible for over 10 products. Thus this entails that the new work-cell will have an increase of volume of orders in comparison to an existing work-cell. In order to meet the customer’s required delivery dates without increasing the normal work-cell staff count, it will become increasingly important to streamline the flow of information and reduce unnecessary re-work. Reducing time spent in data-entry, searching for information such as the correct process sheet, figuring

out which parts to pick, will become crucial if the customer's expected delivery date is to be met.

The second main difference is the added complexity contributed by the increase in the number of possible configurations, with respect to the order code. This will have a significant impact in the assembly process. An increase in configuration combinations also increases the number of process sheets that must be available to choose from, which is currently a manual process. Using an incorrect process sheet will result in assembling an incorrect product. In addition, the number of parts that must be selected from, also increases in comparison to an existing product, potentially increasing the cycle time in assembling the product. Also, the current assembly process lacks a validation process with respect to whether or not the correct parts were selected and assembled properly. With millions of possible configurations, selecting the correct parts and assembling the parts correctly becomes a very difficult and daunting task.

The third main difference is the length of the order code. The length of the new product line may range from 35 to 70 characters in length in comparison to the existing product lines which range from 8 to 20 characters. This will increase the opportunity for errors with respect to data entry. In addition this also complicates matters when deciphering the order code in an attempt to understand what exactly is required to be built. Due to the modularity of the new products, over 9 different components/modules may be required to be assembled in order to build a single product. For example, an order code such as: L90-A00-HCH-H6A-L6B-N6D-S6H-U6J-W7A requires a cpu module of type "A" to be assembled, a chassis to be assembled in the "Horizontal" mounting position, a "C" type faceplate to be assembled, five different digital input/outputs to be assembled of types "A", "B", "D", "H" and "J", and a communications module of type "A". The order code also identifies the slot positions that the modules must be placed in the chassis. In addition, these components/modules must be assembled in a particular manner to produce the final product.

#### ***4.7 Variance Control Analysis***

The process variances within each unit operation were identified using the information gathered in the order entry and manufacturing analysis, the technical interview

questionnaires and information process flow diagrams, as seen in *Appendix 7*. As a result, several key variances were identified. After identifying the key variances, information on the severity and consequences of their occurrences were identified, as seen in *Appendix 8*. This information refers to where and how the key variances occurred and who detected them. In addition, the analysis conducted regarding the key differences between the existing and new product lines was also used to aid in identifying the variances that will have a greater impact with respect to the information process flow of the new product line being introduced. Thus, twelve key variances were identified through the technical system analysis based on criteria of the number of future impacts, and/or their potential severity from a financial, quality, on-time delivery, accuracy of reporting, and customer satisfaction perspective. The twelve key variances are as follows:

N.B.: (number indicates actual variance number)

- Incorrect Order Code Table Displayed in Documents (1)
- Incorrect Order Code Generated as per Customer's Requirement (2)
- Incorrect Price Calculations (4)
- Incorrect and Infeasible Ship Date Calculations (5)
- Incomplete and Incorrect Manual Data Entry (Accpac) (15)
- Improper verification of Job Entry to System (17)
- Incorrect Usage of the Accpac Reporting Tool (19)
- Incorrect and Improper Usage of the "Orders" Macro and "Convert" Program (21)
- Incomplete and Incorrect Manual Data Entry (Auto-label) (26)
- Improper Database Design and Standards (30)
- Improper Interpretation of the Order Code (38)
- Incomplete and Incorrect Manual Data Entry (Test-rig) (46)
- Non-Standardized data Collection Method (57)

These variances were highlighted due to their systematic influence on other variances within the current information process flow and potential influence on the new product line's information process flow which could possibly contribute to several or all of the following; a

degradation in the quality of the product being manufactured, rise in costs, a decrease in on-time delivery, a degradation in the accuracy of reporting, and a decrease in customer satisfaction.

#### 4.7.1 Quotation Requested and Generated

N.B. (first number indicates the variance; subsequent numbers indicate the variances affected)

- **Incorrect Order Code Table Displayed in Documents** (1: 2, 3, 7, 9, 10, 11, 14, 15, 20, 22, 25, 26, 27, 33, 35, 38, 39, 40, 43, 46, 48, 50, 62, 63, 64, 66)

This variance describes the current difficulty in ensuring that the over 150 order code tables are up-to-date and correct in all the various documents that they are displayed in. The order code tables are displayed in the product catalog, product manual, product brochure, and other documents located on the Intranet and Internet. Due to the fact that the order code tables may be incorrect and not up-to-date the order code created as a result of these tables may not meet the customer's needs and requirements (2). Since the order code generated may be incorrect an incomplete and invalid quote may be created (3). Since the quote may be invalid and incorrect the customer may need to make modifications to the quote generated by the sales team (7). In addition, the quality of the order verification (9) and order code validation (10) process may suffer since it may be difficult to identify the fact that the order code is incorrect and invalid. Even once identified it may be difficult to correct the mistake without a significant time delay associated with re-contacting the customer. The quality of the price validation may suffer as well since it may be difficult if not impossible to confirm a price to an invalid order code (11). In addition the quality of the customer's order verification process (14) will suffer if the order code is incorrect and invalid, since even if the error is identified the entire order code generation process must be redone. Also an incorrect and invalid order code will directly impact the quality of the data entry process. Even if the order code is manually entered correctly an invalid and incorrect order code would still be stored on the order-ship-billing system (15). Again as mentioned earlier, an incorrect and invalid order code may make it difficult for the customer to identify the error in the order confirmation process (20). The customer may be under the impression that since the information present on

the order confirmation has undergone various validation and verification processes the data must be correct. An incorrect order code stored on the order-ship-billing-system will directly affect the quality of the “open orders” report (22) generated, since it will contain incorrect and invalid data. Since the data present in the “open orders” report is the same as the data contained in the “order confirmation” report (25), this report will also contain incorrect and invalid data. Thus since the data contained in the “order confirmation” report is manually entered into the Auto-label system, the data will be incorrect (26) thus generating an incorrect Auto-label (27). Since the Auto-label may contain incorrect data the quality of the Auto-label inspection may suffer (33) since it is very difficult to identify an incorrect order code at this point in the process (35). Since the order code may be incorrect, properly interpreting the order code in the manufacturing process may be an impossible task (38). This directly impacts the process of selecting the correct process sheets (39), and parts (40) in order to assemble the product correctly. Thus since the order code is incorrect the labels used on the unit displaying the order code will also be incorrect (43). In addition, since the data from the Auto-label is then manually entered into the test-rig (46) system which then creates the final test sheet (48), incorrect data will be also be present in these processes (50). Again since the order code is incorrect the quality of the data entered in Accpac and in the Job Release system will also be inaccurate. Not having correct and up-to-date order code tables in the various documents may result in rework in the order code generation process, additional phone calls to the customer to confirm the order code, rework in both the multitude of manual data entry processes and the manufacturing/assembly processes. Thus the rework and delays resulting from this variance contributes to an increase in overall costs (63), a decrease in quality levels (62), and a decrease in on-time delivery (64). In addition another consequence of this variance is a decrease in customer satisfaction due to the fact that product delivered, even if on-time, will not meet his/her needs and requirements (66).

With the introduction of the new product line this variance will be increased in magnitude. This is due to the modularity of the product line, every product within the new product line shares certain modules that are described in the order code tables. Adding and editing a module will entail changes to every order code table within the product line that shares that particular module. Thus there is an interdependency between order code tables

that did not exist for the existing products. If the current manual process of maintaining the order code tables is used for the new products being introduced it may become an impossible task to ensure that the order code tables are up-to-date and correct within the various documents distributed.

- **Incorrect Order Code Generated as per Customer's Request (2: 3, 4, 7, 9, 10, 11, 14, 15, 20, 22, 25, 26, 32, 33, 35, 38, 39, 40, 43, 46, 48, 50, 62, 63, 64, 66)**

This variance describes the process of interpreting the order code tables to configure the product to meet the particular specifications and requirements that the customer needs. It is important to note that the manner which the order code is generated with the use of the table is a very manual process. Usually a customer or sales agent has a copy of the order code table in one hand and the brochure/product catalog in the other. As the order code is being created, conforming to the standard displayed in the table, the brochure or catalog is used to aid the selection of various options by reading the detailed descriptions. Two possible problem scenarios can occur during this process. The first is that a valid order code is generated that does not best meet the customer's requirements, incorrect but valid options are selected. The second problem that may arise is that an invalid order code is generated that either does not follow the product rules or the order code is misspelled when generated. Thus due to this variance an invalid order code (does not follow the product rules or is misspelled) or incorrect order code (valid but configuration does not meet the customer's requirements) is used to create an incomplete and invalid quote (3). Since the order code is either invalid or incorrect the price being quoted may also be incorrect (4). Thus the quote the customer receives may require some modifications if he/she identifies the errors (7). In addition, the quality of the order verification (9), order code validation (10), and price validation processes (11) may suffer since it will become increasingly difficult to identify the fact that the order code is incorrect and invalid. Also, the quality of the customer's order verification process (14, 20) will suffer if the order code is incorrect or invalid, since even if the error is identified, the entire order code generation process must be redone. Also an incorrect and invalid order code will directly impact the quality of the data entry process (15). An incorrect or invalid order code stored on the order-ship-billing-system will directly affect the quality of

the “open orders” report (22) generated, since it will contain incorrect and invalid data. Since the data present in the “open orders” report is the same as the data contained in the “order confirmation” report (25), this report will also contain incorrect and invalid data. Thus since the data contained in the “order confirmation” report is manually entered into the Auto-label system, the data will be incorrect (26) thus generating an incorrect Auto-label (32). Since the Auto-label may contain incorrect data the quality of the Auto-label inspection may suffer (33) since it is very difficult to identify an incorrect order code at this point in the process (35). Since the order code may be incorrect, properly interpreting the order code in the manufacturing process may be an impossible task (38). This directly impacts the process of selecting the correct process sheets (39), and parts (40) in order to assemble the product correctly. Thus since the order code is incorrect the labels used on the unit displaying the order code will also be incorrect (43). In addition, since the data from the Auto-label is then manually entered into the test-rig (46) system which then creates the final test sheet (48), incorrect data will be also be present in these processes (50). Again since the order code is incorrect the quality of the data entered in Accpac and in the Job Release system will also be inaccurate. Thus, customers’ or sales members’ inability to easily generate correct and valid order codes may result in rework in the order code generation process, additional phone calls to the customer to confirm the order code, rework in both the multitude of manual data entry processes and the manufacturing/assembly processes. Thus the rework and delays resulting from this variance contributes to an increase in overall costs (63), a decrease in quality levels (62), and a decrease in on-time delivery (64). In addition another consequence of this variance is a decrease in customer satisfaction due to the fact that product delivered, even if on-time, will not meet his/her needs and requirements (66).

With the introduction of the new product line this variance will also be increased in magnitude. The number of possible combinations, ranging in the millions, will make it difficult for both the customer and sales members to easily and quickly configure the product correctly to best meet the requirements and specifications identified. The fact that this is a new product line and limited training may be initially conducted may also contribute to making it even harder to configure the product correctly. In addition the fact that the order codes for the new products being introduced can be up to seventy characters in length in

comparison to the current maximum of twenty characters, manually creating the order code correctly (typing or hand-writing) will become an increasingly difficult task.

- **Incorrect Price Calculations** (4: 6, 7, 11, 15, 19, 54, 62, 63, 66)

This variance describes the manual process of generating price quotations. Currently the order code provided is used to identify the options selected. The price adders for the options are combined with the base price of the product and a price discount may be added depending on the customer. The price adder information is provided by inside sales in a spread sheet format to the various sales agents, while discount information is created and maintained by the respective sales agents and may be stored in multiple format types, such as Microsoft Excel or Word. This manual process of calculating prices may lead to incorrect quotations (6), which may cause the customer to either decline the order or demand the quote be redone (7). If the error is even identified in the manual price validation process, the sales agent associated to the order must be contacted who then in turn must contact the customer explaining the situation, thus delaying the order entry process (11). If the error is not identified during the validation process, it will be entered as is in the order-ship-billing system (15). The customer then has one final opportunity to identify the incorrect pricing when he/she receives the order confirmation report (19). An inaccurate invoice will be the end result of this variance (54). Thus due to the fact that the price was calculated incorrectly, there may be a financial loss if the price calculated was lower than the actual price (63). Also, the overall quality of the transaction has decreased (62). In addition, if the customer discovers that he/she has paid more than usual, customer satisfaction will decrease (66).

With the introduction of the new product line, manually calculating prices will become a more complicated task. The modular nature of the product adds a multitude of different options with varying prices, thus adding complexity to the price calculation process.

- **Incorrect and Infeasible Ship Date Calculations** (5: 15, 20, 62, 64, 66)

The current process used to generate ship dates is very manual and allows Inside Sales members the ability to overbook jobs. The current process involves manually analyzing the lead time required to build the products and the current job schedules. Occasionally, the work-cell leader for the particular product requested is required to be contacted in order to

generate a feasible ship date, although this may add delays in the quoting process. Having such a manual process also has an impact on how the sales agents can quote the process. To schedule a job correctly they require to contact the inside sales team, they then manually generate the ship date, again delaying the quoting process. Entering an incorrect/infeasible ship date decreases the quality of data entry (15) and results in an improper confirmation of the order by the customer (20). This results in an overall decrease in the quality of the purchasing experience with respect to the customer (62). In addition, not being able to generate a correct and feasible ship date quickly and easily may result in not delivering the product on time (64), and decreasing customer satisfaction (66). It is important to note that this variance will have the same results and consequences if the same process continues to be used when the new product line is introduced.

#### 4.7.2 Order Entered into the Order Entry System

- **Incomplete and Incorrect Manual Data Entry** (15: 20, 22, 25, 26, 32, 33, 35, 38, 39, 40, 46, 48, 50, 62, 63, 64, 66)

This variance describes the manual process of re-entering the information contained in the quote into the order-ship-billing system. Information such as the order code, price, required ship date, billing and shipping information are manually entered. It has been identified that the order code is more prone to error with respect to manually data entry due to its length and complex nature. No automatic validation exists for the order code when entering it into the system. In comparison the date field is checked to ensure that a valid date is entered, however this does not ensure that a feasible or correct date is entered. Thus even if the information present in the quote is valid and correct, the manual data entry aspect of the order entry process may invariably cause inaccurate and incorrect data to be entered into the system. Thus the order confirmation report generated by the system will be also be inaccurate (20), requiring the customer to identify the errors. An incorrect order code stored on the order-ship-billing-system will directly affect the quality of the “open orders” report (22) generated, since it will contain incorrect and invalid data. Since the data present in the “open orders” report is the same as the data contained in the “order confirmation” report (25), this report will also contain incorrect and invalid data. Thus since the data contained in the “order

confirmation” report is manually entered into the Auto-label system, the data will be incorrect (26) thus generating an incorrect Auto-label (32). Since the Auto-label may contain incorrect data the quality of the Auto-label inspection may suffer (33) since it is very difficult to identify an incorrect order code at this point in the process (35). Since the order code may be incorrect, properly interpreting the order code in the manufacturing process may be an impossible task (38). This directly impacts the process of selecting the correct process sheets (39), and parts (40) in order to assemble the product correctly. Thus since the order code may be incorrect the labels used on the unit displaying the order code will also be incorrect (43). In addition, since the data from the Auto-label is then manually entered into the test-rig (46) system which then creates the final test sheet (48). Thus, incorrect data will be also be present in these processes (50). Again since the order code is incorrect the quality of the data entered in Accpac and in the Job Release system will also be inaccurate. Thus errors in the manual data entry process may result in rework in the order code generation process, additional phone calls to the customer to confirm the order code/ship date, rework in both the multitude of other manual data entry processes and the manufacturing/assembly processes. Thus the rework and delays resulting from this variance contributes to an increase in overall costs (63), a decrease in quality levels (62), and a decrease in on-time delivery (64). In addition another consequences of this variance is a decrease in customer satisfaction due to the fact that product delivered, if delivered on-time, still may not meet his/her needs and requirements (66).

