RESOURCE PLANNING SOLUTION FOR XENTRAL TECHNOLOGIES' XIAMEN BUSINESS UNIT

by

Ya-Lan Chin
Bachelor of Science, University of British Columbia

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APPROVAL

Name: **Ya-Lan Chin**

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Supervisory Committee:

____

Pek Hooi Soh
Senior Supervisor
Assistant Professor of Technology Management and Strategy

____

Andrew von Nordenflycht
Second Reader
Assistant Professor of Strategy

Date Approved: ____

ABSTRACT

Xentral Technologies' manufacturing facility in Xiamen, China, is experiencing growing pain as the revenue nearly doubled in 2010. The company is looking for a resource planning solution to manage the scale-up of engineering and purchasing personnel to support such rapid growth. This project develops the solution based on internal data collected from interviews with Supply Chain, Engineering, and Business Leaders. Final deliverables include a spreadsheet tool to estimate the purchasing and engineering personnel required from May 2010 to April 2011, a staffing plan, and personnel management recommendations.

DEDICATION

If not for the support of my parents, completion of the Management of Technology MBA program would not have been possible. I am grateful for everything my parents have done for me throughout the program and would like to take this opportunity to dedicate this work to my parents.

ACKNOWLEDGEMENTS

Thank you to the Xentral Technologies employees who provided valuable information and feedbacks throughout the course of the project.

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GLOSSARY

AI	Article Inspection – a manufacturing program on SMT machine
AOI	Automated Optical Inspection – a manufacturing program on SMT machine
BOM	Bill of Material – a document that contains all material information of a product
BU	Business Unit
CAD	Computer Aided Design – CAD files are required for new product introduction
CFT	Customer Focus Team – Xentral's customer centred structure
CFTL	Customer Focus Team Leader
CRIPR	Consolidated Revenue and Inventory Projection Report
DFM	Design for Manufacturability – a software that checks manufacturability issues
DFT	Design for Testing – a software that checks testing issues
EL	Engineering Leader
ECO	Engineering Change Order – generated when there are product revision changes
EOS	End of Sales – products or parts will be set to EOS status during Product Closing stage
EMS	Electronics Manufacturing Services
ERP	Enterprise Resource Planning
FA	First Article – the sample from trial production to check if the parts or products meet specifications
FG	Finished Good
MS	Material Specialist
NCR	Non-Conformance Report – a document that traces corrective actions for defective materials or products
NPI	New Product Introduction
PCE	Product Cost Engineering – a function at the head office that prepares Xentral's quotations to potential new customers
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
PM	Program Manager
PO	Purchase Order
P&P	Pick & Place – a manufacturing program on the SMT machine
PPV	Purchase Price Variance
PS	Procurement Specialist
PM	Program Manager
RMA	Return of Materials – defective products returned by customers
SCL	Supply Chain Leader
SMT	Surface Mounted Technology

1: INTRODUCTION

1.1 Company Profile

Xentral Technologies provides contract manufacturing services to electronics OEMs (Original Equipment Manufacturer) and ranks 27th in the world, or 8th in North America in the EMS (Electronic Manufacturing Services) industry. The majority of Xentral's customers are in the US and Canada. Established in 1991, Xentral Technologies expanded from a small Vancouver company with $1 million revenue and fewer than 20 employees to an international company with over $350 million revenue and 2100 employees. Currently, there are 11 business units, four of which are direct branches from organic growth and seven are new business units from acquisitions. All business units are independent and have full autonomy in operations. Each business unit has $31 million to $59 million revenue and 85 to 300 employees. Table 1 shows the list of business units and their locations. All business units within Canada were from organic growth and business units located outside of Canada were acquired.

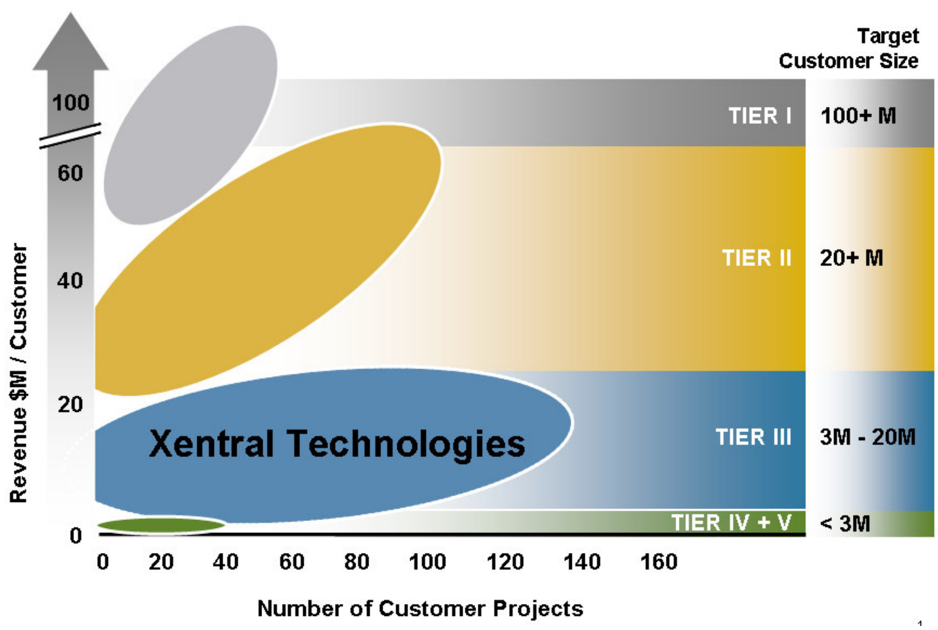
Table 1 – Xentral Technologies Business Unit List

Business Unit	Location	Abbreviation
Burnaby	Burnaby, BC, Canada	BBY
Vancouver	Burnaby, BC, Canada	VAN
Mississauga	Mississauga, ON, Canada	MIS
Toronto	Markham, ON, Canada	TOR
Milwaukee	Oak Creek, WI, USA	MIL
Dallas	Plano, TX, USA	DAL
Lexington	Lexington, KY, USA	LEX
San Peter	St. Peter, MN, USA	STP
Santa Clara	Santa Clara, CA, USA	SAN
Chicago	Wheeling, IL, USA	CHI
Xiamen	Xiamen, China	XIA

1.2 Electronics Manufacturing Services (EMS) Industry

EMS companies provide manufacturing services for customers who do not want capital to be tied up in manufacturing assets and prefer to focus on other aspects of their business, such as design and marketing. The global market value of EMS was $160 billion in 2009 and anticipated to grow by a compound annual growth rate of 6.8% to reach $222.5 billion in 2014. As for 2009, the geographical market share of the EMS market is 50.4% for Asia-Pacific, 20.9% for America, 16.9% for Europe, and 11.9% for the rest of the world (Datamonitor, 2010). In the EMS industry, customers are categorized by contract value into five tiers. Figure 1 shows the contract value range of customers in different tiers and Xentral's positioning.

Figure 1 – Customer Tiers Based on Contract Value



Source: Xentral Technologies LP

With manufacturing contract value above $100 million, Tier I customers are consumer electronics OEMs characterized by large volume, low product mix, and low product complexity, like Apple and Dell. These customers usually partner with large scale EMS providers in China. Tier II customers are characterized by medium volume, medium product mix, and low product complexity. Examples of Tier II customers are TomTom and Hamilton Beach. Their manufacturing contract value ranges from $20 million to $100 million. Tier III customers are characterized by medium volume, high product mix, and high product complexity like Siemens. Their contract value ranges from $3 million to $20 million. Xentral[1] is one of the 15 major players in Tier III. Tier IV and V customers are usually start-up companies that do not have significant market shares yet. Their contract value is less than $3 million.

1.3 Company Mission and Corporate Strategy

Xentral's mission is "to provide the solution of choice for customers who need a focused and responsive manufacturing partner for medium-volume, complex electronic products" (Xentral Technologies, 2010). The corporate strategy is to maintain on-going growth by focusing on the following activities:

a. Maintain financial stability with rigorous focus on ROA (Return on Assets) and debt to assets ratio.

b. Enhance competitiveness by widening service offerings and acquiring manufacturing sites in low cost regions.

c. Invest in IT infrastructure to improve information transparency and operational efficiency.

d. Cultivate a people-centred culture to promote employee satisfaction and engagement.

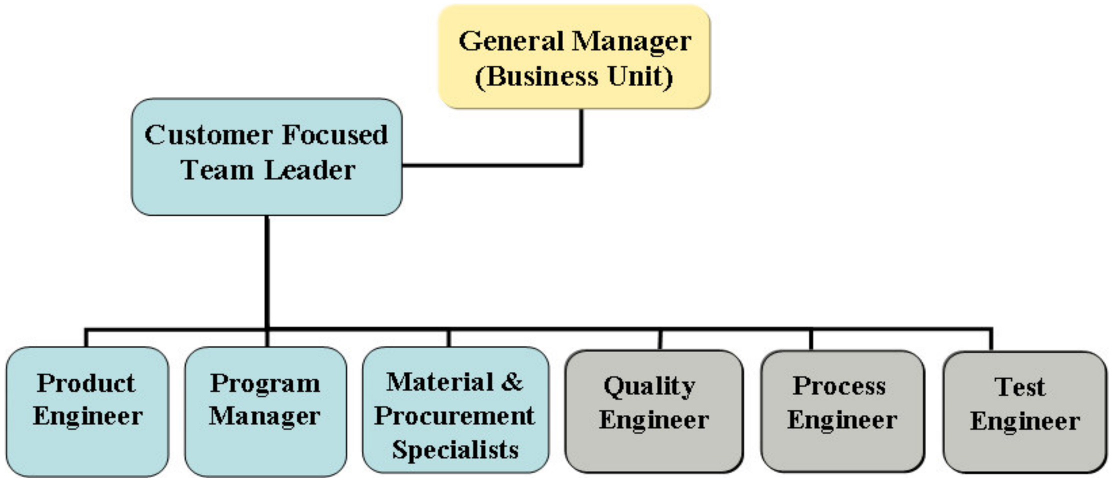
[1] Xentral will be used instead of Xentral Technologies for the rest of the paper.

To avoid heavy dependence on a few high revenue accounts, Xentral's business strategy is to build a diverse customer base across various industry sectors, including industrial instrumentation, biomedical equipment, telecommunication, and security. Xentral aims to provide premium services to customers, so the operational structure is designed to foster customer intimacy. The 11 business units are strategically located to provide easy access and flexibility to customers in different geographical regions. In the past five years, Xentral accelerated the expansion into new geographical regions by acquiring six US based EMS companies. Each acquisition further broadened Xentral's customer base. Xentral caps the size of the business units at 350 people and controls the number of customers to ensure all customers are treated with quality service. Each business unit has three to four customer focus teams dedicated to different sets of customers.

1.4 Customer Focus Team Structure

To realize excellence in customer relations, Xentral implemented a unique structure that is customer-centered. On average, there are four customer focus teams (CFT) in each business unit, and each team handles two to six customers, depending on the complexity of services provided to customers. Each team is led by one Customer Focus Team Leader (CFTL), and team members include at least one Material Specialist, Procurement Specialist, Program Manager and Product Engineer. There are also Quality Engineer, Process Engineer, and Test Engineer assigned to each team but do not report directly to the CFTL. The Program Manager coordinates production with the purchasing information provided by the buyers and ensures the production adheres to the manufacturing process designed by the engineers. The number of each functional role varies depending on workload. Figure 2 illustrates the unique structure described above.

Figure 2 – Customer Focus Team Structure



Source: Xentral Technologies LP

Both Material Specialists and Procurement Specialists are internal buyers. The Material Specialists primarily interface with customers and other team members. This role is more involved in material planning: what parts to buy, what quantity to order, and what suppliers to use. Procurement Specialists primarily interface with suppliers and have more involvement in managing purchase orders (PO). They are responsible for maintaining data integrity in the ERP (Enterprise Resource Planning) system as customer demands change and cause POs to be released, cancelled, rescheduled in, or rescheduled out.

1.5 Acquisition of Voltron Services

In 2008, Xentral acquired a Chicago-based company called Voltron Services and its Chinese subsidiary in Xiamen, China, in order to meet the corporate growth strategy in low cost regions. This acquisition enhances Xentral's competitive advantage in the Tier III market segment (as illustrated in Figure 1) by enabling the company to offer large-scale, quality manufacturing services at lower prices. Currently, most EMS providers who serve the Tier III market segment do not have the capability to offer large-scale manufacturing services in a cost effective way. Nonetheless, there exists a sizable market of high-end Tier III customers who require low-cost Tier II services. Their contract value is too small to obtain premium services from Tier II EMS providers but they are not content with the smaller scale and higher price of Tier III EMS providers either. It is this market segment that Xentral attempts to capture to build its capability. The acquisition of Voltron Services gives Xentral the competitive advantage in scale and price that few other Tier III EMS providers can offer. In addition to the Xiamen operation, Xentral plans to add two new manufacturing facilities in China and Mexico when suitable acquisition opportunities arise.

Before the acquisition, Voltron Services in Chicago handled all procurement processes for the Xiamen subsidiary. Xiamen's operational structure was organized by functions to maximize operational efficiency, which was not particularly customer centric. For example, one engineer handled engineering drawings for all customers, and another engineer handled all development of manufacturing processes. After the acquisition, Xentral Technologies converted Voltron Services' Chicago head office and the Xiamen subsidiary into two independent business units (BU), both of which then implemented the customer focus team structure.

The acquisition of Voltron Services also allows Xentral to leverage its global presence using three business models to serve its customers more effectively:

1. North American BU and CFT interface with customers on front end of the business and manage the customer relationship. Xiamen only handles manufacturing as a subcontractor to North American BU.
2. Xiamen interfaces with customers directly on all business aspects.
3. A hybrid model with the combination of one and two. Some customers have a mix of simple and complex products. Complex products that require extensive communication with customers can be dealt with through model one. Simpler products that are easier to launch and manage can be dealt with through model two.

To date the majority Xiamen's business belonged to model two. Around 30% of the revenue comes from model one and 10% comes from model three.

1.6 Purpose of the Paper

The purpose of this project is to design a resource planning solution for Xentral's newly acquired business unit in Xiamen, China. The business at Xiamen is growing rapidly, but managers currently do not have a means to estimate human resources required for fast growth, specifically in purchasing and engineering personnel. Currently, Xiamen is severely understaffed and employees are over-loaded. This slows down the progress of new product launches and constrains business growth. Managers know they need to hire more people but do not know how many. Manufacturing resources in fixed assets and production labor can be easily estimated by machine placement rate and manual assembling rate. Human resources, such as buyers[2] and engineers, are difficult to

[2] In the context of this paper, buyers are Material Specialists or Procurement Specialists, not customers.

estimate because there are no common methods across the company to quantify such effort required to launch and maintain new business.

This project will aggregate the different methods currently used by Xentral, and develop a spreadsheet tool for managers to visualize the personnel required for engineering and purchasing. The development of the spreadsheet tool starts with an overview of the supply chain and engineering work process to understand the different tasks of buyers and engineers. This overview provides the context to analyze data collected from interviews with the leaders of supply chain and engineering. The data includes a wide range of perspectives on fluctuations in workload and practices for managing personnel. Both qualitative and quantitative data will be analyzed and integrated into a spreadsheet tool that calculates resource requirements from May 2010 to April 2011. Based on the spreadsheet, this report will also provide a staffing plan to help managers fill the additional personnel required. Finally, some long-term recommendations will be made to help Xentral avoid future shortages in purchasing and engineering personnel. Within the scope of this project, resources, personnel, or staff are defined as buyers or engineers.

1.7 Project Methodology and Organization of the Report

The resource planning solution is based on internal data collected from seven interviews: three from Supply Chain Leaders, three from Engineering Leaders, and one from a Xiamen Business Leader. Each interview had 10 to 12 questions and lasted approximately one hour. The names of the interviewees will be undisclosed to respect their privacy. Interviews with the Supply Chain and Engineering Leaders consist of five main topics:

- Purpose of the project
- Variables that would cause fluctuations in workload
- Current personnel management practices
- Relevant quantitative data that would be useful for the project
- Special challenges that Xiamen buyers and engineers face

The interview with Xiamen Business Leader consists of three main topics:

- Xiamen's business before acquisition
- Xiamen's business growth in 2009 and 2010
- Challenges arising during the integration process

In chapter four, the data is summarized, while keeping in mind the supply chain work process presented in chapter two and the engineering work process presented in chapter three. Chapter five analyzes the data and explains the components of the spreadsheet tool. Chapter six will complete the resource planning solution with a staffing plan to fill additional resources required and personnel management recommendations to prevent future shortages in purchasing and engineering personnel.

The author has obtained access to study Xentral and interview its executives. Owing to company confidentiality, the company identity and other data herein reported have been adapted for the purpose of the study. The author has created or adapted all figures and tables from the company sources. All numeric figures reported were the author's estimates based on the company data. Hence, the implementation of the proposed solution should be further verified with real data from the company.

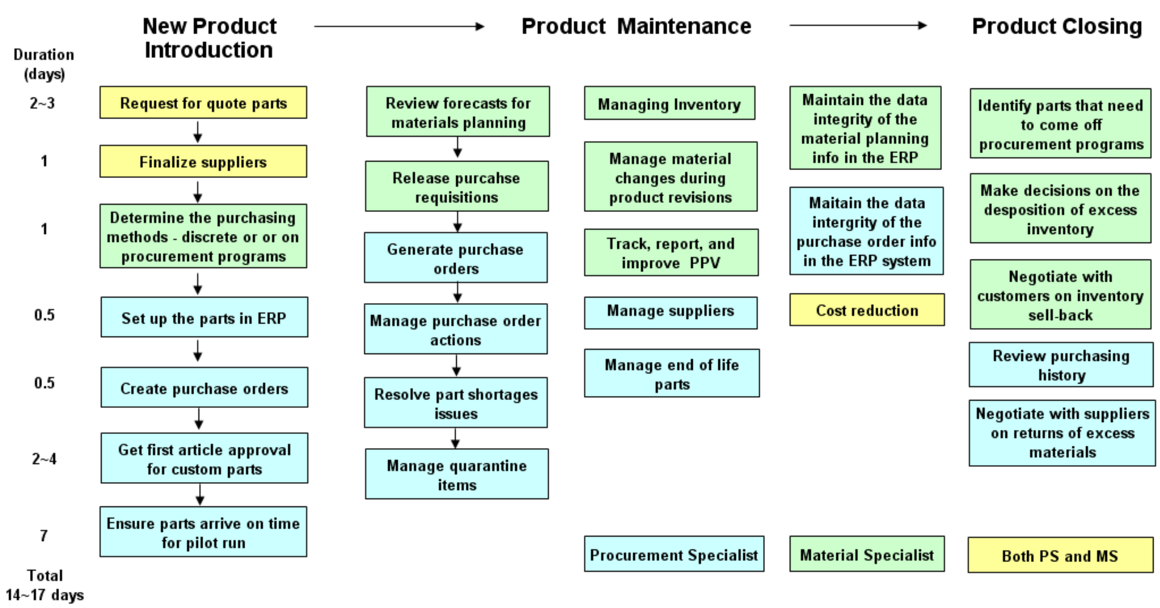
The next chapter will provide an overview of the tasks in Xentral's supply chain work process as the context information to analyze data collected during the interviews with the Supply Chain Leaders. Engineering work process will be provided in chapter three.

2: SUPPLY CHAIN WORK PROCESS

2.1 Overview

There are many electronic parts such as capacitors and resistors in the products Xentral manufactures. The complex process of purchasing and managing these parts is referred to as supply chain work process. In order to evaluate fluctuations in workload, which will be described in detail in chapter four, it is necessary to understand what tasks are involved. Figure 3 presents all the tasks in a process map. A larger process map is available at Appendix 5.

Figure 3 – Supply Chain Work Process



The supply chain work process has three sequential but distinct stages: New Product Introduction (NPI), Product Maintenance, and Product Closing. Tasks in blue are the sole responsibility of Procurement Specialists and tasks in green are the sole responsibility of Material Specialists. Finally, tasks in yellow are shared responsibilities of the two specialists.

2.2 New Product Introduction

When Xentral pursues a new customer, the Product Cost Engineering group (PCE) at the head office prepares quotations to customers based on the material, manufacturing, and other operational costs. The quoting activities precede the NPI activities shown in Figure 3. On average, it takes about six months from quotation to NPI. Although the PCE group collects material prices directly from electronic part suppliers to estimate the material cost, these prices may no longer be current by the time the product launches. Therefore, buyers start the NPI process with intensive re-quoting to obtain the latest material prices. Next, the Material Specialist (MS) determines the purchasing method – either discrete orders or procurement programs. Xentral uses five types of procurement programs to simplify purchasing activities: Auto-release, Flex-release, Kan Ban, Consignment, and Breadman. When a part is on program[3], the ERP system will automatically release purchasing orders to the supplier when there is a shortage. This saves the Procurement Specialist (PS) from spending time on generating purchase orders and monitoring inventory. The part on program is usually factory standard part that is low value and carried by large distributors. The part that is purchased through discrete orders is usually custom item with long lead-time. The Procurement Specialist will set up the suppliers and procurement methods in the ERP system then request first articles (FA) for custom parts so Product Engineers can check if they are made to specifications. After the first articles are approved, the Procurement Specialist will generate purchase orders and

[3] Parts on programs will be purchased by ERP system through predetermined procurement programs

monitor the procurement process to ensure parts arrive on time for the mass production. The NPI process is illustrated in Figure 3 with arrows in between the tasks to show the sequential relationship. The entire process lasts approximately 14 to 17 days and does not include the material lead-time.

2.3 Product Maintenance

After the NPI completes, the product enters into Product Maintenance stage. The Material Specialist reviews the material planning information in the ERP system and determines how many parts to buy, when to place the orders, and when must the materials arrive in-house. Next, the Material Specialist releases purchase requisitions, which will be converted to purchase orders by the Procurement Specialist. After the purchase orders are placed, the Procurement Specialist will manage purchase order (PO) actions for the remainder of the procurement process including PO confirmation, PO cancellation, ship date schedule-in, and ship date schedule-out. These steps are illustrated in Figure 3 with arrows between the tasks to show the sequential relationship. A critical factor that affects the level of difficulty of managing a part is lead-time. It is the time a supplier requires to build and ship the part after a purchase order is received. Some materials have very long lead-time and cause the delivery date to be unacceptably late to the customers. Under this circumstance, the Procurement Specialist must look for other suppliers, alternative parts, or negotiate with existing suppliers to improve lead-time. Even if the customer can accept a late delivery date caused by long material lead-time, it is a challenge to the Procurement Specialist to schedule in and schedule out long lead-time parts in response to changing customer demands. After parts arrive, the production workers will inspect the parts. Defective parts will be quarantined and traced by NCR (non-conformance report), which contains a record of actions taken to solve the issue. The Procurement Specialist will negotiate with suppliers for replacements or credits, then give instructions on the dispositions of the defective parts.

A Material Specialist’s other duties, which are the independent tasks with no arrows in between as shown in the middle column of Figure 3, include managing the inventory to ensure it meets the inventory level set by the Supply Chain Leader. The ideal inventory level will provide sufficient buffer to fulfil the spikes in demands and allow lean operations. When there are product revisions, some materials on the product may change. The material Specialist has to make sure the production team uses up all old parts before using new parts. In addition, the price of a part might vary due to difference in order volume or premium for expedited delivery. The Material Specialist is responsible for tracking, reporting, and improving purchase price variance (PPV).

The Procurement Specialist’s other duties include managing suppliers such as providing forecasts to suppliers, establishing performance evaluation metrics, evaluating supplier performance, and conducting supplier quality audits. When there are parts that are close to the end of life cycle, the Procurement Specialist will source for alternative parts and work with the Product Engineer to get approvals from customers. When customers request cost reduction, the Material Specialist and the Procurement Specialist work together to reduce the material cost by using a cheaper supply sources, cheaper alternatives, or by committing to larger order volume to suppliers. Both the Material Specialist and the Procurement Specialists spend much time on maintaining the data integrity of the supply chain information in the ERP system. The former is responsible for material planning information and the later is responsible for PO information. The Program Manager relies on these two pieces of information to schedule production.

2.4 Product Closing

When a product reaches the end of its life cycle, the Material Specialist will review the bill of materials and identify the parts that need to be removed from the procurement programs. Common electronic parts used on multiple products or parts low in value will usually stay on the programs. Custom or high value parts will be removed from the programs. The Material Specialist processes inventory sales to customer, and the Procurement Specialist processes inventory returns to suppliers. The disposition of excess materials is not under time pressure but requires extensive data mining on purchasing history. On average, it takes about three to six months to finish the tasks in the Product Closing stage.

2.5 Summary of Supply Chain Work Process

Although the supply chain work process appears complicated, the majority of tasks are related to either material planning or purchase order actions. Material planning includes decisions on what quantity of parts to order, which suppliers to purchase parts from, and which purchasing methods to use. Purchase order actions include PO confirmation, PO cancellation, ship date schedule-in, and ship date scheduling-out.

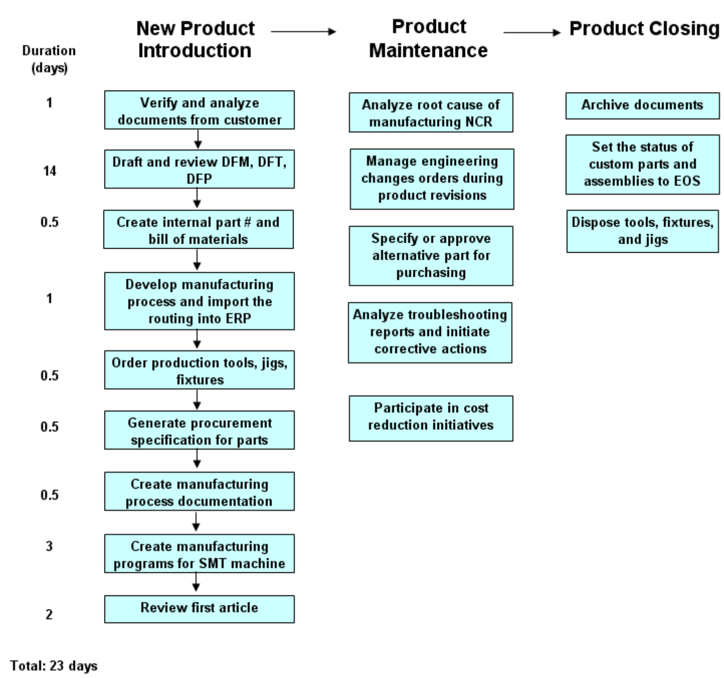
Chapter 4 will provide variables that cause fluctuations in workload based on data collected from the interviews with the Supply Chain Leaders at Burnaby, Toronto, and Xiamen. These variables are usually related to material planning or purchase order actions.

3: ENGINEERING WORK PROCESS

3.1 Overview

Xentral uses surface mounted technology (SMT) in its manufacturing process. With this technology, electronic components are mounted to the printed circuit board (PCB) through a series of manufacturing steps, including screen printing, pick-and-placing, reflow soldering, and flux removal. Each product is set up differently in manufacturing steps depending on customer specifications. The Product Engineer's role is to ensure the manufacturing process builds product that meets customer specifications. Similar to supply chain, engineering work process can be divided to three sets of tasks throughout a product's life cycle. Figure 4 presents all the tasks in a process map from a Product Engineer's perspective. A larger process map is available at Appendix 6.

Figure 4 – Engineering Work Process



The most demanding and time-consuming stage is NPI, followed by Product Maintenance, while Product Closing is the simplest to manage. The NPI process is illustrated in Figure 4 with arrows in between the tasks to show the sequential relationship. Tasks in Product Maintenance and Product Closing are independent with no sequential relationship.

3.2 New Product Introduction

The Product Engineer is the primary coordinator in NPI process. The NPI process consists of a total of nine steps. The first step is to collect, review, and verify the documents from customers. These documents include CAD (computer aided design) files, BOM (bill of materials), procurement specifications, firmware/software, and specialized process/assembly requirements. The second step is to draft DFM files (design for manufacturability) and review DFT files (design for testing) to check for potential problems that might arise during the manufacturing process. The potential problems will be communicated to customers and may lead to changes in product design. After problems are solved, the Product Engineer will create a part number for each part and enter the BOM into the ERP system.