Due to the complexity and length of the order code this variance is most likely to increase in frequency when the new product line is introduced. Even if only one of the seventy characters in a particular order code is mistyped the result is either a delay in the process in order to fix the order code or, worse case, a product assembled that will not meet the customer’s original specifications.

- **Improper Verification of Job Entry to System** (17: 20, 22, 25, 26, 32, 41, 51, 52, 63)

This variance describes the ability to duplicate a job previously entered into the system. Due to an improper implementation and use of the order-ship-billing-system there is no automatic check to ensure that an order/job currently being entered has not already been

entered. This occasionally occurs when a sales agent sends in an order and later on the customer that the sales agent is representing also sends in the same order. Sometimes the error is identified by the customer when he/she receives two order confirmations for the same order with different Job #'s (20), thus requiring a Job to be deleted from the system. If not identified at this point, duplicating a job in the order entry system may result in a duplicate order being scheduled by manufacturing (22). An order confirmation report will be generated (25) for the duplicate order, and the information contained in the report will be manually entered into the Auto-label system (26), thus creating an Auto-label (32). The information present in the Auto-label will aid manufacturing in assembling the product (41), thus duplicating the order. The related product information will be entered into the test-rig, Accpac (51) and the Job Release system (52), thus producing a test report, an invoicing and providing pertinent shipping information respectively for the duplicate order.. Although actually shipping a product has never occurred, the further along the process the duplicate order is identified, the greater the opportunity to increase costs (63) due to the time associated with assembling and testing the unit and the raw materials used. Important to note, is that this variance will have the same results and consequences if the same process is continued to be used when the new product line is introduced.

#### 4.7.3 Confirmation of Order

- **Incorrect Usage of the Accpac Reporting Tool** (19: 21, 62, 63, 64, 65, 66)

When an Inside Sales member is in the process of printing or viewing the order confirmation report, in Accpac, he/she is inadvertently locking out everyone else from viewing the job in Accpac and from exporting the details/information of that job from Accpac. Thus if the "orders" macro is run at this time (21), an incomplete "open orders" report will be generated. The result is that complete orders may be skipped from the report and changes to orders may not be identified in time. Although the next time the "orders" macro is run the missing information may be identified in the report (65), this may result in rework (63), thus reducing overall quality (62) and may also delay the orders from being manufactured and shipped. Thus, this may result in a decrease in the probability of the customer receiving the order on time (64), decreasing customer satisfaction (66). This

variance will have the same results and consequences if the existing process is used when the new product line is introduced.

#### 4.7.4 Generating the Orders Report

- **Incorrect and Improper Usage of the “Orders” Macro and “Convert” Program (21: 22, 64, 66)**

This variance describes the lack of knowledge displayed by the work-cell with regards to the interdependency between the “Orders” macro and the “Convert” program. The “Orders” macro, must be run first, thus exporting the “open orders” information from Accpac to a text file located on the network. The “Convert” program is then run and manipulates the data found in the text file to generate the “open orders” report. Occasionally the “Convert” program is run without running the “Orders” macro. Thus an out-of-date report is generated (22) since the “Orders” macro was not run. The result may entail that complete orders may be missing from the report. Although the next time the “orders” macro is run the missing information may be identified in the next report, this ultimately delays the order from being manufactured and shipped. The result is a decrease in the probability of the customer receiving the order on time (64), thus decreasing customer satisfaction (66). This variance will have the same results and consequences if the existing process is used when the new product line is introduced.

#### 4.7.5 Generating the Auto-label

- **Incomplete and Incorrect Manual Data Entry (26: 32, 33, 35, 38, 39, 40, 42, 43, 46, 48, 50, 62, 63, 64, 66)**

Information that was already entered into the order-ship-billing system, such as order code, required ship date, and related shipping information, is re-entered into the Auto-label program. Since the Auto-label may contain incorrect data (32) the quality of the Auto-label inspection may suffer (33) since it is very difficult to identify an incorrect order code at this point in the process (35). Since the order code may be incorrect, due to the fact that it is more prone to data-entry errors, properly interpreting the order code in the manufacturing process may be an impossible task (38). This directly impacts the process of selecting the correct

process sheets (39), and parts (40) in order to assemble the product correctly. Thus since the order code may be incorrect the labels used on the unit displaying the order code will also be incorrect (43). Also the information presented on the Job Card will also be incorrect (42). In addition, the data from the Auto-label is then manually entered into the test-rig (46) system which then creates a final test sheet (48). Thus, incorrect data will be also be present in these processes (50). Again since the order code is incorrect the quality of the data entered in Accpac and in the Job Release system will also be inaccurate. Thus errors in the manual data entry process may result in rework in the order code generation process, additional phone calls to the customer to confirm the order code/ship date, and rework in both the multitude of other manual data entry processes and the manufacturing/assembly processes. Thus the rework and delays resulting from this variance contributes to an increase in overall costs (63), a decrease in quality levels (62), and a decrease in on-time delivery (64). In addition another consequences of this variance is a decrease in customer satisfaction due to the fact that product delivered, if delivered on time, still may not meet his/her needs and requirements (66).

Due to the complexity and length of the order code, this variance is most likely to increase in frequency when the new product line is introduced. Even if only one of the seventy characters in a particular order code is mistyped the result is either a delay in the process in order to fix the order code or, worse case, a product assembled that will not meet the customer's original specifications.

- **Improper Database Design and Standards (30: 31, 50, 51, 52, 62, 65, 66)**

The variance describes the lack of use of proper database design methodologies and the lack of standardization between the multitude of Auto-label databases. The existing databases allow duplicates in its primary key, the serial number field, thus allowing the creation of duplicate serial numbers (31). The duplicate serial numbers are then entered into the Test-rig (50), Accpac (51) and Job Release system (52). Thus if the unit ever returns for servicing, complications in attempting to retrieve the data will arrive due to the fact that duplicate records will exist in the system. This will impact the quality of the service provided to the customer (62), thus decreasing customer satisfaction (66). In addition, the lack of

standardization between field names in the various Auto-label databases makes consolidating Auto-label reports a daunting task (65). This variance will have the same results and consequences if the existing process is used when the new product line is introduced.

#### 4.7.6 Assembling the Unit

- **Improper Interpretation of the Order Code (38: 39, 40, 41, 62, 63, 66)**

This variance describes the manual process of interpreting the order code displayed on the order conformation report and on the Auto-label to aid in the assembly process. By interpreting the order code incorrectly, incorrect process sheets will be selected (39), incorrect parts may be selected (40), resulting in improper assembly of the product (41). Ultimately this may lead to an increase in cost (63) due to the need for rework, a decrease in quality (62) since the customer did not receive his/her intended product, and a decrease in customer satisfaction (66). It is important to note that this rarely occurs for existing products, however this variance was identified as being key mainly due to the fact that there is an increase in probability of this problem occurring when the new product line is introduced, if this process remains the same. This is due to the added complexity that the new product line will bring to the process. Due to the length of the order code and the number of possible configurations, properly interpreting the order code manually to aid in selecting the correct process sheets and parts will become a more difficult and time consuming task.

#### 4.7.7 Testing the Unit

- **Incomplete and Incorrect Manual Data Entry (46: 48, 49, 50, 53, 62, 63, 64, 66)**

Product information that was already entered into the order-ship-billing system, and in the Auto-label program, such as the order code, required ship date, and quantity, must be re-entered into the Test-rig program. As a result a final test sheet containing incorrect data may result (48) and the Job Card may not be properly updated (49, 50). Again since the order code is incorrect the data entered in Accpac and in the Job Release system will also be inaccurate (53). Thus errors in the manual data entry process may result in rework in the order code generation process, additional phone calls to the customer to confirm the order code/ship date, and rework in both the multitude of other manual data entry processes and the

manufacturing/assembly processes. Thus the rework and delays resulting from this variance contributes to an increase in overall costs (63), a decrease in quality levels (62), and a decrease in on-time delivery (64). In addition, another consequences of this variance is a decrease in customer satisfaction due to the fact that the product delivered, if delivered on time, still may not meet his/her needs and requirements (66).

Due to the complexity and length of the order code, this variance is most likely to increase in frequency when the new product line is introduced. Even if only one of the seventy characters in a particular order code is mistyped, the result is either a delay in the process in order to fix the order code or worse case a product assembled that will not meet the customer's original specifications.

#### **4.7.8 Repairing the Unit**

- **Non-Standardized Data Collection Method (57: 61, 62, 63, 65, 66)**

This variance describes the lack of a common method/standard to collect data regarding defects and other repair related information. Some work-cells use a database to collect the information while others use a spreadsheet. The same information contained in the Auto-label database is manually re-entered either in another database or into a spreadsheet. Thus the data entered may be easily mistyped and incorrect (61). In addition, no standard exists regarding what pieces of information must be collected when the defect is identified and when the problem is solved. Thus this makes reporting difficult when attempting to consolidate data across databases and spreadsheets (65). In addition, the overall quality of the reporting process decreases (62) and costs may increase (63) due to the extra time and effort required to collect the necessary data. If and when the product returns for servicing it will be difficult to identify whether or not the unit had been previously repaired during the manufacturing process. This may delay servicing the unit since valuable historical data may not be easily available, thus decreasing customer satisfaction (66). This variance will have the same results and consequences if the existing process is used when the new product line is introduced.

#### **4.8 Technical Analysis Key Variance Control Table**

The technical analysis key variance control table, as shown in *Appendix 8*, can be used to illustrate the extent to which each key variance affects and is affected by the social system. It aids in identifying where important organizational and information loops exist or are required. The control table identifies the unit operation where the variance occurs, location of observation, the operation where it is controlled and by whom, the actions required to control it, the required information flow necessary for diagnosis and control, and suggestions for job and technology redesign. In addition, the table found in *Appendix 9* is used to identify the interdependencies between the recommendations suggested and the key variances that they affect. This table is necessary since the key variance control table has limited capacity to identify the highly interdependent information processes. The table identifies the interactions and interdependencies between both technology and organizational changes and the variances that they affect.

## **5.0 Social System Analysis**

This analysis focuses on how information technology affects and influences the work-related interactions among people. Data collection for understanding the social system can take many forms. Interviews combined with observation provided a logical and measured basis for guiding change. Analysis was based on the following areas; quality of working life (QWL), goal attainment (G), adaptation (A), integration (I), and long term needs (L). QWL criteria questions were used as a benchmark to gather information about the values and concerns expressed by the Sales and Manufacturing teams about the quality of working life.

### **5.1 Quality of Working Life**

All GE Multilin employees agree that there still exists a strong entrepreneurial culture whose roots trace back to the “early Multilin days” before General Electric acquired the company. This ever present and thriving culture promotes a strong sense of ownership and autonomy in all the individuals who work there. Examples include the manufacturing work-cells, who own the entire manufacturing and related processes with respect to their particular product lines, and the multitude of cross-functional teams that are assembled to solve various issues that are identified as being critical to the customer. In addition, each individual is empowered to undertake projects in order to improve their processes, product quality, and quality of work life. Many employees interviewed stated that they take pride in the ability to be able “to make a difference” and this is one of the main reasons why many perform a multitude of projects that are in addition to their regular duties.

Another important part of the GE Multilin culture which has a great deal of impact and influence on each of the employees on a daily basis is the quality initiative known as 6-Sigma. Even before GE acquired Multilin, quality was always identified as being a critical element for success. Total Quality Management (TQM) was used to ensure the highest possible quality of their products. Thus when GE acquired Multilin, the previous usage of TQM allowed the introduction of 6-Sigma to be quickly embraced by all employees. Unlike the TQM initiative which focused mainly on the processes related to the manufacturing of the product, 6-Sigma focuses on reducing the number of defects in the entire organization. The 6-

Sigma initiative is now deeply embedded in the GE Multilin culture and employees embrace it as a tool that can be used to aid them in improving their processes, product quality, and quality of work life.

Unlike 6-Sigma, information technology is not viewed by many as a tool that can be used to aid in improving their processes, product quality, and quality of work life. This may stem from the fact that until recently an IM/IT department has never existed. The Computer Services department played a very limited role in its place, and they themselves did not fully understand how to use information technology to its full potential. Many questions regarding whether IT could be applied to aid in improving processes resulted in answers such as “it cannot be done” or “it will be too expensive”. This forced employees to look elsewhere to full fill their IT needs. Some developed their own systems isolated from everyone else and others outsourced their projects. Since there were no formal guidelines on how to scope projects, clear goals and objectives were not identified. There were no review processes in place to analyze whether or not IT solutions would indeed solve the problems identified, thus IT was often used as the “silver bullet”. In addition, there were no roadmaps or guidelines to follow. End users’ input was rarely used to develop the systems, and there was no feedback mechanism in place during development and/or testing to aid in ensuring that the final product delivered would meet the original objectives. Thus the final product delivered rarely met the end users’ needs and requirements and was usually abandoned since there was no feedback process in place to evolve the systems that were implemented.

## ***5.2 Team Dynamics of the new Work-Cell***

To ensure the successful introduction of the new product line, a strong work-cell team has been put in place. The new work-cell team shares many similarities and also possesses a few key differences with respect to other work-cell teams.

There are four main similarities that the new work-cell team formed shares with the existing work-cell teams. The first is the fact they are all self-managed teams, a group of individuals that have ownership over all responsibilities with respect to their particular product line. The teams own everything related to their product line from customer relations and creating performance metrics to assembling and testing the products. The second main similarity is the fact that all team members are cross-trained in the various work-cell

functions thus increasing the team's flexibility. The third main similarity is that a majority of team members are 6-Sigma trained and undertake 6-Sigma related projects to aid in improving their processes and quality of work-life. The fourth main similarity is that all members of the team work closely together to overcome any obstacles that might arise. The daily morning meeting is one method used to identify new issues early and address them before they become major problems.

The first major key difference is the fact that approximately half of the team is formed by individuals that are new to the company. Thus, these individuals bring fresh ideas and a different perspective to the team. This provides the team with the ability to easily challenge the "status quo" if it is identified as requiring improvement. The second main key difference is the fact that the rest of the team is comprised of some of the best individuals from other work-cell teams. These individuals bring with them vast knowledge and experience collected over years of working in other work-cell teams and also bring with them the GE Multilin culture and tradition that can be shared with the newcomers. The third main key difference is the fact that a majority of the team have had generally good experiences with using IT solutions in the past to streamline business processes and improve their quality of work-life, and thus are comfortable in using IT systems and solutions. This is unusual since in every other work-cell team there is usually only one or two individuals that are comfortable in using IT solutions. The rest of the team depends on them with respect to being continually trained and reminded on how to properly use and troubleshoot the various systems.

### **5.3 Goal Attainment**

Each year senior management convenes and reviews the accomplishments of the current year and sets the goals that must be achieved for the following year. Discussion ensues regarding the strategy required to "become the number one choice for customers when it comes to quality protection relays and quality services". Factors such as product strategy, markets, financials, and the usage of 6-Sigma are discussed in detail. The output of this meeting is a formal document, which details the past years "hits", successes, and "misses", failures. This document is then reviewed by higher level executives who perform a formal review of the state of the particular business. The particular business's reward for remaining

customer focused and “meeting the numbers” include the promise for growth via increased headcount and/or by acquisitions.