The next step is to develop the manufacturing process and import routing, which is the manufacturing steps of building a product, into ERP system. Then, the Product Engineer orders tools, fixtures, and jigs to prepare for production, followed by generating procurement specifications for parts. Although customers will provide procurement specifications at the onset of NPI, the Product Engineer needs to remove customer logo to protect customer identity and add additional requirements into the specifications to ensure the parts are in compliance with ISO standards. After procurement specifications, next is to create manufacturing process documents such as the quality plan, test requirement, labelling requirement, packaging requirement, and the bill of processes. Afterwards, the Product engineer creates manufacturing programs for the SMT machine, including P&P (pick-and-place), AOI (automated optical inspection), and AI (article inspection). The SMT machine identifies what part to put where on the PCB based on manufacturing programs (SMT, P&P, and AOI). The final step is to review the first article (FA) from the pilot run[4] to check if there are manufacturing or testing issues. After the final article is approved by the customer, the Program Manager will start mass production. The entire process is around 23 days and does not include the waiting time incurred due to incomplete documents from customers and delays caused by changes to product design

3.3 Product Maintenance

When the manufacturing yield is lower than 97% or customers return products due to defectiveness, engineers will generate non-conformance reports to analyze the root causes of problems. In addition, the production workers provide troubleshooting reports regularly to show the reasons for defective products made during the manufacturing process.

Another important task is to initiate engineering change orders (ECO) when there are product revisions. This involves updating the information in the ERP system, the manufacturing documents, and the procurement specifications. Sometimes there are parts on the BOM that are close to the end of the life cycle, which means manufacturers of these parts will discontinue production. In this circumstance, engineers need to review

[4] Pilot run is the production trial prior to mass production.

and approve the alternatives that buyers sourced. When customers demand cost reduction, engineers will review the manufacturing process to propose a new process that can save labour hours or machine time. Alternatively, the engineer will propose new designs that would eliminate the use of expensive materials.

3.4 Product Closing

When a product reaches the end of life cycle, the Product Engineer will obsolete the documents and tools. Manufacturing and procurement documents are removed from the system and stored in the archive. Production tools, jigs, and fixtures will be disposed . The Product Engineer deactivates the products by changing the product status to EOS (end of sale) in the ERP system. Standard parts still being used in other products will not be set to EOS status, but custom parts that have no other uses will be set to EOS status as well.

3.5 Summary of Engineering Work Process

Although the engineering work process appears complicated, most of the tasks are related to engineering documents or manufacturing process. Engineering documents include CAD files, BOM, DFM files, DFT files, procurement specifications, and even firmware or software. Manufacturing processes include SMT machine process, testing process, and manual assembling process. In the next chapter, this report will provide variables that cause fluctuations in workload collected from the interviews with the Engineering Leaders from Burnaby, Toronto, and Xiamen. These variables are usually related to engineering documents or manufacturing process.

4: INTERNAL DATA

4.1 Overview

The work processes described in chapter two and three provide the context to understand the internal data collected from seven interviews. Each interview lasted about one hour and consisted of 10 to 12 questions designed to collect information for the topics listed in section 1.7. All Xentral's senior managers possess in-depth industry experience and unique ways of managing personnel. To leverage their experiences in the design of the spreadsheet tool for measuring resource requirements, seven interviews were conducted with the leaders of supply chain, engineering and business. Table 2 summarizes the interviews.

Table 2 – Interview Information

Business Unit	Interviewee	Interview Style
Burnaby	Supply Chain Leader	Face-to-Face Interview
Toronto	Supply Chain Leader	Phone Interview
Xiamen	Supply Chain Leader	Phone Interview
Burnaby	Engineering Leader	Face-to-Face Interview
Toronto	Engineering Leader	Phone Interview
Xiamen	Engineering Leader	Phone Interview
Xiamen	Business Leader	Face-to-Face interview

The information collected includes quantitative data that measure resource capacity, current methods used to manage personnel, and variables that affect the workload in the NPI and Product Maintenance. The interview with Xiamen Business Leader provides information on Xiamen's business growth, which is required to calculate Xiamen's resource requirement from May 2010 to April 2011.

4.2 Data from Supply Chain Leader at Burnaby Business Unit

The Burnaby Supply Chain Leader mentioned it is very difficult to estimate the number of buyers required for business growth because there are too many variables. According to the Burnaby Supply Chain Leader:

> If a buyer is overloaded I can tell. I will ask her [buyer] if she needs extra help and get another buyer who is less busy to help her. If a CFTL complains there are not enough buyers to finish all the tasks, then I know it is time to hire new buyers… There is no scientific way to decide whether to hire new buyers and how many to hire…it is more based on gut feeling…

During the Supply Chain Summit in 2009, there were discussions around why the buyer's capacity varies so much between different business units. Xentral uses two major metrics to measure the capacity of buyers at different business units: the number of parts managed by a buyer and the number of PO actions performed by a buyer. Data on these two major metrics is provided in Table 3, Purchasing Team Capacity Comparison.

Table 3 – Purchasing Team Capacity Comparison

BU	Material Specialist	Procurement Specialist	Active Parts	Total reschedules	Total buyers	Parts per buyer	Actions per buyer
Burnaby	4	9	6,155	3,860	13	**473**	**297**
Dallas	1	1	2,375	1,971	2	**1,188**	**986**
Lexington	3	4	5,205	2,642	7	**744**	**377**
Milwaukee	5	5	10,181	3,070	10	**1,018**	**307**
Mississauga	3	7	10,309	6,846	10	**1,031**	**685**
St. Peter	1	1	2,816	1,225	2	**1,408**	**613**
Toronto	4	5	7,537	2,809	9	**837**	**312**
Vancouver	5	7	4,443	3,000	12	**370**	**250**

Source: Xentral Technologies LP.

Business units in the US have buyers with the highest capacity, followed by Eastern Canada. Buyers in Western Canada have the lowest capacity. The Burnaby Supply Chain Leader supportively provided a list of variables that can affect the workload in NPI and Product Maintenance, which will be listed in the next two sub-sections.

4.2.1 Supply Chain NPI Variables

The variables for workload in NPI, which will be referred to as NPI variables in this project, are listed below:

1. **Number of items on the BOM –** More parts means more work. If a BOM has more than 100 items, the purchasing activities become very difficult to manage.

2. **Number of custom parts –** Custom parts have long lead-times and limited supply sources. Buyers need to put in more effort to source custom parts, manage suppliers, and ensure the parts are made to specifications. On average, buyers spend 5-10% more time on custom parts than standard parts.

3. **Number of suppliers –** Some products may have many items on the BOM, but most of the items can be purchased from a few suppliers. This reduces the work in supplier management.

4. **Frequency of product revisions –** Product revisions might cause material changes, which drives more work in material planning. Product revisions occur more often for immature products that are newly developed by customers.

4.2.2 Supply Chain Production Variables

Variables that affect buyers' workload in Product Maintenance, referred to as production variables, include all of the five variables above and the four variables listed below:

1. **Availability and accuracy of customer forecasts –** When customers give rush orders, buyers spend much time negotiating with suppliers to expedite materials. If accurate forecasts are available, then buyers can rely on pre-negotiated terms and start material planning early. The accuracy of customer forecasts varies. Inaccurate forecasts have delivery time and order quantity information that is very different from the actual orders. Buyers have to redo material planning and reschedule POs frequently if the forecasts are not accurate.

2. **The number of parts with long lead-time –** Parts with long lead-time are difficult to expedite. Buyers have to repeatedly negotiate with suppliers to improve ship dates.

3. **Proportion of parts on program –** Parts on program are monitored and ordered through the ERP system. This automated purchasing process saves the time on generating PO and monitoring inventory.

4. **Order Volume –** Suppliers do not accept PO rescheduling and cancellation as easily for large orders, so more effort is required to manage large purchase orders.

5. **Lifecycle of parts –** If a product is made of parts that will soon be discontinued, the buyer must source replacements.

Variables that affect the workload in Product Closing stage are not included in this section because Xiamen does not have products that will reach this stage in the near future. The Burnaby Supply Chain Leader mentioned that in general, closing a product required about the same amount of work as maintaining a product. The difference is that tasks in Product Closing do not have strict deadlines, so the work schedules are more flexible.

4.3 Data from Supply Chain Leader at Toronto Business Unit

The Toronto Supply Chain Leader uses two reports to monitor the purchasing activities on a weekly basis. The data from reports must be analyzed from many perspectives or the results might be misleading. Samples of the two reports are provided in Table 4 and Table 5.

The Active Material Report in Table 4 provides two pieces of information: parts with demand and the proportion of the parts on program. Buyers only generate purchase orders for parts that are with demand and are on discrete order. For example, customer 0138 has more parts on demand than others (1752 parts). It appears that the buyer responsible for customer 0138 may be very busy with the purchasing activities involved. Nevertheless, close to 70% of the parts are on program, so majority of the purchase orders will be generated by automated procurement process in the ERP system.

Table 4 – Active Material Report

Customer Number	Total part with demand	Total Parts on Kan-Ban	Total Parts on Flex Release	Total Parts on Consignment	Total Parts on Auto-Release	Total Parts on Discrete Orders	% of parts on Programs
0285	365	0	42	3	0	320	12%
0400	92	0	9	0	0	83	10%
0038	40	3	6	0	0	18	55%
0167	1138	17	657	2	12	450	60%
0037	3	0	2	0	0	1	67%
0024	563	62	302	2	6	191	66%
0117	200	27	76	3	2	92	54%
0138	1752	124	1039	6	41	542	69%
0268	503	8	138	0	0	357	29%
0044	1047	94	623	1	32	297	72%
0016	323	0	128	0	0	152	53%
0166	384	22	137	0	15	210	45%
	6410	357	3159	17	108	2769	57%

Source: Xentral Technologies LP.

Table 5 Purchase Order Action Report shows the number of rescheduling, cancellation, and purchase order release actions required from the buyers responsible for different customers. For example, the buyer responsible for customer number 0138 had to complete 655 purchase order actions, which is the highest number. Nevertheless, the majority of PO were placed to long time suppliers who are cooperative with rescheduling requests, so the work involved is not proportional to the number.

Table 5 – Purchase Order Action Report

Customer	Cancelled	Reschedule-In	Reschedule-Out	Past Due PO	PO to be released	Total Action
0016	2	4	1	4	15	26
0024	9	100	70	10	63	252
0038	0	0	21	2	0	23
0044	11	284	140	10	66	511
0117	5	45	12	2	45	109
0138	34	330	203	1	87	655
0166	4	75	46	10	39	174
0167	6	120	50	21	25	222
0268	6	12	25	0	55	98
0285	16	62	15	6	1	100
0400	76	15	165	16	4	276
0426	11	79	41	0	1	132
Total	180	1126	789	82	401	2578

Source: Xentral Technologies LP.

Another example is customer number 44. There are many parts on demand (1047), but 72% of these parts are on program as shown in Table 4. Despite the high proportion of parts on program, the buyer responsible for this customer will be very busy because the remaining parts on discrete orders are mostly custom parts from Asian suppliers that are difficult to manage due to long distance.

When analyzing the Active Material Report and Purchase Order Action Report, it is important to take into account the experience and knowledge of each buyer. Buyers who are experienced can handle more work than less experienced buyers. According to the Toronto Supply Chain Leader:

> "The data might suggest some buyers will be very busy but when you ask if they need extra help, they might say that they are not busy at all…There are so many variables and team dynamics involved. You have to be very careful how you interpret the data."

Based on the Toronto Supply Chain Leader's experience, an average buyer can handle 800 different parts. The minimum number of parts a buyer should be able to handle is 500 parts and he has never seen a buyer handle more than 1500 parts. He suggests using 500 parts per buyer as a conservative starting point for the capacity of buyers at Xiamen. In addition, the Toronto Supply Chain Leader has a unique method to balance fluctuations in workload. He uses flex resources to support buyers who experience heavier workload due to NPI or rush orders for existing products. He mentioned the work in NPI is at least three times more demanding than Product Maintenance. The flex resources are two procurement specialists who do not belong to any customer focus teams.

4.4 Data from Supply Chain Leader at Xiamen Business Unit

Before the acquisition, Voltron Services' head office at Chicago bought all the materials from the US and shipped to China, so there was no purchasing department at Xiamen. There was only one employee responsible for buying simple consumables, such as gloves and solder paste. After the acquisition, Xiamen became an independent business unit so one Supply Chain Leader and five buyers were hired to manage purchasing activities. New buyers usually have at least two to four years of industrial experience. On average, it takes three months for buyers with industrial experience to become familiar with Xentral's supply chain work process and six months for buyers with limited or no industrial experience to do the same. Unlike the buyers in the North

American business units, Xiamen buyers play dual roles of both the Material and Procurement Specialists.

Xiamen's buyers face unique issues that make their work more challenging, compared to the buyers in North American business units. The largest issue is that Chinese part distributors carry fewer inventories for special materials used for industrial instrumentation than the US distributors. Electronic part manufacturers allocate different quotas for distributors in different geographical regions and there are strict restrictions to prevent selling across geographical boundaries. The American distributors get much higher quota than Chinese distributors, but they cannot sell directly to a Chinese branch of a North American based company. Therefore, Xiamen buyers experience more part shortage issues than the buyers in North America.

Another problem is that Xiamen buyers experience many price variance issues. The PCE group at head office prepares quotations to new customers based on the material prices obtained from North American distributors. Xentral has ten business units in North America and other EMS providers are mostly in Tier III. Xentral's consolidated purchasing power in North America is able to obtain competitive pricing and premium services – a medium fish in a medium pond. Xiamen is a single business unit in China and other EMS providers are mostly in Tier I – a small fish in a big pond. Hence, Xiamen is not able to obtain the same material prices as the North American business units. During NPI, buyers at Xiamen often find their material prices much higher than the prices obtained by the PCE group. As a result, they have to work with the Customer Focus Team Leader to increase the selling prices to customers to cover the higher material costs. The Xiamen Supply Chain Leader feels that with part shortages and price variance issues, the fair number of parts that represents the average buyer's capacity is 500 parts.

4.5 Summary of the Data from Supply Chain Leaders

The Burnaby Supply Chain Leader provided a list of variables that can affect the workload in NPI and Product Maintenance, respectively the NPI variables and production variables. These variables are summarized in Table 6. The fluctuations in workload caused by these variables will be estimated by the complexity matrix in chapter five.

Table 6 – Summary of NPI and Production Variables for Supply Chain

NPI Variables	Production Variables
Number of Items on the BOM	Number of Items on the BOM
Number of Custom Parts	Number of Custom Parts
Number of Suppliers	Number of Suppliers
Frequency of Product Revision	Frequency of Product Revision
	Availability and Accuracy of Customer Forecasts
	Number of Parts with Long Lead-time
	Proportion of the Parts on Program
	Order Volume
	Life Cycle of the Parts

The Toronto Supply Chain Leader uses Active Material Report, Purchase Order Action Report, and weekly capacity meetings to check the actual utilization of each buyer. Underutilized buyers or flex resources (two procurement specialists) will support overloaded buyers. These personnel management methods will be modified to develop the staffing plan and the resource management recommendations in chapter six.

Xiamen Supply Chain Leader mentioned it takes about three months for new buyers with two to four years of industrial experience to be fully familiar with Xentral's supply chain work process. This information will be incorporated into the development of the staffing plan in chapter five. Buyers at Xiamen face two unique issues. Firstly, electronic part distributors in China carry low inventory for special parts used in industrial instrumentation, so buyers at Xiamen often have to deal with part shortage issues. Secondly, there are many purchase price variance issues during NPI because the PCE group prepares quotations to customers with the lower material prices in North America. The Xiamen Supply Chain Leader thinks 500 parts per buyer is a representative of a buyer's capacity at Xiamen. This value is surprisingly consistent with the figure suggested by the Toronto Supply Chain Leader. Chapter five will use the 500 parts per buyer consensus from the two leaders as the baseline capacity of a buyer, an important parameter of the spreadsheet tool.

4.6 Data from Engineering Leader at Burnaby Business Unit

Burnaby uses revenue per engineer as one method to determine how many engineers are required. Ideally, an engineer will handle several customers with combined annual revenue of $3 million. This approach is a guideline to prevent the cost of hiring new engineers exceeding the profit from new business. Based on this guideline, Burnaby keeps the number of product engineers under the total revenue divided by $3 million. Although this approach keeps personnel cost under control, the Burnaby Engineering Leader does not think it is a good method to estimate the actual resource requirement because it overlooks the following NPI variables:

1. **Number of ECO –** ECO (engineering change order) arise when customers change the design or materials of the products. Engineers must update the engineering

documents and modify the manufacturing process. An account of $2 million revenue might need two engineers if there are many ECO.

2. **Maturity of the product –** Products fresh out of the concept development stage may require several rounds of design change. On the other hand, mature products that have been in the market for a while usually have fewer ECO. There is some overlap between this variable and the number of ECO. Nevertheless, not all ECO are from immature products, so it is still necessary to separate these two variables. Sometimes the customer changes designs for mature products if Xentral has manufacturing capability issues or if there are parts with unacceptably long lead-time.

3. **Number of items on the BOM –** Products with many parts (more than 100 parts) are usually more complex. More effort is required to develop the manufacturing process and review the procurement specifications for products with many parts.

4. **Complete documents from customers –** When customer documents, such as BOM or CAD files are incomplete or are unclear, engineers spend more time clarifying details. This can greatly slow down the NPI process.

5. **Requirement of special certification –** Customers in the military sector often request the manufacturing process to be ITAR[5] compliant. Customers in the medical equipment field generally require the products to be compliant with ISO13485 and FDA standards. It is particularly time-consuming to design the

[5] ITAR stands for International Traffic in Arms Regulations. This regulation dictates that information and material related to military products or services may only be shared with US citizens or residents unless the US government grants authorization or exemption.

manufacturing process and manage engineering documents for customers in these two sectors.

6. **Customer supportiveness –** Customers who are responsive to engineering questions and provide clear answers help to simplify the NPI process.

7. **Requirement of special tool –** Some products require the use of special tools in the manufacturing process. More effort is required to source and order special tools.

8. **Complexity of the manufacturing process –** It is more difficult and time consuming to develop the manufacturing process for products that require many steps, special treatments, or extensive manual assembling work. In addition, the yield rate for complex products is more likely to be lower than Xentral's standard. More effort is required to work on troubleshooting, RMA, and NCR for complex products.

The above NPI variables also affect the workload in Product Maintenance except for the special tool and the number of items on the BOM. Manufacturing tools usually last until the product life cycle ends, so ordering tools is a non-recurring step. The number of items on the BOM roughly reflects the work required to develop manufacturing process and review procurement specifications. Most of these two tasks are completed during NPI. After the new products transition to existing products, engineers only need to modify the manufacturing process or revise the procurement specifications when there are ECO. Product Closing consumes very little time from engineers, so the variables that would affect workload in this process are negligible. On average, engineers spend 75% of the time on NPI and 25% on maintaining existing products.

4.7 Data from Engineering Leader at Toronto Business Unit

The Toronto Engineering Leader provided one more NPI variable – customer's experience in dealing with contract manufacturers.

> "Customers who have limited or no outsourcing experience often do not have complete documents and unconsciously assume we know as many details about the products as they do… Engineers spend more time communicating product details with inexperienced customers…"

The Toronto Supply Chain Leader found one engineer per customer is sufficient for maintaining existing business. She uses three metrics to measure an engineer's workload and identifies customers that drive most of the work – the number of ECO, the number of NPI and the number of documents per customer. Like the Toronto Supply Chain Leader, she also uses flex resources to support the overloaded engineers. When a customer focus team needs to launch new products, one Product Engineering Team Leader and two Data Administrators join the team to support the NPI process. The former leads the NPI process and the later takes on time-consuming data entry tasks. The flex resources will be removed from the customer focus team as soon as the NPI finishes.

During the Engineering Summit in 2008, the Engineering Leaders from six business units attended to compare the capacity of engineers at different business units and exchange best practices. The engineer's capacity is measured by three metrics:

number of ECO, number of NPI, and number of finished good handled by an engineer. Table 7 below shows the values of these three metrics across six business units.

Table 7 – Engineering Team Capacity Comparison

Business Unit	BBY	MIS	VAN	TOR	MIL	DAL
Total Product Engineer	16	16	16	14	10	6
Total Finished Good	198	425	236	329	1223	81
FG / Person	12	27	15	24	122	14
Total NPI	N/A	156	N/A	199	143	43
NPI / Person	N/A	10	N/A	14	14	7
Total ECO	872	1514	1024	975	754	367
ECO / Person	55	95	64	70	75	62

From this data, Milwaukee has a much higher finished good per engineer value than other business units do. This is because Milwaukee has many mature products in Product Maintenance stage. Engineers at Mississauga and Toronto have higher capacity compared to the engineers in Dallas, Vancouver, and Burnaby.

4.8 Data from Engineering Leader at Xiamen Business Unit

The Xiamen Engineering Leader is a long-term expatriate from Chicago, which was the former head office of Voltron Services. He is the only person in the management level at Xiamen who has North American experience. Before the acquisition, the engineering tasks in Xiamen were assigned based on functions, not based on customers. For example, an engineer manages ECO and prepares engineering drawings for all customers. Another engineer develops the manufacturing process for all customers. Currently there are four product engineers in China, two document engineers and two process engineers with little crossover between their skill sets. According to the Xiamen Engineering Leader:

> "Document Engineers do not understand how the product flows through the SMT machine, and Process Engineers do not know how to prepare engineering drawings…. it is more difficult to find engineers who have good documentation skills than engineers who have process knowledge…"

After the implementation of the CFT structure, engineers at Xiamen are learning either documentation skills or process knowledge to provide end-to-end services for the customers assigned to them. The Xiamen Engineering Leader mentioned the time difference and language barrier have increased the difficulty in communicating technical details with customers. Although most of the engineers have basic English skills to do the job, they are not as articulate as the English speakers in North America. The time difference issue further reduces the efficiency in communicating technical details with customers. For example, technical issues that require only two days for an engineer at North American business units to solve might require one week for the engineer at Xiamen to solve. Among the four engineers, two were just hired recently. Xiamen Engineering mentioned it takes one to two months to find an engineer with good documentation skills, whereas in North America it only takes a couple of weeks. New engineers require three to six months to become fully accustomed at Xentral's engineering work process.

Xiamen does not have customers in the military or medical sectors, so special certification is not an important variable that affect workload. The most important variable is the completeness of documents from customers. Many of Xiamen's new customers often miss some documents or provide documents that are unclear. As a result, engineers spend much time checking product details with customers during the NPI process. The second most important variable is the number of the parts to re-source. Due to the unique challenges that Xiamen faces in the electronic parts supply system in China, about 20% to 30% of the parts on a new product need to be re-sourced. When customers cannot accept the delivery date and new quotations due to part shortage and material price variances, engineers have to work with buyers to find alternative parts and get approvals from customers.

4.9 Summary of the Data from Engineering Leaders

Burnaby uses revenue per engineer keep engineering personnel costs under control. Ideally, the average revenue per product engineer should be no less than $3 million. This practice will be incorporated into the resource management recommendation in chapter six. The NPI and production variables collected during the interviews are summarized in Table 8.

Table 8 – Summary of NPI and Production Variables for Engineering

NPI Variable	Production Variable
Completeness of Documents	Number of ECO
Number of parts Need to be Re-sourced	Maturity of the Product
Number of ECO	Completeness of Documents
Maturity of the Product	Requirement of Special Certification
Requirement of Special Certification	Customer Supportiveness
Customer Supportiveness	Complexity of the Manufacturing Process
Complexity of the Manufacturing Process	
Number of Parts on the BOM	
Requirement of Special Tool	
Customer's Experience with Contract Manufacturer	
Number of Parts Need to be Re-sourced	

The fluctuations in workload caused by NPI and Production variables will be estimated by the complexity matrix in chapter five. On average, engineers spend 75% of the time on NPI and 25% of the time on Product Maintenance. The data from Table 7, Engineering Team Capacity Comparison, will be used in chapter five to determine the baseline capacity of an engineer, an important parameter of the spreadsheet tool.

The Toronto Engineering Leader found one engineer per customer is sufficient to sustain existing business. When a customer focus team is launching new products, the Toronto Engineering Leader uses flex resources: one Product Engineering Team Leader and two Data Administrators to support the heavier workload during NPI. The staffing plan in chapter six will use flex resources to meet the temporary high demand in personnel during fast growth.

Xiamen Engineering Leader mentioned that document and process engineers in Xiamen had little cross over in their skills sets. After the implementation of CFT structure, engineers are learning documentation skills or process knowledge to provide end-to-end services for their assigned customers. Time difference and language barrier are still communication inefficiencies with customers. These are unique challenges faced by the engineers at Xiamen and will be considered when determining the engineer's baseline capacity.

4.10 Data from Business Leader at Xiamen Business Unit

Before the acquisition, Xiamen built 26 products for Chicago (Voltron Services) as a pure manufacturing plant, so it did not have ownership on customers or revenue. Chicago is now considered an internal customer with 26 products. In 2008, Voltron

Services generated $7.4 million from the 26 products built by Xiamen. In 2009, Xiamen launched 19 new products for five new customers – a slower than expected growth due to the recession. In the first half of 2010, Xiamen launched 38 products for four new customers. The new business scheduled for second half of 2010 is another 41 new products from seven new customers, and the list is still growing. By the end of 2010 the total number of customers will reach at least 17 and the total products will reach at least 121. Xiamen's revenue was $7 million in 2009 and is on track to reach $15 million in 2010. Based on sales projections, the revenue of 2011 is projected to be $30 million. The business growth data is summarized in Table 9 below. There are no products close to reaching Product Closing stage within in the near future.

Table 9 – Xiamen's Business Growth

Year	2008	2009	2010	2011
Number of Products	26	45	121	N/A
Number of Customers	1	6	17	N/A
Revenue ($ million)	7.4	7.2	14	30

Xiamen Business Leader mentioned the time it takes to complete NPI varies depending on the complexity of the product, but the majority of the NPI for a product can be completed within two to three months.

In addition to personnel shortages, Xiamen experiences other growing pains from the integration activities. The implementations of the CFT structure and ERP system from June 2009 to March 2010 completely changed Xiamen's business processes. Engineers and buyers must learn new processes and at the same time cope with heavy workload. Some buyers and engineers showed reluctance in adapting to the CFT structure because they must give up on business processes they were familiar with. The implementation of the ERP system was also not a smooth change. There were bugs disrupting the workflow within the ERP system, so engineers and buyers encountered problems with retrieving correct information from the ERP system. Two senior staff left the company in 2010 with mixed reasons.

5: SPREADSHEET TOOL

5.1 Parameters of the Tool

The raw data collected in chapter four must be synthesized for logical interpretation. This chapter filters and rearranges quantitative data in a systematic way to build the spreadsheet tool for estimating personnel requirements. The development of the tool starts by establishing two measuring parameters – the amount of work and the resource capacity. The second step is to calculate the fluctuations in workload caused by NPI and production variables. This is achieved by using the complexity matrix to generate another two parameters – NPI factor and Production factor. Lastly, NPI duration and production duration will be incorporated into the tool as time parameters.

5.2 Measuring Parameters

Xentral uses the total number of parts and PO actions divided by the number of buyers to measure the capacity of buyers at different business units (Table 3). This tool adopts the total number of parts as the measuring parameter of workload in purchasing, because the information is known prior to the onset of NPI and can be easily obtained from ERP system. PO actions occur mainly in Product Maintenance stage, so it is not inclusive enough to be used as the measuring parameter. Xentral uses the total number of ECO, NPI, and finished goods divide by the number of engineers to measure the capacity of engineers at different business units (Table 7). Engineers cannot predict how many ECO will occur during NPI and throughout the product lifecycle, so it is hindsight information not suitable to be used as the measuring parameter of a projective tool. The number of NPI excludes the work involved in Product Maintenance, so it is not a suitable measure either. By the process of elimination, the spreadsheet tool adopts the total number of finished goods as the measuring parameter of workload in engineering.