As the year progresses communication meetings are held on a quarterly basis to review the current state of the business with respect to the projected plans. All employees are invited to participate in the meetings held by the Operations Manager and the Chief Financial Officer. The goals for the year are reviewed and critical factors for success are discussed in detail. Success stories related to customer satisfaction are also shared throughout the meeting. A “question period” follows each meeting where healthy discussions regarding business strategy usually ensues.

In order to achieve the overarching organizational goal, manufacturing has created their own vision and mission statement that puts the organizational goals in terms that the manufacturing teams can easily understand. Their mission statement identifies specific goals that each work-cell can easily comprehend and thus work toward, such as “meeting customer request dates for delivery and support.” Every morning each work-cell team gathers together to discuss their teams’ specific goals such as “weekly production rates” and any issues or problems that have been identified as being critical factors in achieving their goals. Due to the autonomous nature of each work-cell, each team is empowered to undertake 6-Sigma projects to address the various issues and problems identified during the morning meetings. An individual is usually identified as the “owner” of the project but the entire team is involved in order to make the project a success. Each member of the team takes pride in the fact that he/she can help in achieving the goals identified in the mission statement. Each 6-Sigma project is tracked and reviewed at the various stages of the project’s lifecycle by either the Master Black Belt or one of the various Black Belts. This process ensures that the particular project retains its original focus and purpose and will indeed aid the overall business in achieving the organizational goals identified.

Unlike the Manufacturing team, the Inside Sales team has no personalized vision or mission statement but the underlying goal of “customer satisfaction” is still very apparent. The inside sales team works closely together to identify and solve the various issues and problems as they arise. Since the Inside Sales team deals directly with the customer, they are usually the first to hear about the various issues and problems that lead to customer

dissatisfaction. To deal with the arising issues, the entire team is engaged with 6-Sigma and various projects are always under way to aid in improving their interaction with the customer and the external sales force.

Although each team's goals and subsequent strategies created to achieve those goals are apparent from the perspective of each of the respective team members, they are not apparent for members of other teams or departments. For example specific work-cell goals and strategies may not be apparent to the members of the inside sales team and vice versa. The only time that these goals are shared between both parties are when cross-functional teams are created to solve specific issues that have been identified as mission critical. By working together both teams share valuable information that the other team was usually unaware. Unfortunately once the particular issue has been resolved, the cross-functional teams are usually disbanded. Thus when this occurs, the information sharing between departments usually comes to an abrupt stop.

How information technology plays a role in aiding both the manufacturing and sales teams in attaining their goals and objectives is not well defined or clearly understood. There are no formal approaches, procedures, or road maps to using information technology to bring about process improvement. Most teams view information technology in a limited and restricted manner, and this explains why IT is viewed as only a means to automate manual processes by a majority of the employees. This may be due to the fact that the IM/IT department is still viewed as serving the same function as the previous Computer Services department. Most employees refer to the IM/IT team as the Computer Services department and do not understand the differences between the two.

#### **5.4 Adaptation**

To cope with the increased customer demand in quality protection relays, the company experienced significant growth throughout its history and has adapted significantly well. Multilin has grown 25% annually between 1978-1995, followed by a period of rapid growth: 42% in 1996, 54% in 1997 and 32% in 1998. During this growth period each new employee was given the opportunity to embrace the unique Multilin culture, making them feel like an important part of a winning team.

Another example of the entire organization's ability to adapt to change is its quick adoption of the quality initiative. Even before GE acquired Multilin, the organization had embraced and adapted well to the Total Quality Management (TQM) initiative. TQM was used to ensure the highest possible quality of their products. When the 6-Sigma methodology was first introduced, the organization quickly realized, that unlike TQM which focused solely on the processes related to the manufacturing of their product, 6-Sigma focuses on reducing the number of defects in the entire organization. Thus the entire organization rallied behind 6-Sigma and quickly had over 80% of their employees trained and thus almost instantly started to reap the benefits. Thus, it is apparent that as a whole, GE Multilin can adapt very quickly to embrace new ideas and methodologies in order to be successful.

The culture created by the manufacturing teams, which fosters the creation of self-managed work-cells that have ownership over all responsibilities with respect to a particular product line, allow them to adapt quickly and easily to change. All members of the team are cross-functionally trained with regards to the various processes that are involved with the manufacturing of the particular product. This provides the work-cells with the extra flexibility needed to be able to deal effectively with fluctuations in production demands and the occasional sick leaves. In addition, the culture present encourages all team members to suggest, and aid in implementing, ideas that may increase productivity and work-cell performance. This ensures continual improvement on the part of the work-cells and increases their ability to adapt effectively with change.

Similar to Manufacturing, the members of the Inside Sales team are also cross-functionally trained, thus allowing them to react quickly and effectively to customer demands. The ability of the team to work together to identify and eliminate potential issues, using 6-Sigma methodology, before they become major problems ensures continual improvement on their part.

To be able to react effectively to change on a much more global scale the Manufacturing and Inside Sales teams take advantage of the fact that their employees are cross-trained in order to balance fluctuating production and sales demands. For example, if a particular work-cell is struggling to deal with a sudden increase in demand for their product, members of other work-cells with the required skill sets are called for to help. The same can

be said when the Inside Sales team requires additional assistance. Cross-trained members of the manufacturing work-cells that can be freed up come to their assistance. To deal with larger challenges, cross-functional groups are created to quickly and effectively deal with rising issues that cross departmental boundaries.

In order to adapt to changing processes, various teams would identify the need for new systems. Due to the fact that an IM/IT department did not exist until recently, the various teams would take ownership in the implementation of IT related projects. The particular team would identify the need for a system and then would determine the best means to achieve the system on their own. This is consistent with the autonomous nature displayed by the teams. Two potentially different courses of action would then result. Some teams, with technically savvy members, developed their own systems isolated from everyone else. Other teams who lacked members with such skill sets would outsource the projects. Regardless of the course of action, due to a lack of knowledge with respect to implementing IT related projects, projects were usually not scoped properly and essential issues such as documentation, scalability, flexibility, standardization, and security issues, were not adequately addresses. Thus a majority of the projects implemented did not meet the deliverables originally promised. Teams that delivered systems using in-house talent would evolve the system in order to meet the system's objectives. Teams that developed systems in this manner would add new components and modules to the original system until the in-house talents were either promoted to other jobs or left the company. Once this occurred, the particular system would stop evolving, due to a lack of in-house technical knowledge and a lack of proper documentation. Within a few months the team would be usually incapable of evolving the system to adapt effectively to future needs, and thus the system would be abandoned by many. Teams that outsourced their project would be heavily dependent on the particular third-party selected for changes to the system. Due to a lack of experience in implementing IT solutions, the scope of the project would change frequently thus usually making the project cost-prohibitive to continue. Thus most teams were left with systems that did not address the original scope of the project and thus were usually abandoned. In addition, since there was no process in place to capture "lessons learned" in past IT projects, the same mistakes were repeated decreasing the chances of successful IT project implementation drastically.

## **5.5 Integration**

To survive in a competitive business environment with increasing user requirements a flat organization is essential in order to react quickly and effectively to the various user demands. GE Multilin is already a very flat organization and this provides the various teams with increased responsibility and challenge in order to meet customer needs. Cross training has been embraced for the sake of both job efficiency and job enhancement. In addition, employees are empowered to help better define their jobs and roles in the company contributing to personal job satisfaction.

Communication among team members is exemplary, however communication among different departments and teams, such as Sales and Manufacturing has been described by many as “inadequate”. Meetings between departments are only held as reactive measures to address critical problems and issues that have occurred or are continuing to occur. There are no processes currently in place to encourage a proactive mentality with regards to identifying potential issues and problems before they arise. Poor communication across departments also has resulted in duplicate efforts with respect to projects. Occurrences of different teams unknowingly working on the same problem, which most often crosses departmental boundaries, are not rare.

Poor communication is also prevalent in IT projects. There have been cases where individuals from different Manufacturing work-cells have been unknowingly working on the same project, thus duplicating effort. This may be partially due to the autonomous nature of the work-cells since individuals are currently encouraged and empowered to undertake projects that will improve their processes, product quality, and quality of work-life. Unfortunately, there is currently no process in place to share ideas between departments or to identify which projects are being worked on.

Another problem that often surfaces with respect to IT projects is ownership of information. It is frequently said that “information is the glue that holds an organizational structure together”. Information can be used to integrate process activities, both within a process and across multiple processes. In addition, information collected from one process may prove essential for another. There is currently a lack of procedures and structure with respect to collecting and gathering information at GE Multilin. Since information cuts across numerous departmental lines, each department feels like they own the information. This

results in duplicate information being housed in various systems which may easily lead to integrity issues. In addition, there is no current process in place to share information across departments, including success and failures with respect to IT projects.

### **5.6 Long Term Development**

New employees are welcomed to GE Multilin with a plant tour, and an informal orientation that includes environmental & safety training. The next few days are spent with their team members who train them on the variety of duties and tasks that await them. Cross training usually starts almost immediately, which results in employees becoming certified to perform a variety of job functions. There is usually no formal training or classes for new employees with respect to their job duties and function. Most new employees express dissatisfaction with the initial orientation program. Most new employees interviewed stated that they would have liked an overview of the short term and long term goals of the organization and they would have liked to spend more time meeting with the other teams and individuals that they were likely to interact with.

All employees attend 6-Sigma training, otherwise known as “green belt” training. There are two, one week classes that employees must attend, and all employees must complete at least two “6-sigma projects” within the same year to become “green belt certified”. “Green Belt” training also provides the attendees with the opportunity to interact with individuals from other departments and disciplines. There are approximately ten to fifteen attendees per class that represent a variety of disciplines. Meeting individuals from other departments will aid the attendees in making contacts that may be invaluable when working on cross-functional projects. Only a few individuals a year are selected to participate in “black belt” training, a more thorough and extensive course in 6-Sigma methodology, which may eventually lead to a position in the 6-Sigma department.

Formal training courses, with respect to particular job functions and duties, are few and far in between. However employees are encouraged to attend off-site classes, after hours, intended to aid them to further their career development. Employees are also encouraged to subscribe to work-related journals, magazines and seminars to aid them in further career development. Courses related to improving leadership skills, and team dynamics are offered

via other GE training facilities, however only certain employees identified by upper management as prime candidates can attend.

There are very few IT related training courses offered at GE Multilin. The training courses offered, take place after work, and are taught by a third party training company. Topics include fundamentals in Microsoft Windows 95, Word, Excel, Corel and Visio. Many employees complain that the courses are too basic and are not challenging enough. Also many employees indicated that how the courses are taught, do little to identify how to better use the tools in actual work environments.

### ***5.7 Rewards and Recognition***

Individual goals are set at the beginning of each year with the employee's direct supervisor, and are re-evaluated and measured throughout the year, and are then reviewed at the end of each year. Before the review phase each employee must complete a form identifying past achievements, goals accomplished during the year and future objectives. The direct supervisor then provides each employee with a written review recognizing achievements and identifying areas for further improvement. Annual salary raises are given according to the individual's yearly performance.

Employees interviewed, in the Sales and Manufacturing departments, stated that rewards and recognition usually only occurs once a year after their review process. The recognition that employees receive as the year progresses, for meeting their various goals and objectives usually results in nothing more than a "pat on the back". They also stated that the use of incentives would aid in enticing them to work harder toward their goals. The only formal reward ceremony is the annual 6-Sigma "green belt competition", where teams present a 6-Sigma related project that was conducted during the year in front of judges and their peers. Prizes are given to all who enter and special recognition and reward are given to those that the judges feel have captured the essence of 6-Sigma.

## **6.0 Recommendations**

Recommendations will be provided using the information gathered from both the research and analysis conducted. The recommendations will focus on two key areas and will address both social and technical issues identified in the analysis. The two key areas of focus are:

1. Identifying key areas for improvement with regards to the current order entry to manufacturing information process flows.
2. Development and implementation of new information systems that will support the introduction of the new product line.

### **6.1 Basic Assumptions: Role of the IM/IT department**

In order for GE Multilin to start using information technology to its full potential, it is essential for the IM/IT department to identify its new role to the entire organization and immediately differentiate itself from the Computer Services department's past. Many employees are not even aware of the fact that the IM/IT department has been created and is composed of 5 main teams: End-User Computing (replacing the Computer Services department's role), Core Applications, Infrastructure, Special Projects, and Application Development. Each of the five team's main functions and goals must be clearly defined and identified to the organization to ensure successful integration with the other departments and teams.

To be successful the IM/IT team must clearly identify to the organization the role that information technology plays in aiding the company in attaining their goals and objectives. It must become apparent to the organization that IT is a tool that can be used to aid in improving their processes, product quality, and quality of work life. To ensure the success of present and future projects utilizing information technology, the IM/IT team must quickly identify itself as a partner to the various teams and departments with respect to implementing information technology solutions.

### **6.2 Identifying Key Areas for Improvement with regards to the current Order Entry to Manufacturing Process Flows**

The following recommendations are with respect to improving the general order entry to manufacturing information process flows. The following recommendations will address both

social and technical issues identified in the analysis. These recommendations can be implemented independently from the recommendations that will be provided in the next section, related to the introduction of the new product line.

The recommendations in this section will be divided into 7 main categories, which include:

- A. The IM/IT Team as a Partner in bringing about Process Improvement
- B. Training
- C. Communication
- D. Streamlining the Order Entry Information Process Flows
- E. Streamlining the Order Entry to Manufacturing Process Flows
- F. Streamlining the Manufacturing Information Process Flows
- G. Integrating Information Process Flows

#### **6.2.1 The IM/IT Team as a Partner in bringing about Process Improvement**

The following recommendations will ensure that the IM/IT team will integrate successfully in the organization and will quickly identify itself as a partner to the various teams and departments with respect to implementing information technology solutions. This will ensure that IT will be used as a tool, by the various teams, to aid in improving their processes, product quality, and quality of work life

##### **Recommendation #1**

**It is recommended that a monthly newsletter and the Intranet be used as tools to heighten the organization's awareness of the IM/IT department's role as a partner in bringing about process improvement.**

Information such as the IM/IT team's mission and vision statement could be easily made available to everyone via the Intranet and the monthly newsletter. This will provide the team with the opportunity to differentiate itself from the Computer Services department's past.

**Recommendation #2**

It is recommended that a formal process be established to aid the organization in identifying and scoping out projects that may be able to use IT to bring about process improvement.

Any formal processes, methodology, roadmaps, and procedures developed by the IM/IT team should be posted on the Intranet, thus making them easily available to everyone 24x7.

**Recommendation #3**

It is recommended that a process be established that would enable the various teams to place IT related requests quickly and easily on the IM/IT department. The requests could range from requiring training on specific systems to fixing bugs.

This would establish a formal feedback channel from the organization to the IM/IT department, allowing the IM/IT team to act quickly to resolve any issues identified before they become serious problems. In addition, this would further allow them to differentiate themselves for the Computer Services department, who could not handle such requests effectively.

**Recommendation #4**

It is recommended that the IM/IT team immediately attain ownership with respect to the technical implementation and evolution of all systems/programs currently used in the organization and any that will be introduced in the future.

It is essential for the IM/IT team to identify its role to the organization as a partner in bringing about process improvement. Thus any other department/team that requires to make modifications to any current system or requires a new system/program must work directly with the IM/IT department to do so. The current autonomous nature of the teams with respect to making their own decisions regarding developing and evolving the various systems and programs must be put to an end.