Calculated with the data from Table 3 Purchasing Team Capacity Comparison, the average number of parts per buyer is 884. This data does not differentiate parts in NPI or Product Maintenance stage and excludes parts in the Product Closing stage. Considering that buyers in China face unique issues that lower their capacity, the average of 884 parts per buyer is too high for Xiamen. The Toronto Supply Chain Leader suggests using 500 parts per buyer as the starting point, a value that Xiamen Supply Chain Leader also suggested in the interview. The two leaders did not specify whether the 500 parts per buyer include parts in both NPI and Product Maintenance or just one of these two stages. The spreadsheet tool uses 500 parts per buyer as the baseline capacity of a buyer at Xiamen, assuming all 500 parts are in Product Maintenance stage.

The average products (finished goods) per engineer calculated with the data from Table 7 Engineering Team Capacity Comparison is 18.6.[6] This number also excludes products in Product Closing stage and does not differentiate products in NPI or Product Maintenance stage. Taking into account the communication inefficiencies with customers due to language barrier and time difference, this tool uses the data point at the lower end from Burnaby, 12 products per engineer, as the baseline capacity of an engineer in Xiamen and assumes all 12 products are in Product Maintenance stage.

[6] Data from Milwaukee is excluded from the calculation due to the highly stable business nature, which is atypical

Appendix 1 shows a snapshot of the tool with the basic parameters highlighted in red and the calculated results in blue. The tool sums up the number of parts of all active products to calculate the total workload in purchasing, then divide it by the buyer's baseline capacity to calculate the number of buyers required for each month. Engineering personnel is calculated with the same logic. The tool will sum up the number of all active products then divide it by the engineer's baseline capacity to calculate the number of engineers required for each month.

It is necessary to increase the weighing of parts and products in NPI to reflect the heavier work compared with Product Maintenance. The Toronto Supply Chain Leader mentioned the effort required to launch a product is at least three times more than maintaining a product. The Burnaby Engineering Leader mentioned that engineers spend 75% of the time on NPI, which is three times more than the 25% of the time spent on Product Maintenance. Based on these two pieces of information, the tool will multiply the parts and products in NPI stage by a factor of three, which is referred to as NPI multiplier. In other words, one product in NPI would be treated as three existing products, and 50 parts in NPI stage would be treated as 150 parts in Product Maintenance stage. The NPI multiplier will be incorporated into NPI factor to adjust the workload from NPI. In this project, NPI multiplier is set to three by default, but managers can adjust the value.

5.3 Complexity Matrix, NPI Factor, and Production Factor

Currently Xentral does not have a method to calculate the accumulative impact of NPI variables on workload. This project provides complexity matrix as the solution. The assumption behind the complexity matrix is that work required to launch an average product is an absolute value of one. The NPI variable causes work to be more or less than the average work required to launch a product, depending on the condition. Table 10 illustrates how to use the complexity matrix to calculate the combined impact of two NPI variables on work from an immature product with more than 100 parts on the BOM.

Table 10 – Complexity Matrix and NPI Variables (Engineering)

NPI Variables	Work Factor	Conditions
Maturity of the product	0.8	Mature product that has been in the market for a while
	1	Medium mature product that has been in the market for short period of time
	1.2	Immature product newly developed by customers
# of items on the BOM	0.8	1 to 50 items
	1	50 to 100 items
	1.2	More than 100 items
	1.2	Average of selected work factors
	↓	X 3 (NPI multiplier)
	3.6	**NPI factor**

Products newly developed by customers are highly immature because many of them have manufacturability issues and have high potential of design changes. Work required to launch immature products might be 20% more demanding than average, which is translated to a work factor of 1.2 in the complexity matrix. Products that have been in the market shortly might not have manufacturability issues, but customers might want to change product designs in response to the feedbacks from end users. The majority of Xentral's products belong to this category, so the work factor is one. Products that have been in the market for a long time mostly have no manufacturability issues and have less design changes, so the maturity is high. Work required to launch mature products might be 20% less demanding the average, which is translated to a work factor of 0.8 in the complexity matrix. The conditions and work factors of the second NPI variable, the number of items on the BOM, are determined with the same logic. The example in Table 10 is based on an immature product with total number of parts falls into the range of 50 to 100 parts, so the average work factor s is 1.2. The average work factor will be multiplied with NPI multiplier (3) to generate NPI factor. NPI factor represents the combined impact of the NPI variables on work required to launch the product. In Table 10, the calculated NPI factor is 3.6, which means the spreadsheet will add 3.6 products in the calculation of total NPI workload.

Due to lack of data for statistical analysis, the conditions and work factors in Table 10 are subjectively chosen for demonstration purposes. Ideally, the conditions and work factors should be determined based on statistical analysis from data that show how various conditions affect the buyer's and engineer's work hours. This data is not available in Xentral, and would be very costly and time-consuming to collect. This project recommends using an open approach in the application of complexity matrix. Managers can include all variables, exclude some, or add other variables based on perceived importance. The conditions and work factors can be determined based on managerial discretion. It is recommended that Xentral starts collecting data on the work hours of buyers and engineers during NPI so the managers would have means to better determine the conditions and the work factors for the NPI variables.

The complexity matrix can also be used to calculate the accumulative impact of production variables on work from Product Maintenance, except there is no multiplier to increase the average work factor in the generation of production factor. Table 11 illustrates how to use the complexity matrix to calculate the combined impact of two production variables on work from a product with no forecasts and has less than 25% of the parts on program.

Table 11 – Complexity Matrix and Production Variables (Supply Chain)

Variables	**Workload Factor**	**Conditions**
Availability and accuracy of the forecasts	0.7	Forecast accurate within 5% variance
	1	Forecast accurate within 10% variance
	1.2	Forecast not accurate, variance exceeds 20%
	1.5	No forecast available. Many rush orders
Proportion of part on program	0.7	More than 75% of the parts on program
	0.8	50% to 75% parts on program
	1	25% to 50% parts on program
	1.3	Less than 25% of parts on program
Production Factor	→ **1.4**	Average of selected work factors

Some customers provide forecasts with accurate information in quantity and delivery date. Buyers have more time to do material planning and do not have to schedule in or schedule out PO frequently. When the variance between actual orders and forecasts is within 5%, work required to maintain the product might be 30% less demanding than average, which translated to a work factor of 0.7. The majority of the customer forecasts have variance within 10%, so this condition will be translated into a work factor of one. When the variance between actual orders and forecasts exceeds 20%, work required to maintain the products might be 20% more demanding than average, which translated to a work factor of 1.2. Some customers do not provide forecasts and often request rush orders. Work required to maintain the product under this condition might be 30% more demanding than average, which is translated to a work factor of 1.3. The second production variable, proportion of parts on program, can be analyzed with the same logic. The example in Table 11 is based on a product with no forecasts and has less than 25% of the parts are on program. The average work factor is 1.4, which is also the production factor that represents the combined impact from the two production variables. Assume this product has 50 parts, the spreadsheet tool will add 50 times 1.4 (production factor) equals 70 parts in the calculation of workload from Product Maintenance. Due to lack of data for statistical analysis, the conditions and work factors in Table 11 are subjectively chosen for demonstration purposes. Managers can use the open approach described previously when using complexity matrix to adjust work from maintaining an existing product. Appendix 2 shows how NPI and production factors adjust the work from each product by manipulation the product or part numbers.

5.4 NPI Duration & Production Duration

In the supply chain and engineering work process maps, the NPI process only takes 14 to 17 days for supply chain and 23 days for engineering, but these durations are based on optimal condition in which everything proceeds smoothly. In reality, there are many issues to be resolved during NPI, so the average NPI duration is two to three months[7] for both supply chain and engineering. To estimate the purchasing workload from NPI for each month, this tool adds up the number of parts (after NPI factor adjustment) with NPI duration spans across that month. For example, if a product will be launched from August to September and the number of parts (after NPI factor adjustment) is 150, the tool will add 150 in the calculation of workload from NPI for August and September. Monthly engineering workload from NPI will be calculated with the same method, except the calculation is based on the number of products instead of the

[7] Data provided by Xiamen Business Leader

number of parts. This tool uses two months as the default NPI duration, but managers can adjust the duration for each product.

The period during which buyers or engineers work on Product Maintenance is referred to as production duration in this project. Production durations are determined based on the delivery dates of the sales orders. The work in purchasing starts much earlier than the delivery date, depending on the material lead-time. After the materials arrive, buyers have to deal with defective materials or hidden shortages[8], so their work does not end until the production finishes. This tool uses four months as the default production duration for supply chain with the Xiamen Supply Chain Leader's suggestion of using three months for material lead-time and one month for manufacturing. The production duration for each product can be adjusted on an individual basis. The purchasing workload of each month is calculated by adding up the number of parts (after production factor adjustment) for products with production duration spans across that month. For example, if a product has 50 parts (after production factor adjustment) is on a sales order with delivery date in November, the tool will include these 50 parts in the calculation of total purchasing workload from August to November. Engineers' work takes place during production and material lead-time is not a concern. The tool uses one month as the default production duration for engineering. The spreadsheet calculates monthly engineering workload from Product Maintenance by adding up the number of products (after production factor adjustment) with delivery date falls into that month. For example, if a product is on a sales order with delivery date in January and this product will become

[8] Hidden shortage happens when ERP system shows more quantity than the actual quantity in the inventory. This is usually not caught until the production workers find they do not have enough parts to build a product.

two products after adjusted by production factor, the tool will include two products in the calculation of the engineering workload in January. Appendix 2 shows how NPI and production durations are incorporated into the tool.

5.5 Data Input Tabs, Output Tabs & CRIPR Report

The data output tab of the spreadsheet tool shown in Appendix 1 has complex formula embedded. To prevent users from changing the formula by mistake during the data entry process, there is a separate tab for updating the values of different parameters, including NPI factor, production factor, NPI duration, and production duration. In addition, there is a data input tab for sales orders information from the CRIPR report (Consolidated Revenue and Inventory Projection Report, Appendix 4). CRIPR report can easily be generated from the ERP system and contains information of the products, quantities, and delivery dates of all sales orders. Users can simply copy and paste the CRIPR report to the CRIPR data input tab to update sales order information. Nevertheless, information in the CRIPR only contains solid sales orders, so data from forecasts with relative high chance of turning into solid orders needs to be entered manually. There are separate data output tabs for supply chain and engineering. Appendix 1 to 4 shows the data output tab for supply chain, data output tab for engineering, data input tab for parameters, and data input tab for CRIPR report respectively.

5.6 Engineering and Purchasing Workload Graphs

The spreadsheet tool can provide graphs to help manager visualize the distribution of workload between NPI and Product Maintenance as shown in Figure 5 and 6. These graphs provide quick high-level overview of the workload trend.

Figure 5 – Purchasing Workload Graph

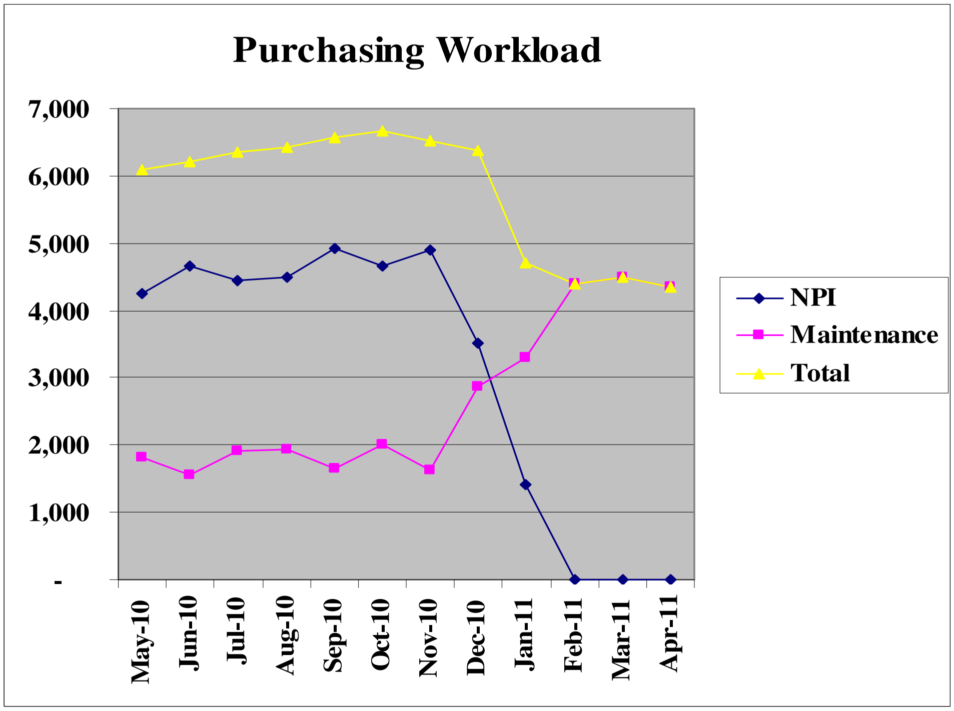
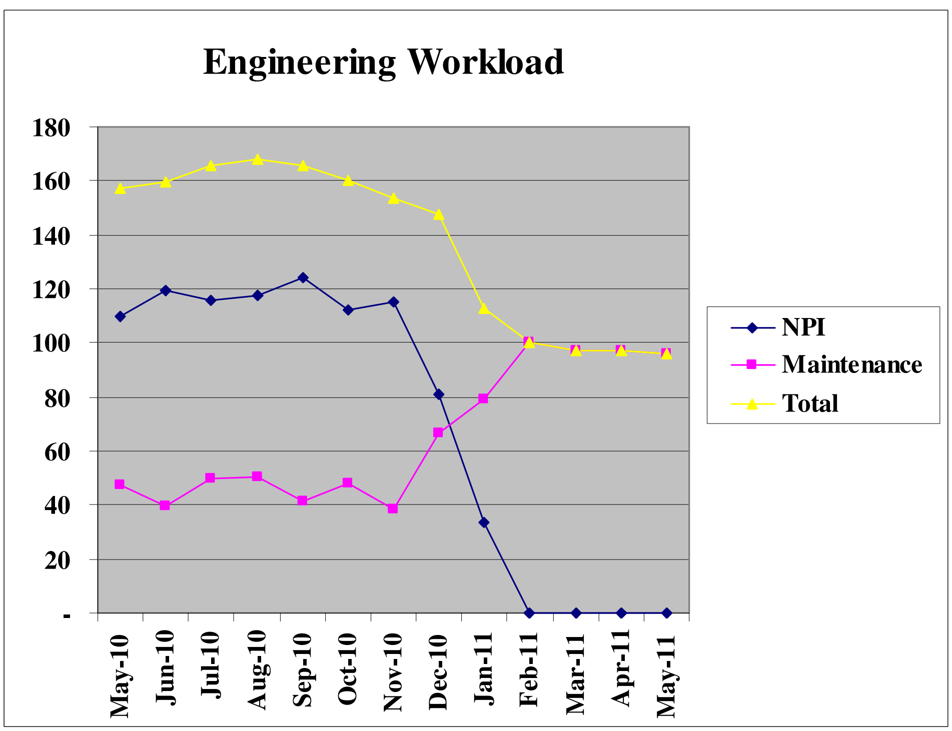


Figure 6 – Engineering Workload Graph



5.7 Summary of the Spreadsheet Tool

The spreadsheet tool consists of six parameters, one complexity matrix, two data input tabs, two data output tabs, and two workload graphs. These components are summarized in Table 12.