**Recommendation #5**

It is recommended that as each new system is implemented an “owner”, other than the IM/IT team, be identified as being responsible to ensure that the system continues to meet the organization’s needs.

Only the teams and individuals using the systems/programs on a regular basis can easily identify whether or not the systems are still achieving the desired results and goals. Thus, making them “owners” of the particular system and related information process flow provides them with the needed ability to maintain and evolve the systems to continue to meet the necessary goals and objectives. Any issues identified by the “owner” as being critical should be immediately brought to the attention of the IM/IT department.

**Recommendation #6**

It is recommended that a control mechanism be put in place for each system implemented to ensure that it will continue to meet the original goals and objectives specified.

An example of a control mechanism may be the creation of a Pareto chart on a regular basis. The initial Pareto chart can be used to identify the fact that defects have been reduced and subsequent charts generated can be used to identify whether or not the process remains stable or in control.

## 6.2.2 Training

The following recommendations ensure that the appropriate teams and individuals are provided with the necessary training in order to fully take advantage of the existing information systems and any future systems that are introduced to the organization.

**Recommendation #7**

It is recommended that a variety of IT related courses be offered to employees that clearly identify when and how to use the tools in their actual work environment. Employees should be encouraged to bring work-related examples to class to be discussed and worked on.

This addresses the issue raised by a large number of employees stating that the current courses offered did little to identify how to better use the tools in their day to day activities.

**Recommendation #8**

It is recommended that a process be established to educate new users to the various systems and programs that they require in order to perform their daily duties.

This will ensure that new employees and any employees who transfer from one team/department to another will have the proper training necessary to perform their job functions.

**Recommendation #9**

It is recommended that for any system introduced to the organization, whether it be a purchased system or a “home grown” program/system, the necessary documentation to continue to operate the system properly should be available at all times.

User manuals and related documentation should be available on the Intranet for anyone to download and print. With respect to custom designed systems and “home grown” systems any and all documentation regarding system architecture and design should be readily available to the IM/IT team to aid in trouble shooting and to aid in determining the difficulty of making future enhancements as they are required.

**6.2.3 Communication**

The following recommendations will aid in improving the various teams and departments’ abilities to communicate and share information among themselves.

**Recommendation #10**

It is recommended that the Intranet be used to share departmental mission and vision statements, goals, and other related information.

This addresses the issue raised by a variety of teams regarding not knowing and/or fully understanding the goals of other departments and teams.

**Recommendation #11**

**It is recommended that that the Intranet be used as a resource to share information across departmental boundaries such as projects currently being worked on, minutes of past meetings, and other related documents.**

Each department/team should own their Intranet pages and keep them updated with the latest information related to projects being worked on and other related information. This will ensure that the various teams are aware of what each other are working on thus decreasing the chances of two teams working on the same project unknowingly. In addition, lessons learned implementing new systems and applications can also be easily shared with others via the Intranet.

**Recommendation #12**

**It is recommended that the Intranet and the monthly newsletter be used to recognize the achievements of teams and individuals during the course of the year.**

This will address the concern of the various teams regarding the lack of recognition they receive when they achieve and surpass the various goals and objectives set throughout the year.

**6.2.4 Streamlining the Order Entry Information Processes**

The following recommendations will aid in streamlining the current order entry information processes and should be able to be implemented rather easily and quickly.

**Correct & Feasible Ship date Calculations**

**Recommendation #13**

**It is recommended that a scheduling package be used to automate the process of issuing ship dates.**

Further investigation is required to determine whether there is such a scheduling package available in the current order-ship-billing system.

### **Elimination of Duplicate Order Entry**

#### **Recommendation #14**

It is recommended that a modification be made to the Order-Ship-Billing System to ensure that each customer purchase order number is unique.

This will ensure that the same order cannot be accidentally entered twice by different Inside Sales members.

### **Correct Usage of Accpac Reporting Tool**

#### **Recommendation #15**

It is recommended to train any and all individuals that are currently using the reporting tool or will be using the tool in the future, in the proper usage of the tool and also made aware of the resulting consequences of inappropriate usage.

Training individuals in the proper usage of the reporting tool will eliminate any possibility of inadvertently locking everyone else from viewing the job in Accpac and from exporting the details/information of that job from Accpac.

## **6.2.5 Streamlining the Order Entry to Manufacturing Information Process Flows**

The following recommendations will aid in streamlining the processes that transfer information from order entry to Manufacturing.

#### **Recommendation #16**

It is recommended that the “Orders” macro be scheduled to run early in the morning and during lunch, thus decreasing the probability that a member of Inside Sales is locking the Job in the Order-Ship-Billing System.

This will decrease the number of orders that are not exported from the Order-Ship-Billing system when the “Orders” macro is run.

#### **Recommendation #17**

It is recommended that an error log be automatically generated identifying the jobs that were not exported from Order-Ship-Billing System via the “Orders” macro.

This will identify to Manufacturing which jobs were not exported correctly and provide them with the opportunity to re-run the macro thus exporting the remaining orders that were not exported the first time.

**Recommendation #18**

It is recommended that the “Orders” macro and “Convert” program be integrated into one application. This new application will ensure that every time a new “open orders” report is generated, the latest “open orders” data will be used.

This will ensure that for every “open-orders” report generated via the current “Convert” program, the latest “open orders” data exported via the current “Orders” macro will be used.

**Recommendation #19**

It is recommended that until the recommendation above is implemented, a process/instruction sheet should be created that explains the interaction and interdependencies between the “Orders” macro and the “Convert” program.

This process sheet should be placed in an area that is clearly visible when a Manufacturing member is about to use the “Orders” and “Convert” program.

**6.2.6 Streamlining the Manufacturing Information Process Flows**

The following recommendations will aid in streamlining the general Manufacturing information process flows. These recommendations can be implemented independently or in conjunction with the recommendations provided to support the introduction of the new product line.

**Recommendation #20**

It is recommended to standardize the naming convention of the common fields in the Auto-label databases.

This will make reporting across multiple Auto-label databases a very quick and easy task.

**Recommendation #21**

**It is recommended that the Auto-label databases be modified to ensure that they are normalized and properly indexed. The serial number field should also be specified as being unique thus ensuring that serial number duplication does not accidentally occur.**

This will increase the efficiency of querying on the databases and will also ensure that the serial numbers will increment correctly.

**Recommendation #22**

**It is recommended that the Auto-label program's interface be modified to improve its usability.**

Several of the program's screens can be grouped and some of the required fields to fill can be easily eliminated thus streamlining the process of printing labels. For example, instead of typing the date the label was printed, the program can automatically generate and store the date before printing each label.

**Recommendation #23**

**It is recommended that the information collected via the defect log be standardized across the Manufacturing work-cells. The amount of information that must be manually entered should be reduced to only include critical pieces of information. In addition, the defect log should be modified to automatically generate the metrics currently manually created using the information stored in its database.**

**6.2.7 Integrating Information Process Flows**

The following recommendations will aid in integrating the various information process flows.

**Recommendation #24**

**It is recommended that a process be established to ensure that when common applications are used across various teams/departments, the databases and interfaces are standardized.**

This will ensure that reporting across the various databases can be easily performed since common field names are used. Also, standardizing on a common interface decreases

the amount of time spent training individuals who move from one department/team to another.

**Recommendation #25**

**It is recommended that each team/department maintain a map of their current information process flows and make this available via the Intranet. Systems/programs used should be identified on the map as well.**

This will ensure that all the teams are aware of the various systems/programs currently used in the organization, thus eliminating the possibility of creating/purchasing redundant systems accidentally. In addition the map can also be used to identify areas for improvement and may also make implementing new systems easier since the current information has been already collected and gathered, thus saving valuable time and resources.

**6.3 Development and implementation of new information processes that will support the introduction of the new product line**

The following recommendations are with respect to the development and implementation of the new information process flows required to support the introduction of the new product line at GE Multilin. The recommendations will focus on how to apply IT tools in order to streamline the order entry to manufacturing processes with respect to the new product line.

It is important to note that the recommendations identified to support the introduction of the new product line can also be later applied to the other product lines. Once the recommendations have been successfully implemented, with regards to the new product line, and a control mechanism has been put in place to ensure that they will continue to be successful, the best practices can be then shared to the other product lines. Thus each new system introduced must be designed to be portable between product lines and work-cells.

The recommendations in this section will be divided into 4 main categories, which include:

- A. Streamlining the Order Entry Information Process Flows
- B. Integrating Information Process Flows
- C. Streamlining the Manufacturing Information Process Flows
- D. Training Required to Support the New Information Process Flows

### 6.3.1 Streamlining the Order Entry Information Process Flows

#### Correct Order Code Tables Displayed in Documents

These recommendations are necessary to ensure that the order code tables for the new product line will always be up-to-date and correct, thus aiding to ensure that the order codes generated from these tables by customers and Sales Agents will be correct. Once these recommendations have been implemented successfully, a translation strategy should be defined and implemented for the other product lines. This will ensure that the over 150 order code tables, representing the other product lines, will be up-to-date and correct in all the various documents that they are displayed in. A process flow displaying how recommendations 26 through 30 interact together can be seen in Appendix 10.

#### **Recommendation #26:**

It is recommended that the information related to the order code tables be created and maintained in a single location. The information contained in this single source could then be exported to multiple formats, such as Excel and Quark.

This will ensure that all the order code tables in the various formats will contain the latest and correct information.

#### **Recommendation #27:**

It is recommended that a configurator type system be used to contain and maintain all the information related to the order code tables.

Thus the configurator type system would act as the single source of information for order code tables as identified in Recommendation #26.

**Recommendation #28:**

It is recommended that the Product Support Engineers be identified as “owners” of the information related to the order code tables. Thus, each Product Support Engineer would be responsible for updating the order code related information of each of their corresponding products.

**Recommendation #29:**

It is recommended that a process/system be put in place that would allow authorized individuals with the ability to export the order code related information to create the order code tables required in the various formats, such as Excel, Word, and Quark.

Each order code table created would be generated via the system thus ensuring that the correct most up-to-date information is used. Each order code table created would also contain a date stamp identifying when it was created.

**Recommendation #30:**

It is recommended that a process be put in place that identifies to the individuals authorized when the order code related information has been updated by the Product Support Engineers, thus allowing them to re-create up-to-date tables.

E-mail could be used as a “trigger” to identify when the order code tables presented to the customer in a variety of formats should be updated. Thus HTML, Word, Excel, and Quark documents could all be updated at the same time.

**Correct Order Code Generated as Per Customers' Requirements**

These recommendations will ensure that even with the order code combinations ranging in the millions, the customer and the Sales Agents will be able to easily and quickly configure the new product line correctly to best meet the requirements and specifications identified. Once these recommendations are translated to the other product lines, customers and Sales Agents will be able to configure any product easily and correctly.

**Recommendation #31:**

It is recommended that a configurator type system be used to aid customers in the order code generation process by asking them a select number of questions and automatically

determining the correct order code configuration that best meets their needs. This should be available to the customer via the Internet and on CD.

The order code related information displayed by the configurator type system to the customer will always be up-to-date since the Product Support Engineers will be updating and maintaining the information contained within the same configurator. This will ensure that the 45 character created will be correct and Manufacturing will be able to build it.

**Recommendation #32:**

It is recommended that the configurator interface used by the customer to configure the product, to his/her needs and automatically generate the correct order code, be designed with the customer perspective in mind instead of the traditional engineering/manufacturing perspective.

The current order code table format displayed in product catalogs and brochures was originally designed by the engineers developing the product to identify to Manufacturing which configurations were possible to manufacture/assemble. The current order code table format was not originally designed to be used by the customer, and thus does not display the information in such a manner to quickly aid the customer in determining which options best meets his/her needs. In addition, pertinent information that was assumed to be obvious for internal employees, but not for customers is missing from the current tables. However, it is important to note that the current order code table should still be used for internal purposes, which it was originally designed for.

**Correct & Consistent Price/Quote Generation**

These recommendations will ensure that customers and Sales Agents will be able to generate quotes for the new product line easily and quickly, even though the modular nature of the new product line will add major complexity to the price calculation process. Once implemented successfully for the new product line, these recommendations can be used to aid customer and Sales Agents in generating correct and consistently formatted quotes for any product.

**Recommendation #33:**

It is recommended that the same configurator type system be used to provide the customer with the ability to automatically calculate the price of the particular product configured.

This feature should be Web based allowing the customer to generate correct quotes twenty-four hours a day, seven days a week. By allowing the customer with a means to identify him/herself, customer specific prices and discounts may be provided. Further investigation is required to determine where and how the pricing information would be stored and maintained.

**Recommendation #34:**

It is recommended that the same configurator type system be provided to Inside Sales members and Sales Agents to aid them in automatically calculating correct pricing for specific configurations and in generating consistently formatted quotes.

Thus, quotes provided to the customer using the configurator type system will always contain the correct information and will always be formatted in the same manner.

**Configurator Related Issues**

The following recommendations will aid in ensuring that the configurator type system be selected will meet the requirements and implemented successfully.

**Recommendation #35:**

It is recommended to investigate the possibility of storing and maintaining pricing data in the configurator type system. Inside Sales should retain ownership of this process.

An investigation should be conducted to determine if pricing information should be moved from the excel spreadsheet to the configurator type system or another system. If required, a "spread sheet" like report can be created exporting the data from the configurator type system.

**Recommendation #36:**

It is recommended that before the configurator type system is implemented, a process should be established identifying critical inputs and outputs to the system and the individuals responsible for updating the information contained in the configurator.

A preliminary process flow can be seen in Appendix 11.

**Recommendation #37:**

**It is recommended that a cross-functional team be created to compile a complete list of features and functionality that the configurator type system would require before the selection/purchasing phase commences.**

**The team should comprise of individuals from the External and Internal Sales force, from Engineering, and from Manufacturing.**

### **6.3.2 Integrating Information Process Flows**

#### **Complete & Correct Order Entry**

**The following recommendation aids in ensuring that even though the complexity and length of the order code is increased with respect to the new product line, the order related data, including the order code, will be entered correctly into the Order-Ship-Billing system. Once implemented successfully for the new product line, this recommendation can be used to ensure that all order related data will be entered correctly into the Order-Ship-Billing system.**

**Recommendation #38:**

**It is recommended that an investigation be conducted in the possibility of using the Internet and/or EDI to provide customers and Sales Agents with the ability to place orders directly on the Order-Ship-Billing System. An online configurator should be used to ensure that correct order codes are created and quoted correctly.**

**This would eliminate the need for manual data entry thus eliminating all variances and errors caused by data incorrectly entered into the Order-Ship-Billing System.**

#### **Complete & Correct Manufacturing Data Entry**

**The following recommendation aids in ensuring that the order related data including the order code, will be entered correctly into the Auto-label system. Once implemented successfully for the new product line, this recommendation can be used to ensure that all order related data will be entered correctly into the Auto-Label system.**

**Recommendation #39:**

It is recommended that the Auto-label program be modified to allow the user to select a particular order and then use the data already exported from Accpac, via the "Orders" macro, to fill the auto-label form with the particular order related data selected, without the need of manual intervention.

This will eliminate the variances and errors resulting from incorrect manual data entry in the manufacturing process, such as assembling an incorrect unit due to an incorrectly typing the order code.

**Recommendation #40:**

It is recommended that the Test-rig system be modified to automatically extract the product-related information already entered into the Auto-label system without manual data entry. The serial number field can be used as the primary key, enabling the extraction of the particular product related data from the Auto-label system.