Table 12 – Summary of the Spreadsheet Tool

Component	Description
Parameter 1 – Amount of work	Total workload in supply chain is the sum of parts. Total workload in engineering is the sum of products.
Parameter 2 – Resource Capacity	The baseline capacity is 500 parts per buyer and 12 products per engineer by default, but the values are adjustable.
Parameter 3 – NPI Factor	Represents the combined impact of all NPI variables on work required to launch a product
Parameter 4 – Production Factor	Represents the combined impact of all production variables on work required to maintain a product
Parameter 5 – NPI Duration	The spreadsheet tool adds the product (parts) into total workload for month X if the NPI duration of the product (parts) spin across month X.
Parameter 6 – Production Duration	The spreadsheet tool adds the product (parts) into total workload for month X if the production duration of the product (parts) spins across month X.
Complexity Matrix	Facilitate the calculation of NPI and production factors. In the matrix, fluctuations in workload caused by certain conditions are translated to work factors. The production factor is the average work factor. The NPI factor is the average work factor times NPI multiplier. The NPI multiplier is set to 3 by default, but the value is adjustable.
Data Input Tab	There are two data input tabs. One is for updating values for the parameters such as NPI factor. Another tab is for updating CRIPR report that contains sales order information.
Data Output Tab	There are separate data output tabs for supply chain and engineering personnel requirements.
Workload Graph	Show the distribution of workload from NPI and Product maintenance. There are separate workload graphs for engineering and supply chain.

6: RESOURCE MANAGEMENT RECOMMENDATIONS

6.1 Overview

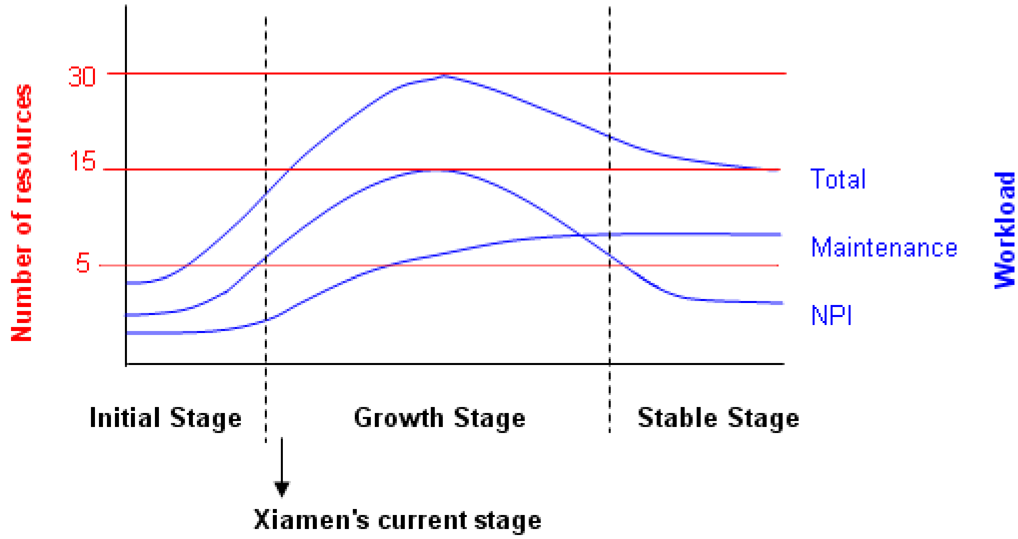
Resource planning is a dynamic topic that needs to be reviewed from different perspectives for optimal staffing decisions. The spreadsheet tool developed in the previous chapter is only one part of a multifaceted solution that Xiamen needs. This chapter will provide a staffing plan based on the resources estimated by the spreadsheet tool. The personnel management practices collected during the interviews will be modified to provide recommendations that are tailored to Xiamen's needs. To understand the underlying condition that drives the development of the staffing plan, a high-level overview of the workload and resource requirements at different stages of Xiamen's growth will be provided at the beginning of the chapter.

6.2 Resource requirement changes over time

Xiamen is currently in a growth stage, but eventually machine capacity will reach 80% utilization[9] and become a bottleneck that slows down business growth. Once business slows down, fewer personnel are required than during the growth stage. The author developed a growth model in consultation with the Xiamen Business Leader shown in Figure 7. In this model, there are three stages of Xiamen's growth – initial stage, growth stage, and stable stage. The precise conditions that define each stage will be based on the manager's subjective opinion and can be different between managers. This project will focus on the workload patterns at different stages

[9] It is Xentral's practice to keep the maximum machine utilization at 80%.

Figure 7 – Different Stages of Xiamen's Growth



The workload from NPI, Product Maintenance, and the total workload will have the patterns in blue lines illustrated in Figure 7. At initial stage, workload from Product Maintenance is small and there are few NPI activities, so the total workload is low. During the growth stage, workload from Product Maintenance increases gradually, while workload from NPI increases at a faster rate. Xiamen is at the beginning of the growth stage. In the stable stage, the majority of workload comes from Product Maintenance, and workload from NPI decreases to a low and steady level. The business units in North America are at the stable stage.

The red lines show the resources required at different stages. The numbers are arbitrary figures used for demonstration purpose, not representative of the actual resource requirements at each stage. When the total workload reaches the highest level at the growth stage, the resources required are 30 staff. At stable stages, the resources required reduce to 15 staff due to lower total workload. The number 5 represents the current staff number. If managers hire permanent staff based on the resource requirement during the growth stage, there will be excess staff at the stable stage. In light of this understanding, managers should hire permanent staff based on the resource requirement at the stable stage (15) minus the current staff number (5). Differences in required resources between the growth stage (30) and the stable stage (15) can be filled by flex resources.

This project uses the concept of planning and control in operation management to manage personnel requirement at different periods. Planning is a formalization of what is intended to happen at some time in the future. Control is the process of monitoring operations activity and coping with any deviations from the plan (Nigel & Stuart, 2007). This project applies the planning and control concept to develop the staffing plan and reality check to manage personnel requirements.

6.3 Staffing Plan

Based on the business growth data provided by Xiamen Business Leader and the CRIPR report in May 2010, the spreadsheet tool calculated the number of buyers and engineers required from May 2010 to April 2011. Table 13 shows these projections. Workload graphs in Figure 5 and 6 in the previous chapter show the workload trend in supply chain and engineering.

Table 13 – Xiamen's Resource Requirement May 2010 – April 2011

Date	2010								2011			
	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Buyers	12	12	13	13	13	13	13	12	10	9	9	9
Engineers	13	13	14	14	14	13	12	12	9	8	8	8
Current buyers: 5 Current Engineers: 4												

May to December 2010 requires more resources because there are many NPI activities. February to April 2011 requires fewer resources because all products in NPI would have transitioned to the Product Maintenance. Nine buyers and eight engineers are required for Product Maintenance (February to April 2011), but Xiamen only has five buyers and four engineers in May 2010. Therefore, Xiamen needs to hire another four buyers and four engineers as permanent staff. Resources required during the period with heavy NPI activities (May to December 2010) are 13 buyers and 14 engineers. Calculated with the resources required for Product Maintenance, 9 buyers and 8 engineers, the resource gap between NPI and Product Maintenance is four buyers and six engineers. When using this tool, managers should be aware that sales orders for existing products and new business are still increasing. The estimation is less accurate for the months that are further away. The estimated resource requirement of April 2011 is not as accurate as August 2010.

6.3.1 Permanent Resources

In Xentral, new staff will be assigned to different CFT and be trained by the existing staff within the teams. If Xiamen hires new staff based on the figures mentioned in above section, the ratio of new to existing staff will be one to one. This means all existing staff will spend significant amount of time training new staff. New staff are buyers or engineers who join Xentral for fewer than six months. Most customer specific information is taught on an individual basis, so the knowledge transferring process takes time. This project recommends that Xentral keep the ratio between new staff and existing staff as one to one. Beyond this ratio, it will be difficult for existing staff to balance between their regular tasks and trainings for new staff. Consequently, existing staff may not be able to deliver quality work or new staff may not have access to quality trainings. Another recommendation is to allocate the purchasing activities from existing business only to new staff for the first six months of their tenure. This would allow more time for new staff to become accustomed at Xentral's work process and learn to handle the challenging work in NPI. Let existing staff handle the NPI work to ensure the quality of the services meets customer standard.

6.3.2 Flex Resources

The flex resources at Toronto are permanent staff rotating between customer focus teams. This arrangement works well when the NPI activities are low, but is not suitable when the business growth is fast. It is recommended that Xiamen use contract workers or human resource agency to fill the flex resources, an arrangement that allows easy dismissal of excess flex resources once Xiamen's growth reaches the stable stage. Flex resources can take on the tasks that are more administrative in nature so permanent staff can focus on the more difficult work. The tasks handled by flex resources can include, but are not limited to entering BOM into the ERP system, generating purchase orders, and preparing PPV reports. In order to recruit and effectively use a team of flex resources to support all customer focus teams, it is necessary to delegate a team lead in charge of coordinating and training the flex resources. The team lead can communicate with all staff regularly to understand each person's workload and look for tasks that requires flex resources. With this coordination, the team lead can allocate and train flex resources effectively to maximize their value. It is recommended that Xiamen still keep two to three flex resources after it reaches stable stage to support the lower but steady workload from NPI.

6.3.3 Quarterly Resource Requirement Review

Hiring takes time and new staff require training and time to gather experience in Xentral's work environment to become fully productive. To avoid hiring permanent staff on an ad hoc basis, managers should review resource requirement in advance to leave sufficient time for hiring and training new staff. It is recommended that the managers review resource requirement for the next three to four quarters at the first week of previous quarter. For example, the resource requirement of 2011 Q1 to Q3 should be reviewed in September 2010. At the first week of each quarter, managers update the data input tab of the spreadsheet tool with the latest CRIPR report. Supply Chain and Engineering Leaders use the complexity matrix to calculate NPI factors for new products and re-assess the production factors for existing products if necessary. NPI and production durations should also be updated. In this project, the NPI factor, production factor, NPI duration, and production duration are set to default values defined in chapter five. Using defaults addresses the project sponsor's lack of time to evaluate values of parameters for every product and the urgent need for immediate staffing actions. Nevertheless, the tool provides better estimation when the data entered has been reviewed with managerial discretion.

6.4 Reality Check & Continuous Improvement of the Tool

Plans are based on expectations, during their implementation things do not always happen as expected. Control is the process of coping with these changes (Nigel & Stuart, 2007). Managers need a measure to monitor the deviations from plan and react accordingly. It is recommended that the Xiamen Supply Chain Leader adopt the personnel management practices from Toronto to monitor the reality and view resource requirements from other perspectives – e.g., using the Active Material Report, Purchase Order Action Report, and monthly capacity meeting to check the workload of individual buyers. Monthly capacity meeting gives overloaded buyers the opportunity to request assistance. If all buyers are overloaded, then Supply Chain Leader should hire new buyers. Engineering Leader can also use the same approach to manage resources. The reports used to monitor each engineer's workload will show the ECO, NPI, and documents from different customers.

The tool is meant to provide a rough estimation, not precise predications for actual resource requirement. Throughout the application process, managers will accumulate user experience as a source of feedbacks for continuous improvement.

If there is a large gap between estimation from the spreadsheet tool and actual resource requirement, Supply Chain and Engineering Leaders can investigate the reasons and suggest ways to modify the tool to enhance the accuracy of the estimation. For example, an improvement can be an added function to the spreadsheet tool or replacing the complexity matrix with a more precise method of measuring impact of NPI or production variables on workload. The improvement can also be as minor as changing the baseline capacity of a buyer to beyond 500 parts per buyer. Continuous upgrades to provide better functions, and allows the spreadsheet tool to evolve and stay in tune with reality.

6.5 Cost Control

In addition to evaluating resource requirement based on overall workload, managers must watch the costs of hiring additional personnel as well. Burnaby uses revenue per engineer to keep the cost of engineering personnel under control. If the average annual revenue per engineer is lower than $3 million, there must be a compelling reason to hire additional engineers. Even if the estimation from the tool shows additional personnel are required, managers should not hire new staff if the cost cannot be justified by future revenue. Table 14 shows the revenue of some business units in North America and the number of staff in 2008.

Table 14 – 2008 Revenue per Resource

BU	BBY	VAN	MIS	TOR	DAL	MIL	Average
Revenue ($ Million)	47.5	57.3	29.9	42.1	34.3	72.3	283.4
Total Buyers	16	15	13	12	5	14	75
Total Engineers	16	16	16	14	6	10.5	78.5
Revenue/buyer	2.97	3.82	2.30	3.51	6.86	5.16	3.78
Revenue/engineer	2.97	3.58	1.87	3.01	5.72	6.89	3.61

Source: Xentral Technologies LP

From the data in Table 14, the average revenue per resource is $3.78 million per buyer and $3.61 million per engineer. Xiamen's revenue in 2010 is $14 million. The resources Xiamen needs to maintain all business after the products in NPI transition to Product Maintenance (February to April 2011) are nine buyers and eight engineers, so the revenue per permanent staff required, based on the calculation from the spreadsheet, works out to $1.67 million per buyer and $1.88 million per engineer. The current staff level is five buyers and four engineers, so the revenue per current staff works out to $3.00 million per buyer and $3.75 million per engineer.