This will eliminate the variances resulting from incorrect manual data entry in the testing process.

**Recommendation #41:**

It is recommended that the barcodes of the serial numbers of finished products be scanned into the Order-Ship-Billing and Job Release system instead of manually entering each one.

This will eliminate the variances caused by manual data entry errors, such as not closing the jobs in the systems resulting in a delay in shipment.

### **6.3.3 Streamlining the Manufacturing Information Process Flow**

The following recommendations will aid in streamlining the manufacturing information flow processes with respect to the new product line. Once implemented successfully, these recommendations can then be translated to other product lines.

## **Streamlining the Auto-label Generation Process**

### **Recommendation #42:**

It is recommended that once an Auto-label form is created, documentation is written identifying and describing the various form calculations and important field names. Once the form is modified so should the documentation.

This will aid in maintaining the form and will also aid individuals that have not originally created the form to make modifications easily and quickly. Thus the documentation will identify why a particular form was created in a particular manner. This is extremely important with respect to the new product line due to the fact that the Auto-label form will be more complex and have more calculations than any other form created thus far.

## **Validation in Product Assembly**

### **Recommendation #43:**

It is recommended that a system be put in place that automatically deciphers a product's order code and displays the necessary process sheets and parts that must be selected to properly assemble the product.

This aids in streamlining the process of assembling the product by decreasing the time spent deciphering the order code and determining the correct process sheets and parts for this particular order.

### **Recommendation #44:**

It is recommended that the same system mentioned in the recommendation above have the ability to validate whether the product was assembled correctly. This could be performed by scanning the unique serial number of each part used in the assembly process into the system, which would then compare them to the actual parts that should be used and identify inconsistencies.

This recommendation aids in decreasing the time spent inspecting the assembly of the product and also aids in increasing the quality of the assembly process.

### **Recommendation #45:**

It is recommended that the same system mentioned above be used to automatically capture the information traditionally hand written on the job card, thus streamlining the process.

Information such as the full name of the individual that completed the process step, the individual that inspected the work performed, and the date that the work was performed and inspected can automatically be saved using the system. Using a login screen will aid in identifying the individuals using the system, and thus aid in capturing their full name.

#### **6.3.4 Training Required to Support the New Information Process Flows**

The following recommendations ensure that the proper processes are established and the proper teams are trained in supporting the new information process flows.

**Recommendation #46:**

**It is recommended that a process be established to ensure that the necessary teams and departments be properly trained when new systems are introduced.**

A combination of hands on training and resources such as documentation and user manuals should be available to all. The Intranet can be used to post and print documentation such as user manuals 24x7.

**Recommendation #47:**

**It is recommended that as the systems are implemented, users should be trained on how to provide feedback with regards to issues identified when first using the systems. A feedback mechanism should be put in place providing the users with an easy means to convey feedback to the IM/IT department.**

Once a system has been implemented a feedback cycle is important to ensure continual improvement. Therefore a feedback mechanism should be put in place to allow users to voice their concerns and requests. The feedback can then be used to improve the system, determine how to prioritize the release of upcoming features and functions, and improve the aid in identifying and eliminating software bugs. The “owner” of the information process flow in question should be the contact person with the IM/IT team with regards to taking action on the feedback provided.

## **7.0 Post Implementation**

Since the analysis conducted took place at the same time that the company was establishing its order entry to manufacturing processes to sustain the introduction of the new product line, all the information collected and recommendations generated were immediately shared with GE Multilin for implementation. A cross-functional team was established to aid in implementing the recommendations and included members from the Sales, Manufacturing, Finance, Information Management, and Engineering departments. At the time the product line was officially released into production, a large number of recommendations were implemented as seen in Appendix 12. It is important to note that the organizational change process model, shown in *Figure 2.2.2*, was used as a roadmap throughout the implementation stage.

### **7.1 New Information Process Flow Established**

As a result of implementing the recommendations, a new information process flow was established to support the introduction of the new product line, as seen in Appendix 13. At the time the product line was officially released into production, a new information process flow was in place, addressing 4 major areas which included:

1. Streamlining the Order Entry Information Process Flows
2. Integrating Information Process flows
3. Streamlining the Manufacturing Information Process Flows
4. Training

#### **7.1.1 Streamlining the Order Entry Information Process Flows**

At the time the product line was officially released into production, a “home grown” Web based configurator system was implemented to aid in supporting the release of the new product line. The main goals of this project were to eliminate the defects associated with improper product configuration by both the customer and Sales force and eliminating redundant data entry in the order entry process (recommendations #26 through #37). The cross-functional team realized that the “need for right-the-first-time product configuration had never been greater” and that “companies lose 2-3% of revenue in rework and penalty costs due to errors in the initial product configuration” (PC AI, 1996).

The team identified three main criteria that would aid them in achieving their goals. The first was the fact that the configurator would have to be Web based in order to be easily accessible by both internal and external users. The second was the fact that the configurator would have to be “an add on” to the existing order entry system, since purchasing an integrated configurator would not be feasible since none existed that would easily integrate with either the current or the future order-ship-billing system at the time. The third was that although the configurator would have to be “an add on”, it still would have to interact with the order entry system by passing data electronically, eliminating the redundant data entry factor. Due to these criteria and other factors, it was decided to build the configurator internally, instead of purchasing an “off-the shelf package”.

The configurator would need to possess all the features listed in Table 1, of section 2.3.4, including the ability to access external databases and interact with external programs, a feature that the existing “add-on” configurators did not possess. An additional feature required included the ability for users from the Sales and Manufacturing Teams to easily maintain the program, thus allowing them to take ownership of the information processes. The maintenance piece would allow them to easily edit and update the product definitions and rule sets.

As a result of the analysis conducted and the work performed by the cross-functional team, the configurator system was implemented successfully. It succeeded in meeting its objectives which included: 1. “eliminating the defects associated with improper product configuration” with respect to the Sales force and the customer and 2. “eliminating redundant data entry in the Sales process”. Thus by using the configurator both customers and Sales agents can now quickly and easily configure the new product line correctly to best meet the requirements and specifications identified, even though the order code combinations range in the millions. In addition, a quote can be generated online by both the customer and Sales force

### **7.1.2 Integrating the Order Entry and Manufacturing Information Process Flows**

At the time the product line was officially released into production, recommendations #38 through #41 were implemented successfully. By using the configurator the Inside Sales team no longer needs to manually enter the order code into the OSB system, the order code is

easily transferred between system using a “cut & paste” type method. Without the use of the configurator there would be an 80% probability of miss-typing an order code, twelve out of fifteen orders would be entered incorrectly resulting in a delay in shipment and/or an incorrectly configured product delivered to the customer. With the use of the configurator, manual data entry is eliminated reducing the defects to zero.

In addition, the Auto-label program was redesigned to provide users with the ability to select a particular order and automatically retrieve the orders related information from Accpac and thus generating the labels without any manual intervention. Thus, information such as the order code, company name, P.O.# are automatically filled out on the labels by the system. Thus, all variances attributed to incorrect manual data entry in the manufacturing process are eliminated. Also the time it took to generate a label is reduced from over eight minutes to less than a minute.

Also, the Test-rig system was modified to automatically extract the product related information already entered into the Auto-label program , thus eliminating the need for manual data entry. Thus, all variances attributed to incorrect manual data entry in the Testing process are eliminated.

Another process in which manual data entry was eliminated, included the “Closing the Job” process step. Instead of manually typing each product serial number into both the OSB and Job Release system to signify that the particular order was completed, the serial numbers are now scanned into the systems. Thus, variances caused by incorrectly typing the serial numbers into the systems are eliminated.

### **7.1.3 Streamlining the Manufacturing Information Process Flows**

At the time the product line was officially released into production, recommendations #42 through #45 were implemented successfully. A process was established to carefully document the creation of the Auto-label form and the various calculations and field names contained within. Thus even though the Auto-label form contains the most complex calculations, since it must be capable of handling over 10 different products, it is the easiest to maintain making modifications easy and quick to implement.

A new manufacturing system was implemented, code named “InfoTrack” that aids in validating the assembly process of the new product line. The system automatically deciphers

a product's order code, once the serial number of the product is scanned into the system from the printed label generated from Auto-label, and automatically displays the correct process sheets and parts that must be used to properly assemble the product. The system also validates whether the correct parts are used in the assembly process, by providing the user with the ability to scan the bar code of each part into the system and comparing them with the actual part that should be used. If an incorrect part is used, the system identifies the inconsistency and displays the correct part number that should be used. Thus, even though millions of possible configurations exist with respect to the new product line, the new system makes selecting the correct parts and assembling the parts correctly an easy and quick task. A computer was installed at each work bench of the new work-cell in order to allow the team to use the system at each process step. The system could be used by several manufacturing members working on the same product but at different and independent process steps. The system clearly identified each step that is required to be performed and illustrates which steps have been completed and which still have not. As each process step is completed the manufacturing member completing the process scans his/her personal identification into the system, thus eliminating the need of the traditional job card. Cycle time for each process step is also collected via the system providing essential data for continuous process improvement.

#### **7.1.4 Training**

At the time the product line was officially released into production, recommendations #46 through #47 were implemented successfully. All work-cell members of the new product line were fully trained regarding how to effectively use the new information process flow. In addition, a feedback mechanism was implemented to provide manufacturing members with the ability to give invaluable feedback with respect to debugging and continually improving the information process flow to the IM/IT team.

#### **7.2 Transition Strategy**

As the specifications and requirements for the new systems were being created, the cross-functional team ensured that valuable inputs from the various other work-cells and departments were added to ensure that the new systems being developed could be easily

translated to the other product lines. Two months after the new information process flow was successfully implemented, a transition strategy was developed to translate the new information process flow to the other eleven product lines. Shortly thereafter, an “owner” was identified for each product line to ensure the successful and smooth implementation of the new information process flow. Product line by product line was translated to the new process flow with the help of the IM/IT team. The configurator system, the redesigned Auto-label program, the modified Test-rig program and other related recommendations were successfully implemented for each product line, as seen in Appendix 14. As the new systems were introduced, each respective “owner” was trained on how to maintain and easily update the information contained within the systems. In addition, each “owner” trained also aided in training other “owners” and team members on how to implement and maintain the new systems successfully. Also, a feedback mechanism was implemented to ensure continuous improvement. As a result of the transition strategy, the new information process flow was implemented across eleven other product lines within six months.

### **7.3 Benefits**

An analysis was conducted comparing the old information process flow of a particular product line to the new information flow implemented. It is important to note that the comparison analysis conducted was conceptual in nature and not a data based analysis of actual results. The comparison identifies the number of opportunities for error in the old and new process. An error or defect is defined as an incorrect piece of information that could lead to a late delivery or miss configured product. The results of the analysis can be seen in Table 7.3.

*Table 7.3: Comparison Between the Old and New Processes*

<b>Area of Impact</b>	<b>Defects (old process)</b>	<b>Defects (new process)</b>
<b>Order Entry</b>	5 (Data Entry)	0
<b>Manufacturing</b>	17 (Data Entry)	0
	4 (Database Maintenance)	1
	3 (Form Selection)	0
	3 (Product Assembly)	1
	2 (S/N data entry)	0
<b>Total</b>	<b>34 opportunities/unit</b>	<b>2 opportunities/unit</b>

By implementing the new information process, the number of defects were reduced from approximately 34 opportunities for error per unit to approximately 2 opportunities for error. As more recommendations are implemented, identified from both the thesis analysis conducted and the feedback provided by the teams, the number of defects may be further reduced.

## **8.0 Lessons Learned**

By having had the opportunity to conduct an analysis and at the same time aid in implementing the recommendations that resulted from it, six essential lessons were learned:

### **1. Using a Sociotechnical Approach**

It is essential to consider both technical and social aspects when analyzing a process or system for the purpose of improving or streamlining it. Only by doing so can enough information be collected to implement IT solutions effectively to ensure their continued success and evolution. If either the technical or social aspect of a process or system is not fully analyzed, the chances of successfully improving and streamlining that process or system is severely reduced. The resulting solution may either lack the technical foundation or structure to continue to be a viable option or it may not integrate fully into the organization's culture. Thus using a sociotechnical approach ensures that the resulting solution takes both technical and social issues into consideration.

### **2. The Need for a Well Defined Plan**

The development of a well-defined implementation plan, with short and long-term goals aids in keeping the project on track. By defining the goals and objectives up front, there is less of a chance that the project will be strayed off course due to factors such as "scope creep". Thus, developing and following a well-defined plan will increase the chances of a successful implementation.

### **3. The Need for Training**

The development of a training schedule ensures that all users will utilize the system to its full potential. Training may either take the form of courses, or the distribution of instructions or manuals. Whatever the method used, training is essential for the long-term success of the project. On-line documentation may be enough, but it may be wise to ensure that an e-mail address or phone number be available so that users can call for support when needed.

#### **4. Promoting the System**

Occasionally, training users on how to properly utilize the system may just not be enough to ensure continual usage. Promoting the capabilities of the system and illustrating the advantages of using the system may be required to ensure continual usage. Most users always ask “what’s in it for me?” when confronted with a new tool, thus describing the benefits up front may ease the transition. A similar approach may be used to convince customers to quickly adopt new tools such as an online configurator.

#### **5. Creating Ownership**

For every information process flow or system implemented in the organization, an “owner”, a person or persons responsible for the continued success of the process or system, should be identified. The “owner” identified should be an individual that has great familiarity with the process and/or system in questions and uses it on a regular basis.

To ensure the continued evolution and success of new information process flows, systems should be designed with ease of maintenance in mind, thus providing the opportunity to put ownership back to the individuals/stakeholders that currently own the process. Only the teams and individuals that use the systems/processes on a regular basis can easily identify whether or not the systems are still achieving the desired results and goals. Any issues identified by the “owners” should be brought to the attention of the IM/IT department so that they be resolved before the issues become serious problems.

#### **6. Continual Improvement via User Feedback**

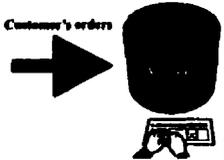
Once the system has been implemented a feedback mechanism is essential to ensure continual improvement. By providing users with the ability to voice their concerns and requests issues can be resolved before they evolve into serious problems. Providing an option for the user to remain anonymous may increase the amount of feedback received. A process should be established to properly capture the feedback provided in order to use it to improve the system, determine how to prioritize the release of upcoming features and functions, and improve the detection and elimination of software bugs.

### **In Conclusion**

**In light of the above, to ensure continued success with respect to using information technology to streamline business processes, the IM/IT team must continue to identify itself as a partner to the organization in implementing IT solutions. Taking the above lessons learned into consideration will aid in identifying and implementing IT solutions successfully. If implemented successfully, these solutions will ultimately aid in streamlining business processes, in improving product quality, and in improving the quality of work life for the entire organization.**

# Appendix #1: Order Entry to Manufacturing Information Process Flow

## Inside Sales



Open orders

## Manufacturing Work-Cell

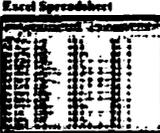


(Export of open orders from Accpac)

Auto.mac

Auto.prn

Convert.exe



(The excel spreadsheet is used by a majority of the work-cells to replace Accpac's standard "order action report". The added features it contains include the identification of new, late, and changed jobs that are currently "open". This is usually run by the work-cell each morning.)

(There are currently 3 different versions of the Autolabel program currently in use which include PartForm Pro, FormFlow 1.1 and FormFlow 2.1 Non-compatibility is an issue.)

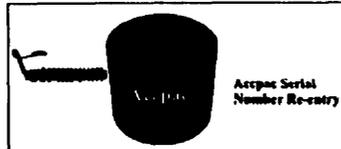


Repair Database

(There are currently 3 alternate methods that a particular work-cell may use to record repairs. The first is the FaxPro database created for all work-cells, the second is the recent Excel version that automates charging and the third is the non-electronic "july sheet".)



Parts used are stored via a special barcode reader and then dumped into the PQRS database manually.



Accpac Serial Number Re-entry

(The serial numbers created by the work-cell are either re-entered into Accpac manually or are scanned in.)



Job Release Database

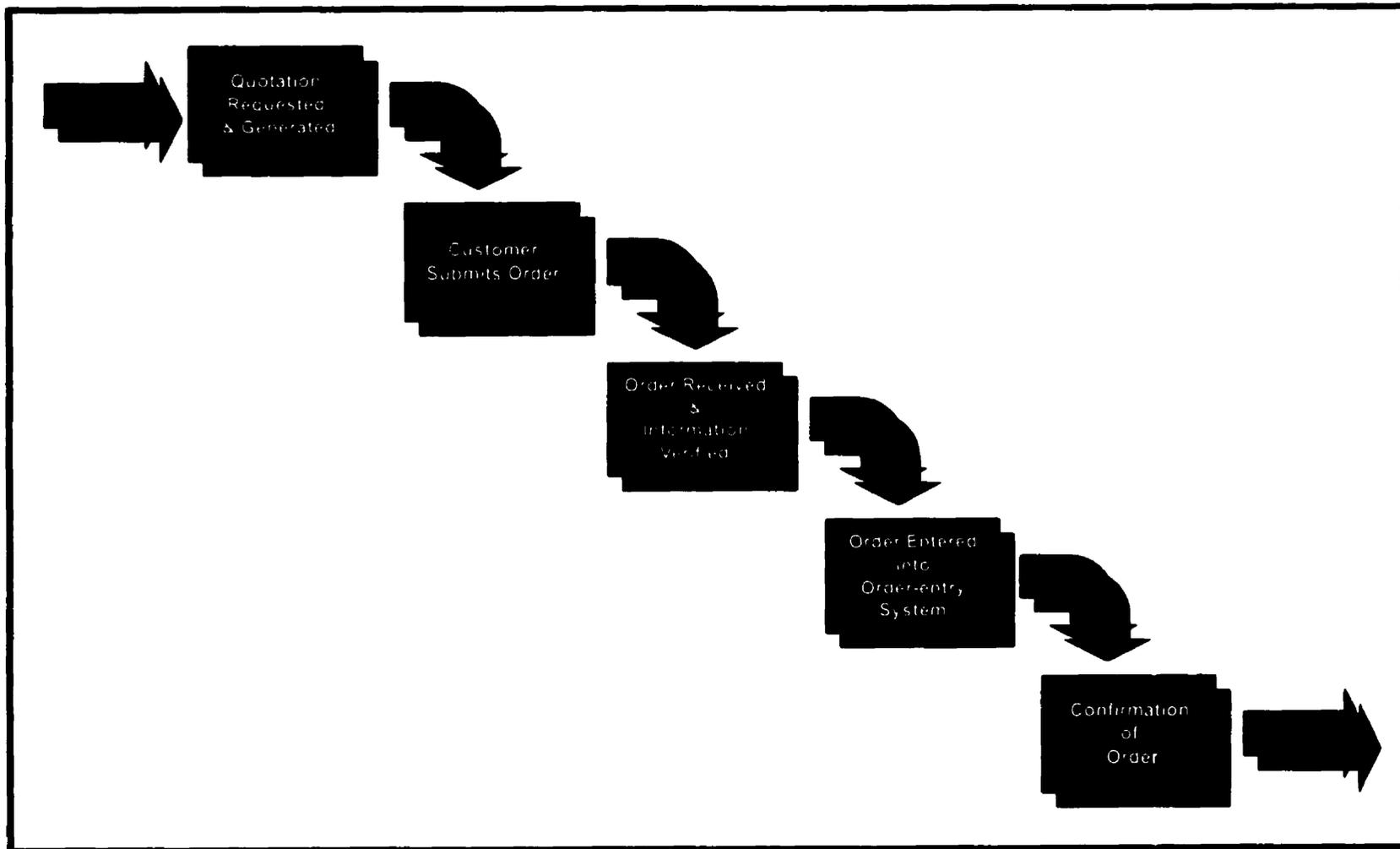
Used to subsume to shipping and accounting that jobs are completed

(The Autolabel database is a FaxPro based application and is structured differently for each work-cell. 13 standard fields exist. There can be numerous databases per work-cell per product. These databases can be easily merged.)

By typing or scanning a serial number into the test-rig, autolabel data is automatically retrieved and a final test sheet is then produced

Test Rig

## Appendix #2: Order Entry Information Process Flow



### Appendix #3: Purchase Order Check List

1. Company name
2. P.O.#
3. Bill to
4. Ship to
5. Terms
6. FOB
7. Date required
8. Ship via
9. PPD or Collect
10. Order Code
11. Quantity
12. Price
13. End user
14. Consultant name & related info.
15. References  
(for new customers only)

## GE MULTILIN PURCHASE ORDER CHECKLIST

Purchase orders must be made out to "GE MULTILIN"  
 Phone: (985) 294-6222  
 Fax: (985) 294-8512