One interpretation for Xiamen's revenue per resource is that new customers give small orders for NPI. Large orders come after NPI is completed and Xentral's ability to manufacturer products with correct specifications is proven. During rapid growth with many NPI, resource requirement increase precedes revenue increase, so lower revenue per resource is justifiable. The second interpretation is that if managers hire additional staff based on the calculation from the spreadsheet tool, the low revenue per resource might suggest that Xiamen is not growing in a sustainable way. Xiamen must spend money before they make money, but overspending will harm cash flow. The third and most important interpretation is that a lower revenue per resource compared with the business units in North America may be completely justifiable, due to the cheaper labour cost in China. These are just some considerations about cost control for Xiamen, and the complete cost analysis is the responsibility of the Finance department.

6.6 Scenario Analysis for Controlled Sales Growth

When potential business comes closer to realization, Xentral has to provide the tentative NPI start date, which would affect customer's decision on whether to award the business to Xentral. It was difficult to provide NPI schedule due to lack of understanding of how overall workload and resource requirement would change when Xiamen won potential business. The goal is to provide schedules to consumers sooner, in order to increase the chance of winning bids. However, Xiamen may not have enough personnel to handle so much new businesses. According to a research that studied bidding strategies and workload dynamics in a project-based professional service organization, under-resourced projects required more work than adequately sourced projects. This is because many tasks will be executed incorrectly and requires redoing in under-resourced condition. A change in bidding strategy at the organizational level that avoids or reduces bidding for projects which cannot be resourced properly improves the organization's performance (Steffan & David, 2006).

Each NPI is like a project. The spreadsheet tool can estimate resource requirement for multiple scenarios, each with a different combination of potential NPI and the hypothetical start dates. Managers should review if it is feasible to increase staff based on the numbers estimated by the tool, taking into account that new staff need around three months to gain familiarity with Xentral's work processes and the recommendation of keeping new to existing staff ratio under one to one. Based on the scenario analysis, managers can control the NPI start date and sales growth, making sure they are in parallel with feasible personnel increase. When managers must choose between several potential business opportunities, it is recommended to give priority to business that yields higher revenue per resource.

6.7 Employee Retention in Challenging Work Environment

Managers can spend much effort on resource planning, but desired improvements may not come if Xiamen cannot retain employees. The two staff that left during the integration period can be just a tip of the iceberg if there is no sound retention plan. The survey done by DDI[10] and SHRM[11] shows that human resource professionals in China expect the new-employee tenure to be little more than two years, including high level leaders. Furthermore, around 62% of the 862 employees who responded to the survey have been with their company for less than one year. Xiamen is not immune to this labour market nature.

The survey results indicate that the top two retention drivers are good manager or boss, and recognition of individual contributions. The top reason for turnover is the lack

[10] DDI – Development Dimensions International Inc.
[11] SHRM – Society of Human Resource Management

of growth and development opportunities. Financial incentive from another offer becomes an important turnover reason when the employee is dissatisfied with the current company's leadership (DDI, 2007). Based on these results, Xiamen should develop a retention plan with superior leadership.

Xiamen's work environment is filled with issues that lower morale and challenge manager's leadership. Part shortages and price variance issues increase the difficulty of managing purchasing activities. Engineers have to learn new skill set and work with time difference and language barrier. The integration activities and fast business growth pressure staff to adapt to new business processes and at the same time cope with increasing workload. Some issues will be resolved, but new issues will arise. Instead of letting the endless issues deflate morale, managers can leverage issues to build rapport with leadership that transforms challenges to opportunities for individual growth aligned with the company's growth. To develop an effective employee retention program, this project borrows the findings from a study that investigated employees' perceptions of career management activities in the hotel industry in China. There is a strong desire for formal mentoring from hotel employees' point-of-view. Without a clear career ladder and sufficient motivation, participants[12] feel dissatisfied with their current jobs and still others feel puzzled about their future. In addition to mentoring, a career plan was also found useful for hotel managers' long-term career development. Having a clear foreseeable future is a great motivation for them (Haiyan, 2010). Based on these findings, this project proposes a career development plan with more hierarchy and clearly defined competence requirements at each level, paired with formal mentoring sessions.

[12] Participants in this study are hotel emloyees.

The buyers and engineers in North America have the same titles regardless of their seniority and competence. Compensations are undisclosed. This flat, confidential system does not provide employees the visibility of their growth opportunities within the company. The author recommends separating each role to three levels. For example, establish three levels for the role of Product Engineer – Junior Product Engineer, Product Engineer, and Senior Product Engineer. The competence requirements, salary ranges, and duties associated with each level should be clearly defined. Managers can provide regular and formal mentoring sessions to help employees understand how contribute to the company's growth can advance their careers. One way to ensure the mentoring sessions are effective is to set SMART goals for employees. Achieving success requires having a vision what success is like, a vision that is broken down into clearly defined goals and measures of achievements (Health Care Registration, 2010). When managers set goals that are Specific, Measurable, Attainable, Relevant, and Time-bound, employees have a better grasp of the path leading towards success. Clearly defined competence requirements and salary range at each level of the hierarchy give employees the visibility of career ladder, and formal mentoring sessions with SMART goals help employees climb the career ladder. These two components, when combined together, form a powerful retention program that can transform the challenging work environment into a workplace full of opportunities and hope in the eyes of employees.

6.8 Summary of Recommendations

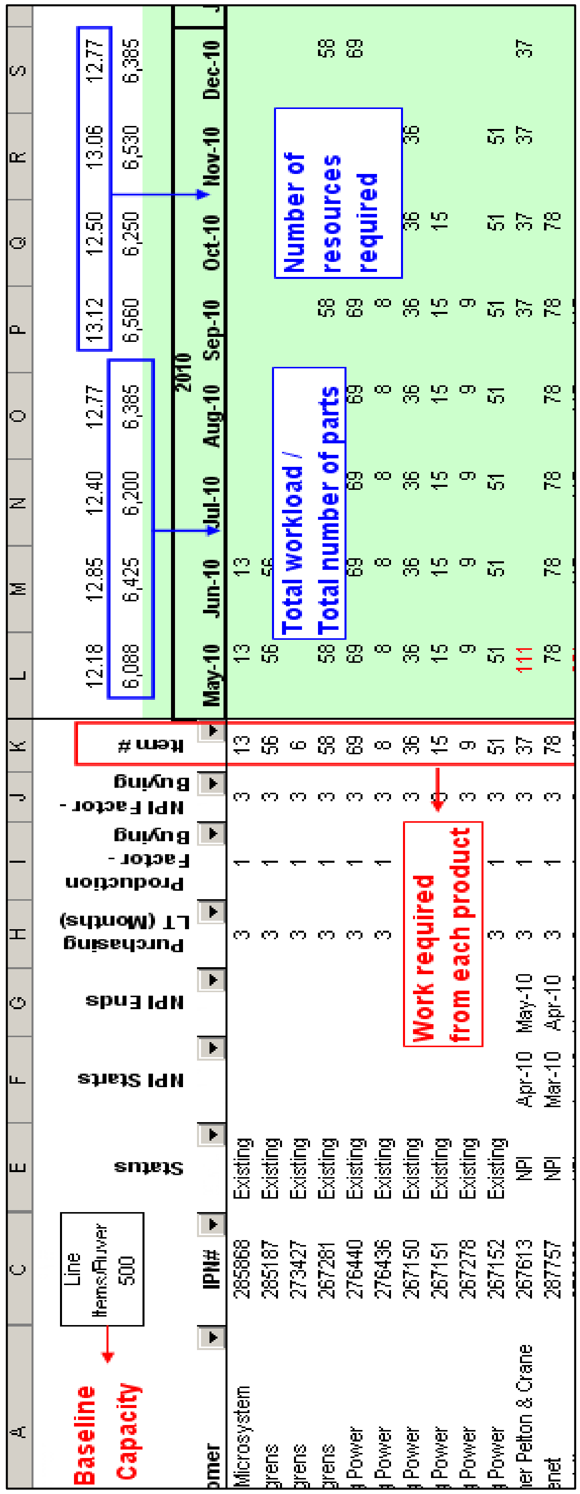
Xiamen's business growth has outpaced the organizational growth, and personnel requirement was just one aspect that lacks planning. This project recommends that managers use the spreadsheet tool to analyze personnel requirements for different combinations of potential business opportunities and NPI start dates. Based on the scenario analysis, managers can prioritize and schedule new business opportunities to ensure the business growth can be supported by feasible personnel increases. The feasible personnel increase should keep new to existing staff ratio under 1:1 to allow enough time for knowledge transfer. In addition, personnel increase should be paired with cost control to ensure the business is growing in a sustainable way. Other recommendations are to hire permanent staff based on the resources required to maintain the business after all NPI complete, and use flex resources to support the temporary surge in the workload caused by accumulative NPI. Managers should review the resource requirements of the next three to four quarters in the first month of the previous quarter to prepare for personnel increase required for new business. Other practices that can help managers fine-tune personnel management are monthly capacity meetings and management reports[13].

The resource planning solution is only effective if the talent can be retained. China is a labour market where employees can easily find opportunities, so Xiamen needs an exceptional retention plan and superior leadership that align the company's growth with employees' career growth. The resource planning solution includes an employee retention program that gives employees the visibility of the career ladder within the company and formal mentoring sessions that help employees advance their career. Nevertheless, the employee retention program developed in the project is not sufficient to maximize employee commitment. The author recommends the company to develop a more through retention plan as the next project.

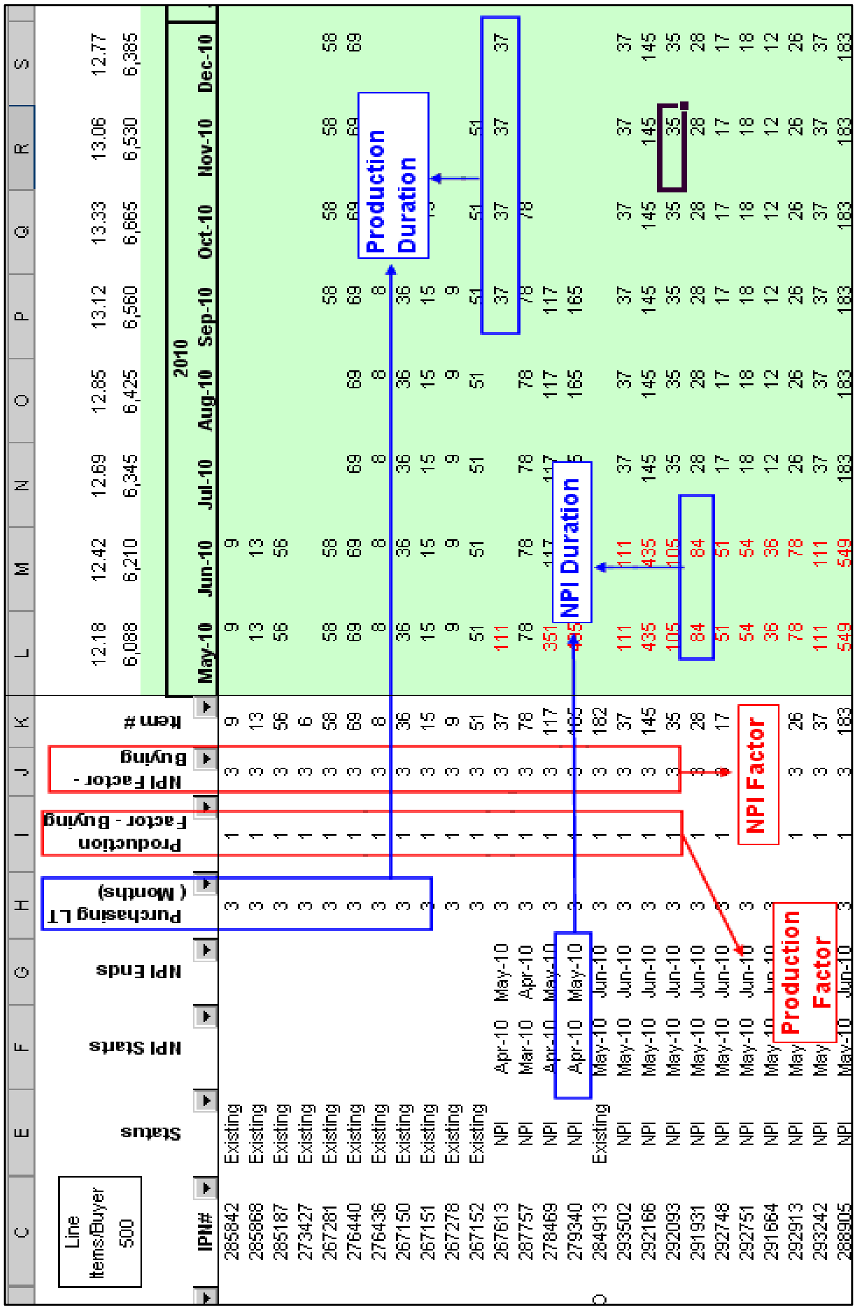
[13] Management reports include active material report, purchase order action report for supply chain, and ECO report, NPI report, and finished good report for engineering.