POP \_\_\_\_\_

BILL TO:	SHIP TO:	SHIP VIA	PPD or COLLECT
3	4	8	9
5	6	7	

TERMS:  NET 30  FOB  MAREMAN  DATE REQ'D

FULL ORDER CODE \_\_\_\_\_

END USER NAME AND LOCATION (CITY/STATE) \_\_\_\_\_

CONSULTANT NAME AND LOCATION \_\_\_\_\_

ATTACH REFERENCES IF NEW CUSTOMER \_\_\_\_\_

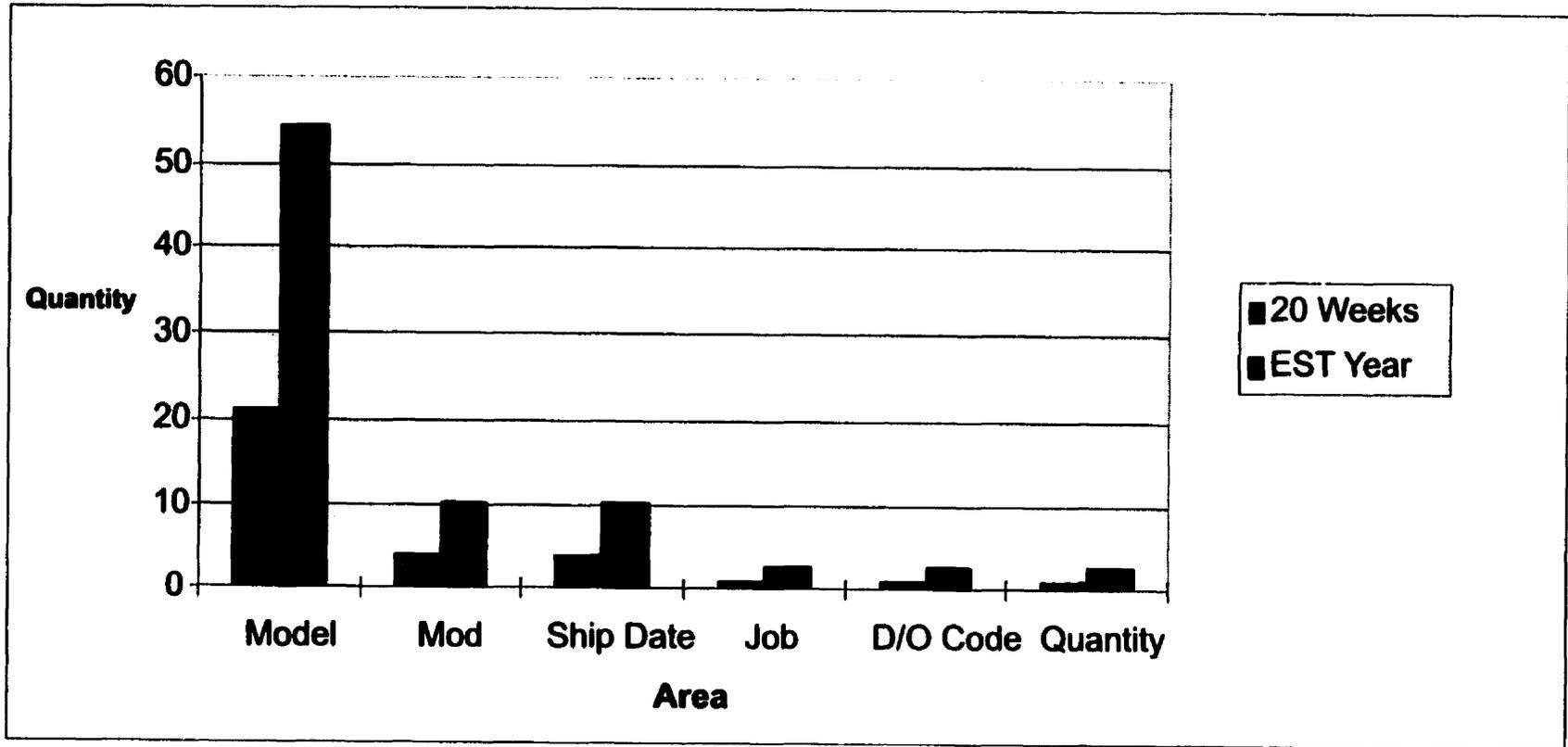
QUANTITY \_\_\_\_\_ PRICE \_\_\_\_\_

CITY \_\_\_\_\_

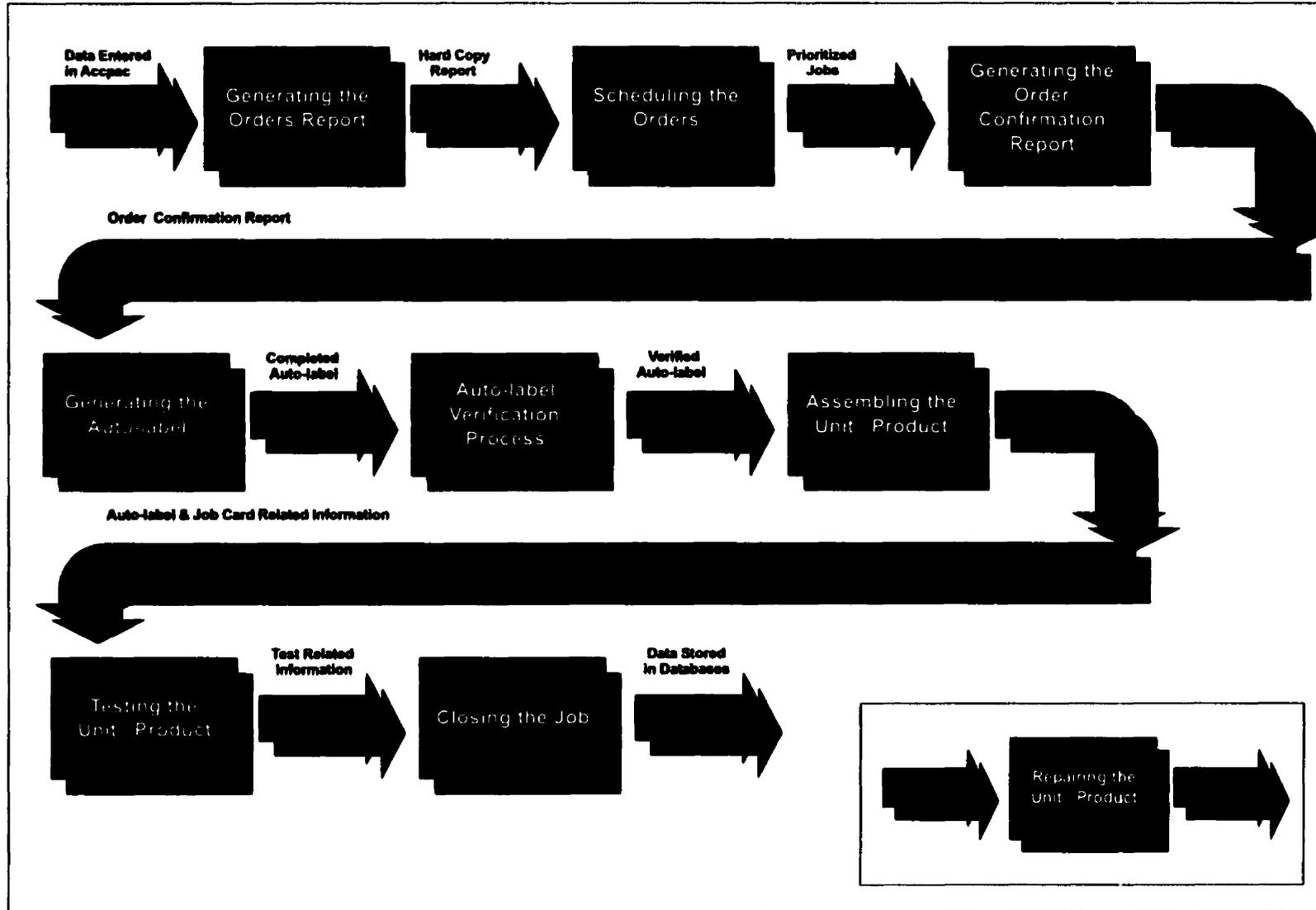
POPULATION REF AT 1253P

### Appendix #4 Defects attributed to Data Entry

104



# Appendix #5 : Manufacturing Information Process Flow

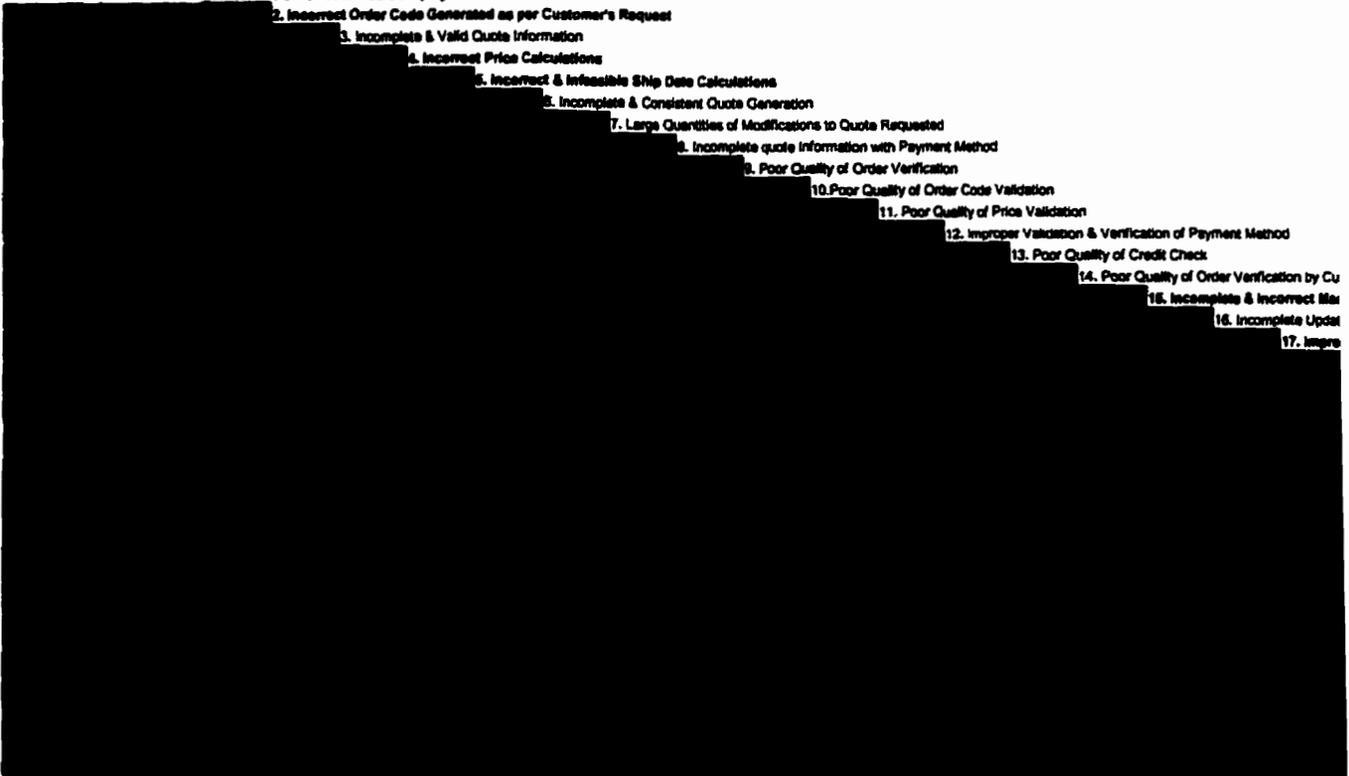




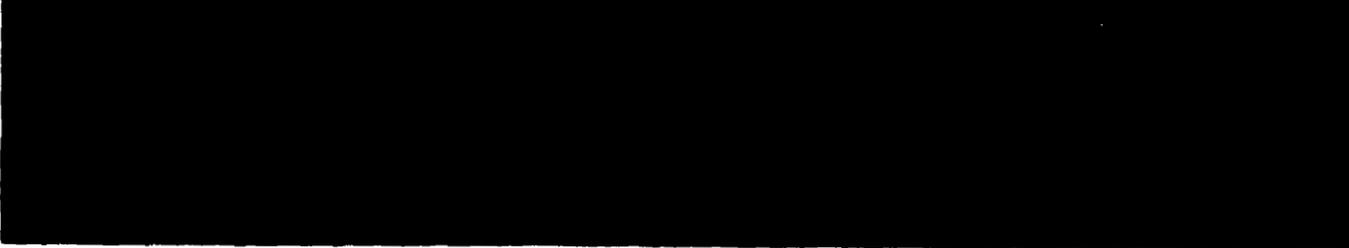
Appendix #7

ORDER-ENTRY TO MANUFACTURING PROCESS VARIANCE ANALYSIS

1. Incorrect Order Code Table Displayed in Documents
2. Incorrect Order Code Generated as per Customer's Request
3. Incomplete & Valid Quote Information
4. Incorrect Price Calculations
5. Incorrect & Infeasible Ship Date Calculations
6. Incomplete & Consistent Quote Generation
7. Large Quantities of Modifications to Quote Requested
8. Incomplete quote information with Payment Method
9. Poor Quality of Order Verification
10. Poor Quality of Order Code Validation
11. Poor Quality of Price Validation
12. Improper Validation & Verification of Payment Method
13. Poor Quality of Credit Check
14. Poor Quality of Order Verification by Customer
15. Incomplete & Incorrect Material
16. Incomplete Update
17. Improve



Phase	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Assembling the Unit / Product	1	2													15		
	1	2													15		
	1	2															17
Testing the Unit / Product	1	2													15		
	1	2													15		
	1	2													15		
Closing the Job																	17
																	17
				4													

















## Appendix #8: Technical Analysis Key Variance Control Table

Note: When identifying the unit operation the letter refers to either the Sales (S) or Manufacturing (M) process, the number refers to which one

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
<b>1. Incorrect Order Code table displayed in documents</b>	Creation of order code tables (outside the order entry and manufacturing processes)	<p>S3. Order Received &amp; Information Verified</p> <hr/> <p>M2. Scheduling the Orders (invalid order codes may be identified by visual inspection)</p> <hr/> <p>M6. Assembling the Unit (all remaining invalid order codes are identified at this stage)</p> <hr/> <p>The customer will identify products that have not been configured as per original spec, thus incorrect order codes</p>	At the point where the order code tables are manually re-created for other documents (manuals, brochures, product catalogs, etc...)	Product Support Engineer (the Product Support Engineer originally generates the order code table and is ultimately the person who can identify whether other copies of the table are incorrect)	Visual inspection of the copied tables, comparing the copies with the original	The original order code table is required and the time/date the table was last updated.	<p>An "owner" should be formally identified who would be responsible to ensure that the particular "order code table" be updated. The Product Support Engineer seems to be the best choice.</p> <p>A process should be put in place that aids the "owner" to identify to others when and what changes should be made to the order code table. Each new order code table created should be inspected for validity before being released.</p>	<p>A configurator type system could be used to contain all the information related to the order code tables. The Product Support Engineers (owners of the information) would update the order code information.</p> <p>A system would then be put in place that would allow authorized individuals to create the order code table required in the various formats needed, such as Excel, Word &amp; Quark. Each order code table created would be generated via the system thus ensuring the accuracy of the data.</p>

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
2. Incorrect Order Code generated as per customer's requirements	S1. When the quote is generated	S1. Quotation generated & requested	S1. When quote is generated	By either a Sales Agent or an Inside Sales member	Assessing the customer's needs and requirements and then generating an order code that best fits the description	Information regarding the customer's needs and requirements.	When a Sales agent or an Inside Sales member receives an order code from a customer, they should not assume that the order code given meets the customer's needs. If possible they should ask the customer if they need assistance in ensuring that order code generated meets their needs.	Utilize a "configurator" type system that could "walk the customer" through the order code generation process by asking a variety of questions to adequately determine which options most meets the customer's needs and requirements. By allowing users to access this system via the Internet, customer's would be able to configure the product to best meet their needs, 24 hours a day, 7 days a week.
		S5. Confirmation of Order When the customer receives the order and attempts to use the product	S2. When Inside Sales receives the order					

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
<b>4. Incorrect Price Calculations</b>	S1. Quotation Requested & Generated (either by a Sales Agent or Inside Sales)	S1. Quotation generated & requested	S1. When quote is generated	Inside Sales controls the price structure and creates the price list while the Sales Agent determines which discount is applied to which customer	A sales member manually compares the order code provided by the customer to the breakdown listed on the Excel spreadsheet and manually adds the necessary options to the base price. Depending on the customer a discount schedule may be used in the quotation process.	An up-to-date price list and the customer's specific discount schedule are required.	Train individuals to place the price list and discount schedules on the company Intranet so that the up-to-date lists are available to all.	Utilize a "configurator" type system to automatically generate the correct price while the order code is being configured. By having this system available on the Internet, with the appropriate security measures, customers could generate their own quotes, with prices customized to them. In addition, Sales Agents across the globe could access this system to generate correct and consistent quotes.

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
5. Incorrect & Infeasible Ship Date Calculations	1. Quotation Requested & Generated	<p>S1. Scheduling the Orders during the <u>quoting process</u></p> <p>By the customer, when the order is not delivered as promised.</p>	S1. Quotation Requested & Generated	Inside Sales	Manually analyzing the lead time required to build the product and checking the current job schedules.	The lead time for the particular product and the current job schedule	The lead time for the various products should be updated and provided to Inside Sales by the respective work-cell leaders as often as required. Also for large orders, the work-cell leaders must be contacted to verify the ship-date issued. Thus training is required to ensure that this occurs.	A scheduling package could be used to automate the process of issuing ship dates. The system would take in consideration the various lead times and the current job schedule. For large quantities, the system may require the work-cell leader to authorize the ship date provided to the customer.

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
<b>15. Incomplete &amp; Incorrect Manual Data Entry (Accpac)</b>	S4. Order Entered into Order-Entry System.	S5. Confirmation of Order (customer may identify inaccurate information)	S4. Order Entered into Order-entry System	The Inside Sales member responsible for data-entry controls this process.	Comparing the data entered with the data contained in the original order submitted	The original order And the data entered into order-entry system are required.	Training is required to enforce the process of visual inspection. Also training is required to ensure that once an order is entered, the information is verified to be correct by manually comparing the data with the original order.	Providing the customer with the ability to enter the order directly into the order-entry system, thus eliminating manual data entry. EDI or the Internet may provide the customer with this ability. The appropriate verification and validation checks must be in place before customers could place orders directly into the system.
		M4. Generating the Auto-label (a manufacturing member may identify invalid data at this stage)						
		M6. Assembling the Unit (Invalid order code will be identified at this stage)						
		By the customer when they receive a product that was not as originally specified.						

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
17. Improper Verification of Job Entry to System	S4. Order Entered into Order Entry System	S5. Confirmation of the Order (the customer will receive 2 order confirmations with different job numbers but the same P.O.)	This variance is controlled at the point of data entry.	Inside Sales	Ensure that the same customer purchase order number is not used more than once.	The purchase order number is required.	All orders should be verified by the local Sales Agent first, thus the order should only be entered once the Sales Agent forwards the order.	Accpac should be modified to automatically check to ensure that the customer purchase order number is unique and has never been entered before.
		M2. Scheduling the Order (the work-cell leader may notice that 2 exact orders were placed and must be delivered on the same day)						

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
19. Incorrect Usage of the Accpac Reporting Tool	S5. Confirmation of Order	M2. Scheduling the orders	S5. Confirmation of order	Inside Sales	Limit the amount of time a job is viewed, or print the job details instead	Information regarding the usage of Accpac and potential results of misuse	Train Inside Sales in the proper usage of Accpac. A job should be printed instead of viewed live, if no changes are being made.	The macro should be set to identify which jobs were not properly exported from the system. An error log should be generated so manufacturing would be able to identify when to re-run the macro.
			M1. Generating the Orders Report (running the "orders" macro)	Manufacturing team member responsible for generating the orders report	Ensure that no one is viewing an order before running the macro	Information regarding the interactivity between the macro and Accpac	Specific times in the day, such as early in the morning and at lunch, should be identified as time intervals when the macro should be run. If the macro must be run at other times, Sales may be required to be contacted to ensure that no one is viewing the job.	

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
<b>21. Incorrect &amp; Improper Usage of the "Orders" Macro and "Convert" Program</b>	M1. Generating the Orders Report	M2. Scheduling the Orders	M1. Generating the Orders Report	The manufacturing member running the "convert" program	Ensure that the "orders" macro has been run first before running the "Convert" program. This ensures that the latest data will be used to generate the "open orders" report.	The last time the "orders" macro was run.	Create a process/instruction sheet that explains the interactions between the macro and the "Convert" program. The process sheet should be placed in an area that is visible when performing the task at hand.	Automate the "orders" macro to run early in the morning and during lunch. An error log should be automatically generated identifying jobs that were potentially skipped. An analysis should be performed regarding merging the "orders" macro and "Convert" program into a unified program. At a minimum the last time the "orders" macro was run should be clearly identified on the "open orders" report generated by the "Convert" program.

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
<b>26. Incomplete &amp; Incorrect Manual Data Entry (Auto-label)</b>	M4. Generating the Auto-label	M6. Assembling the Unit (Invalid order code will be identified at this stage)	M4. Order Entered into the Auto-label Program	The Manufacturing member responsible for data-entry controls this process.	Comparing the data entered with the data contained in the order confirmation report	Order confirmation report and the data entered into order-entry system	Enforce the process of visual inspection and ensure that once an order is entered, the information is verified to be correct by manually comparing the data with the original order	The Auto-label program may be able to be modified to allow the user to select a particular order and then automatically export the necessary information already stored in Accpac to complete the auto-label form, without manual intervention.
		By the customer if they receive an incorrectly configured product.						

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
<b>31. Improper Database Design &amp; Standards</b>	When the Auto-label databases were first designed and when new ones are introduced.	Reporting across multiple databases	When the databases are first designed	Manufacturing work-cell members responsible for developing and maintaining the Auto-label databases	Proper design methodologies should be used (i.e.: Normalization rules should be applied)	Database design methodologies	Training the individuals responsible for database development is required. The IM department should be responsible, or at least involved, in the design and development of such databases.	The Auto-label databases should be upgraded to at least Access 2.0. Currently the databases are designed in Fox Pro (version 2.6). This old version of Fox Pro is limited in capability compared to the newer database programs available now.

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
38. Improper Interpretation of the Order Code	M6. Assembling the Unit	M6. Assembling the Unit	M6. Assembling the Unit	Manufacturing team	Correctly translating the order code to aid in collecting the parts and process sheets required.	Correct order code and correct order code breakdown and interpretation	Work-cell members should not only be trained regarding the order code and the variety of related options and modifications but should also have a product catalog handy at all times. The product catalog explains the order code and related options and modifications in detail.	A system can be developed that automatically deciphers the order code and displays the necessary process sheets and parts that must be selected to properly assemble the product. Thus the system would ultimately validate whether the product was assembled correctly.
		Customer receives incorrectly configured product						

Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
<b>46. Incomplete &amp; Correct Manual Data Entry (Test-rig)</b>	M7. Testing the Unit/product	M7. When the product fails the test.	M7. When manually entering the data.	The Manufacturing member responsible for data-entry controls this process.	Comparing the data entered with the data contained in the order confirmation report	Order confirmation report and the data entered into order-entry system	Train employees to enforce the process of visual inspection and ensure that once an order is entered, the information is verified to be correct by manually comparing the data with the original order.	The Test-rig program may be able to be modified to automatically extract the information already entered in the Auto-label system. The serial number would be the key, and be used to extract the data from the Auto-label database.

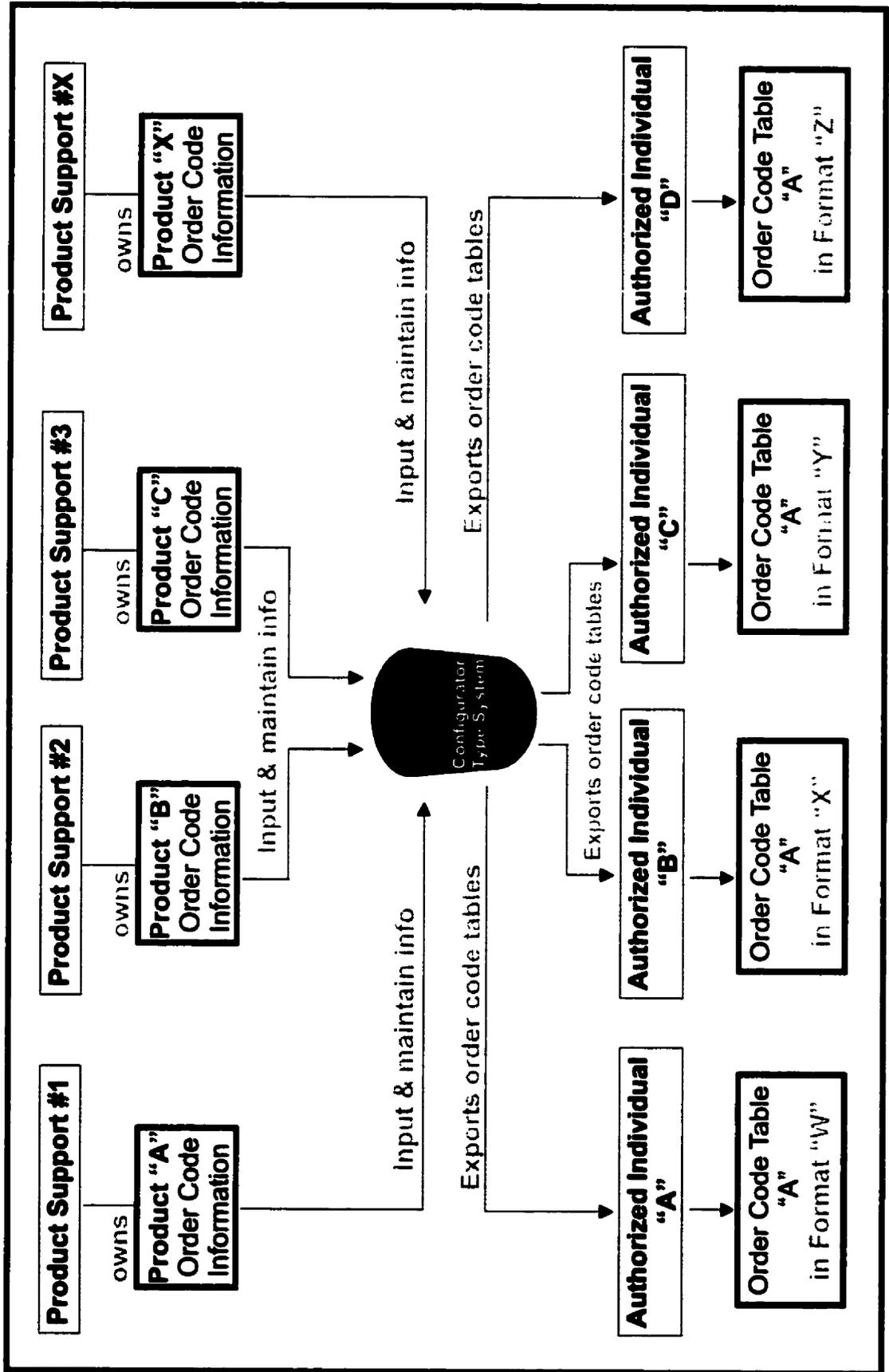
Key Variance	Name of Unit Operation			Controlled by whom?	Activities Required to control	Info related to Control Activities	Suggestions For Jobs or Organization Redesign	Suggestions for changes in the Technology
	Where Occurs	Where Observed	Where Controlled?					
57. Non-Standardized Data Collection Method	M9. Repairing the Uni/Product	Consolidating data across databases.	M9. Repairing the product	Work-cell members who identify a defect and the individuals who attempts to solve the issues identified	Capturing the data related to defects in a standard format and retyping the information already contained in the Auto-label database.	Data related to defects (both the initial problem identified and the particular solution needed to resolve the problem). The information contained in the Auto-label database regarding the product characteristics such as the order code.	A standard process to collect data regarding defects should be created. Input needed to create the process should come from individuals located across the various work-cells. Current best practices should be leveraged and improved. Communication across work-cells should be more widely promoted.	A standard data collection system should be implemented. The data collected should only be mandatory if it aids in meeting the original goals of the system. The goals include: to aid in generating reports that share common data across work-cells and to ease the process of identifying problematic issues when the product returns from the field for servicing..
		When product returns from the field for servicing.						

**Appendix #9: Interdependencies between Recommendations Suggested & the Key Variances Identified**

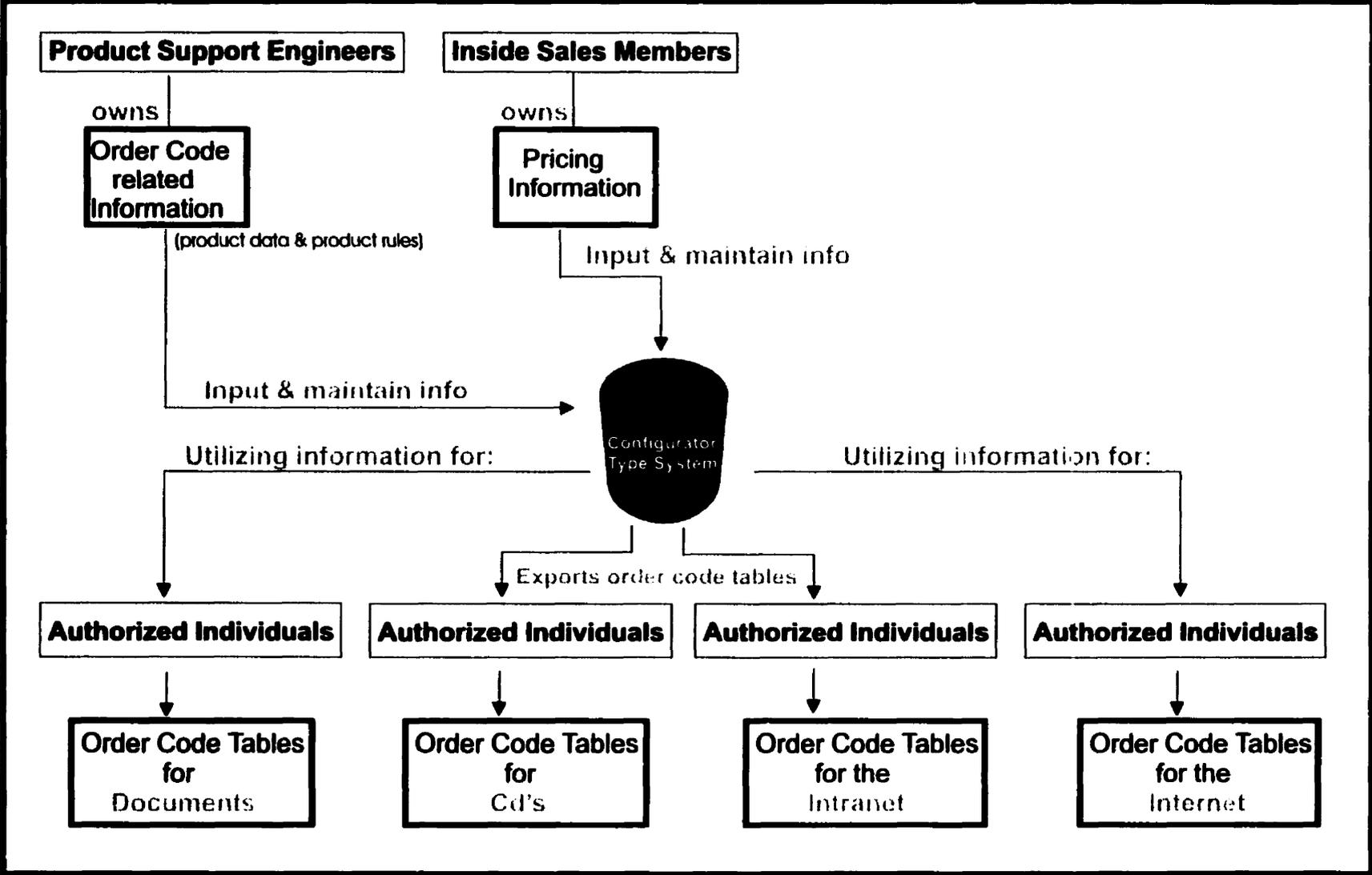
Technology Changes	Key Variances Affected												
	1	2	4	5	15	17	19	21	26	30	38	46	57
Configurator Type System	√	√	√		√				√		√	√	
Scheduling Package (Ship Dates)				√	√								
EDI or INET connection to OSB					√				√		√	√	
Accpac Fix - P.O.# or uniqueness						√							
Accpac Macro Error Log							√	√					
Auto-Label Modifications									√		√	√	
Database Upgrades										√			√
Product Assembly Validation System											√		
Back-End System Integration					√				√	√		√	
Standard Data Collection System										√			√

Job & Organizational Design Changes	Key Variances Affected												
	1	2	4	5	15	17	19	21	26	30	38	46	57
Creating "owners"/ownership	√		√							√			
New "validation" processes	√	√			√	√		√	√			√	√
Training	√	√	√	√	√	√	√	√	√	√	√	√	√

# Appendix #10: Process Flow for Recommendations 26 through 30



# Appendix #11: Configurator Information Process Flow



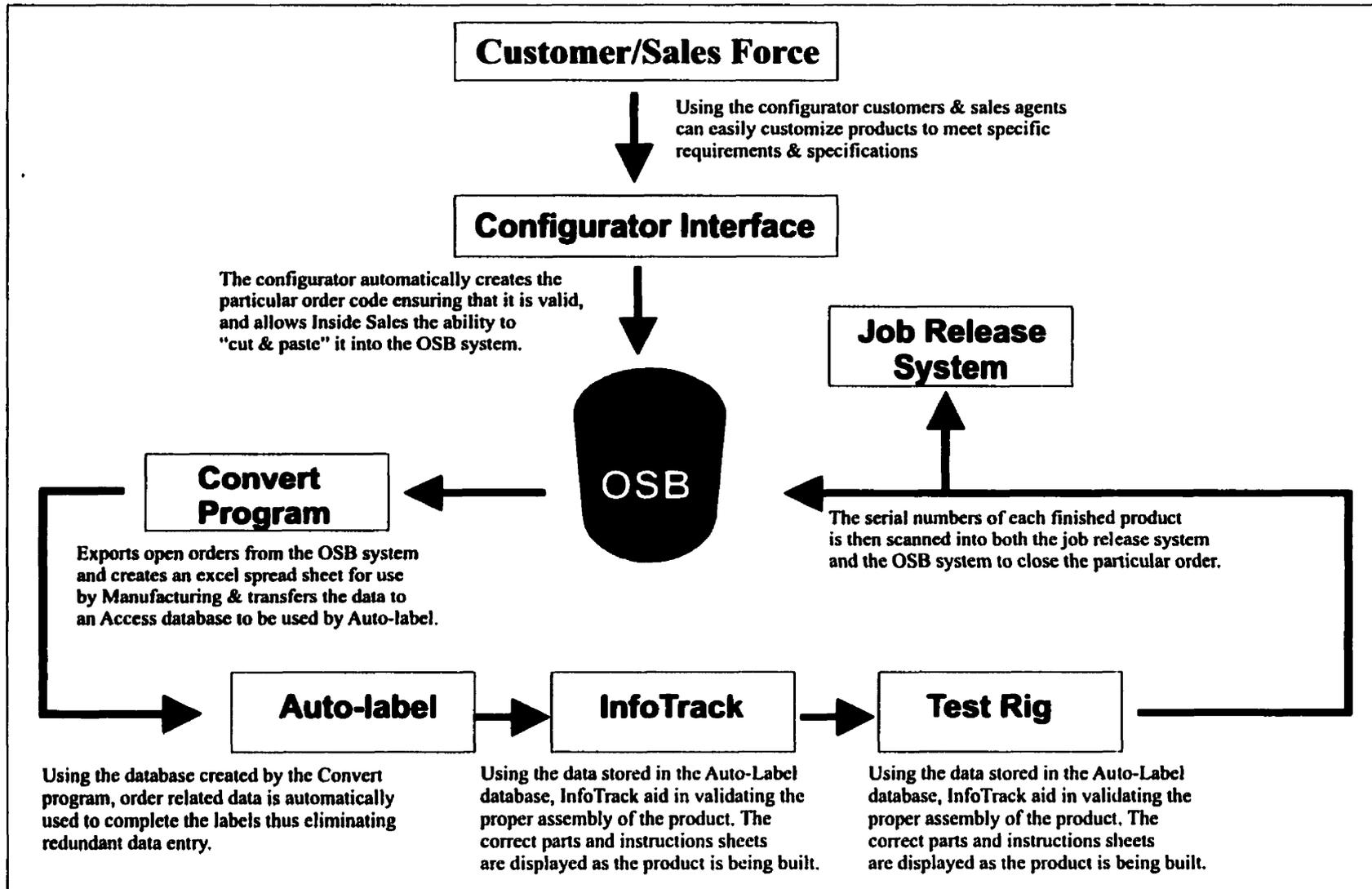
## Appendix 12

Status of recommendations at the time the new product was released into production.

Recommendation		Status
<b>General recommendations</b>		
IM/IT Team as a partner in bringing about Process Improvement	#1	Implemented
	#2	In development
	#3	Implemented
	#4	Implemented
	#5	Implemented
	#6	In development
Training	#7	Not implemented
	#8	In development
	#9	Implemented
Communication	#10	Implemented
	#11	Implemented
	#12	Not implemented
Streamlining the Order-Entry Information Processes	#13	Implemented
	#14	Implemented
	#15	Implemented
Streamlining the OE to Mfg. Information Processes	#16	Implemented
	#17	In development
	#18	In development
	#19	Implemented
Streamlining the Mfg. Information Processes	#20	Not Implemented
	#21	New product line only
	#22	New product line only
	#23	In development
Integrating Info. Process Flows	#24	In development
	#25	Not implemented
<b>New product line specific recommendations</b>		
Streamlining Order Code Tables Displayed in Documents	#26	Implemented
	#27	Implemented
	#28	Implemented
	#29	In development
	#30	Implemented
	#31	Implemented
	#32	Implemented
	#33	Implemented
	#34	Implemented
	#35	Implemented
	#36	Implemented
#37	Implemented	

<b>Integrating Information Process Flows</b>	<b>#38</b>	<b>In development</b>
	<b>#39</b>	<b>Implemented</b>
	<b>#40</b>	<b>Implemented</b>
	<b>#41</b>	<b>Implemented</b>
<b>Streamlining the Mfg. Information Processes</b>	<b>#42</b>	<b>Implemented</b>
	<b>#43</b>	<b>Implemented</b>
	<b>#44</b>	<b>Implemented</b>
	<b>#45</b>	<b>Implemented</b>
<b>Training</b>	<b>#46</b>	<b>Implemented</b>
	<b>#47</b>	<b>Implemented</b>

## Appendix 13: New Information Process Flow



## Appendix 14

Recommendations that were translated to other Product lines.

Recommendation	Status	
<b>General recommendations</b>		
IM/IT Team as a partner in bringing about Process Improvement	#1	Implemented
	#2	Implemented
	#3	Implemented
	#4	Implemented
	#5	Implemented
	#6	Implemented
Training	#7	In development
	#8	Implemented
	#9	Implemented
Communication	#10	Implemented
	#11	Implemented
	#12	Not implemented
Streamlining the Order-Entry Information Processes	#13	Implemented
	#14	Implemented
	#15	Implemented
Streamlining the OE to Mfg. Information Processes	#16	Implemented
	#17	In development
	#18	In development
	#19	Implemented
Streamlining the Mfg. Information Processes	#20	Implemented
	#21	Implemented
	#22	Implemented
	#23	Implemented
Integrating Info. Process Flows	#24	Implemented
	#25	In development
<b>Recommendations translated from new product line</b>		
Streamlining Order Code Tables Displayed in Documents	#26	Implemented
	#27	Implemented
	#28	Implemented
	#29	In development
	#30	Implemented
	#31	Implemented
	#32	Implemented
	#33	Implemented
	#34	Implemented
	#35	Implemented
	#36	Implemented
	#37	Implemented

<b>Integrating Information Process Flows</b>	<b>#38</b>	<b>Implemented</b>
	<b>#39</b>	<b>Implemented</b>
	<b>#40</b>	<b>Implemented</b>
	<b>#41</b>	<b>Implemented</b>
<b>Streamlining the Mfg. Information Processes</b>	<b>#42</b>	<b>Implemented</b>
	<b>#43</b>	<b>Only for one product line</b>
	<b>#44</b>	<b>Only for one product line</b>
	<b>#45</b>	<b>Only for one product line</b>
<b>Training</b>	<b>#46</b>	<b>Implemented</b>
	<b>#47</b>	<b>Implemented</b>

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