APPENDICES

Appendix 1 – Data Output Tab (Supply Chain) with Measuring Parameters and Calculated Results for Personnel Requirement



Appendix 2 – Data Output Tab (Engineering) with NPI factor, Production factor, NPI Duration, and Production Duration



Appendix 3 – Data Input Tab for Parameters

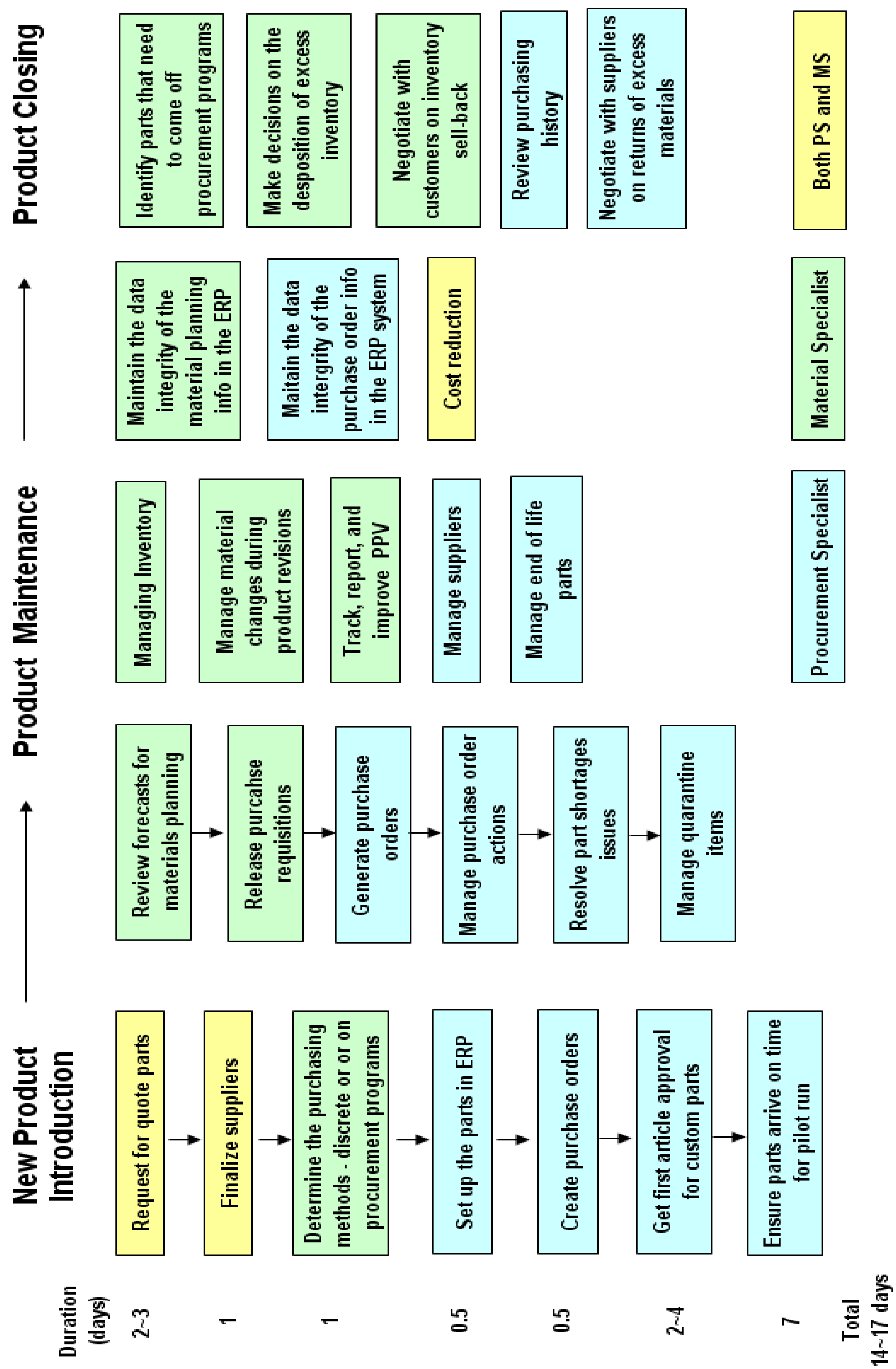
stomer	IPN#	Project	Purchasing LT (Months)	Production Factor - Buying	NPI Factor - Engineering	Production Factor - Engineering	Status	Item #	NPI Period (Days)	NPI Factor - Buying	NPI Starts	NPI Ends
	273427	RoHS|YES|CHZ OSTERGRENS|10	3	1	3	1	Existing	6	60	3		
	267281	RoHS|YES|M2M-CHZ|1001540-LF	3	1	3	1	Existing	58	60	3		
er	276440	RoHS|YES|CHZ SPANG POWER|1	3	1	3	1	Existing	69	60	3		
er	276436	RoHS|YES|CHZ SPANG POWER|1	3	1	3	1	Existing	8	60	3		
er	267150	RoHS|YES|M2M-CHZ|KA-1210900	3	1	3	1	Existing	36	60	3		
er	267151	RoHS|YES|M2M-CHZ|KA-1211000	3	1	3	1	Existing	15	60	3		
er	267278	RoHS|YES|M2M-CHZ|KA-1211500	3	1	3	1	Existing	9	60	3		
er	267152	RoHS|YES|M2M-CHZ|KA-1212000	3	1	3	1	Existing	51	60	3		
near LLC	267083	RoHS|YES|M2M-CHZ|9500-702-2	3	1	3	1	Existing	5	60	3		
near LLC	267084	RoHS|YES|M2M-CHZ|9500-702-2	3	1	3	1	Existing	6	60	3		
	267101	RoHS|YES|M2M-CHZ|A82116-LF	3	1	3	1	Existing	4	60	3		
	267273	RoHS|YES|M2M-CHZ|A82115-LF	3	1	3	1	Existing	4	60	3		
ctronics	267740	RoHS|NO|M2M-CHZ|200-0466-26	3	1	3	1	Existing	52	60	3		
ems	272785	RoHS|TBD|CHZ NOVA CONTROL	3	1	3	1	Existing	54	60	3		
	287757	RoHS|TBD|CHZ PEOPLENET|M-01	3	1	3	1	NPI	78	60	3	Mar-10	Apr-10
lton & Crane	267613	RoHS|YES|M2M-CHZ|049777-LF|0	3	1	3	1	NPI	37	60	3	Apr-10	May-10
ver/TORONTO	284913	RoHS|YES|SATCON|SSC-12-10-0	3	1	3	1	Existing	182	60	3	May-10	
ns	278469	RoHS|TBD|CHZ STAR SOLUTION	3	1	3	1	NPI	117	60	3	Apr-10	May-10
ns	279340	RoHS|TBD|CHZ STAR SOLUTION	3	1	3	1	NPI	165	60	3	Apr-10	May-10
ver	293502	RoHS|TBD|CHZ-SATCON|PC0113	3	1	3	1	NPI	37	60	3	May-10	Jun-10
ver	292166	RoHS|YES|CHZ-SATCON|PC0204	3	1	3	1	NPI	145	60	3	May-10	Jun-10
ver	292093	RoHS|YES|CHZ-SATCON|PC0204	3	1	3	1	NPI	35	60	3	May-10	Jun-10
ver	291931	RoHS|TBD|CHZ-SATCON|PC0206	3	1	3	1	NPI	28	60	3	May-10	Jun-10
ver	292748	RoHS|TBD|CHZ-SATCON|PC0204	3	1	3	1	NPI	17	60	3	May-10	Jun-10
ver	292751	RoHS|TBD|CHZ-SATCON|PC0204	3	1	3	1	NPI	18	60	3	May-10	Jun-10

Appendix 4 –Data Input Tab for CRIPR Report

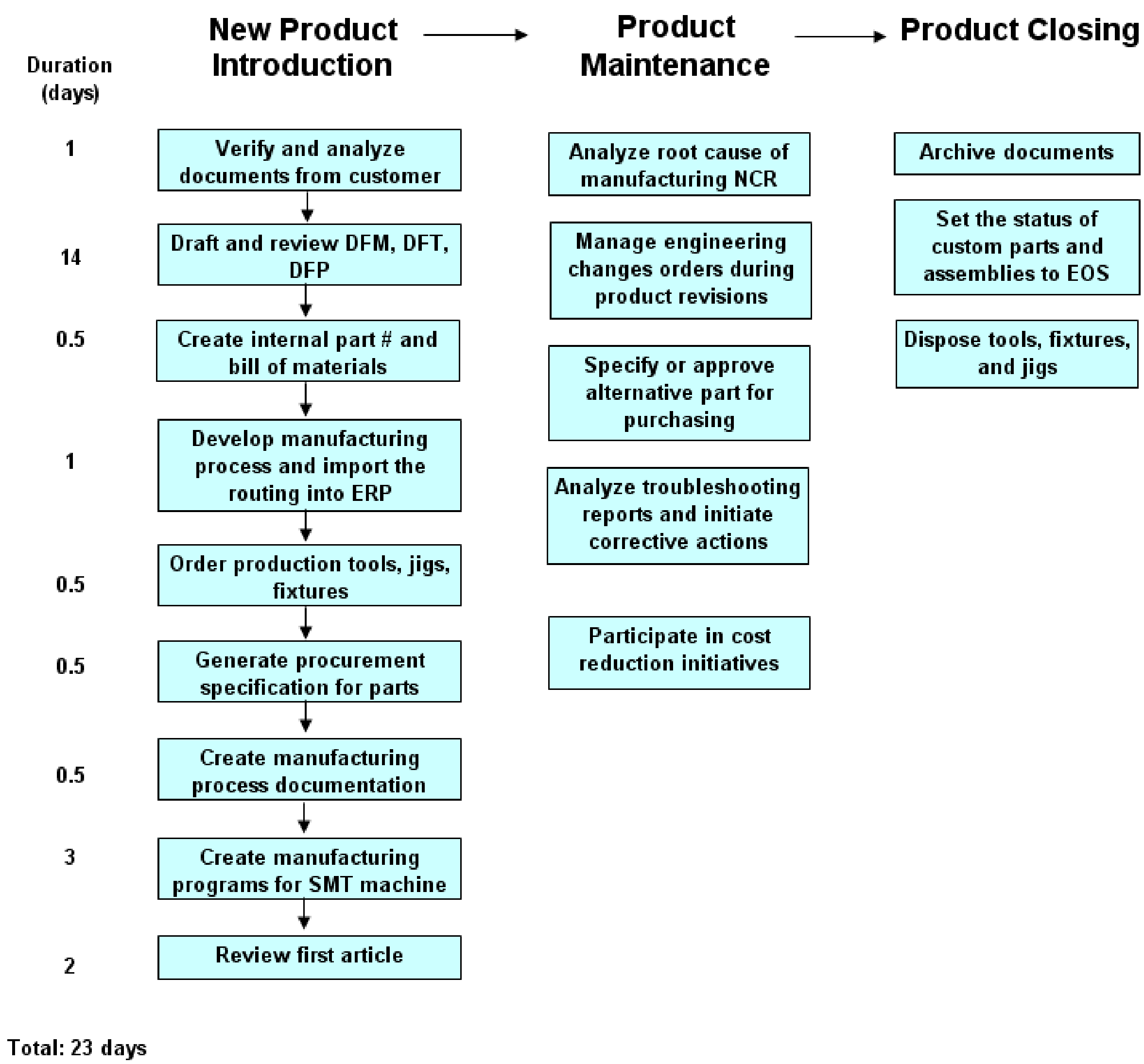
mer Name (GL)	Sales Order Number	Order Type	IPN	Unit Selling Price	Scheduled/Actual Quantity	Scheduled/Actual Revenue (USD)	Scheduled/Actual Ship Date	Week	Month	Snapshot Date
YSTEMS	102482	General Trade Sales CHZ	0274167	23.05	100	2305	17-Dec-10	12/19/2010	12/1/2010	29-May-10
YSTEMS	102482	General Trade Sales CHZ	0274167	23.05	100	2305	19-Nov-10	11/21/2010	11/1/2010	29-May-10
YSTEMS	102482	General Trade Sales CHZ	0274167	23.05	100	2305	15-Oct-10	10/17/2010	10/1/2010	29-May-10
YSTEMS	102482	General Trade Sales CHZ	0274167	23.05	100	2305	17-Sep-10	9/19/2010	9/1/2010	29-May-10
YSTEMS	92838	General Trade Sales CHZ	0274167	23.05	200	4610	4-Oct-10	10/10/2010	10/1/2010	29-May-10
YSTEMS	92838	General Trade Sales CHZ	0274167	23.05	150	3457.5	2-Aug-10	8/8/2010	8/1/2010	29-May-10
YSTEMS	92838	General Trade Sales CHZ	0274167	23.05	150	3457.5	11-Jun-10	6/13/2010	6/1/2010	29-May-10
OVA EUROPE	104014	General Trade Sales CHZ	0273003	10	200	2000	21-Jun-10	6/27/2010	6/1/2010	29-May-10
YSTEMS	92441	General Trade Sales CHZ	0273003	10	3	30	4-Jun-10	6/6/2010	6/1/2010	29-May-10
YSTEMS	92441	General Trade Sales CHZ	0273003	10	50	500	18-Jun-10	6/20/2010	6/1/2010	29-May-10
YSTEMS	92441	General Trade Sales CHZ	0273003	10	100	1000	4-Jun-10	6/6/2010	6/1/2010	29-May-10
LUTIONS	104011	Domestic Sales CHZ	0279340	34920.10256	10	51158.24	1-Jul-10	7/4/2010	7/1/2010	29-May-10
LUTIONS	104011	Domestic Sales CHZ	0278469	19456.94872	50	142522.95	25-Sep-10	9/26/2010	9/1/2010	29-May-10
LUTIONS	104011	Domestic Sales CHZ	0278469	19456.94872	10	28504.59	1-Jul-10	7/4/2010	7/1/2010	29-May-10
YSTEMS	102092	General Trade Sales CHZ	0277748	7	100	700	4-Nov-10	11/7/2010	11/1/2010	29-May-10
OVA EUROPE	104248	General Trade Sales CHZ	0277185	24.99	350	8746.5	10-Sep-10	9/12/2010	9/1/2010	29-May-10
OVA EUROPE	104248	General Trade Sales CHZ	0277185	24.99	350	8746.5	9-Jul-10	7/11/2010	7/1/2010	29-May-10
OVA EUROPE	104248	General Trade Sales CHZ	0277185	24.99	350	8746.5	10-Dec-10	12/12/2010	12/1/2010	29-May-10
OVA EUROPE	104248	General Trade Sales CHZ	0277185	24.99	350	8746.5	12-Nov-10	11/14/2010	11/1/2010	29-May-10
OVA EUROPE	104248	General Trade Sales CHZ	0277185	24.99	350	8746.5	8-Oct-10	10/10/2010	10/1/2010	29-May-10
OVA EUROPE	104248	General Trade Sales CHZ	0277185	24.99	350	8746.5	10-Jun-10	6/13/2010	6/1/2010	29-May-10
YSTEMS	94716	General Trade Sales CHZ	0273003	10	300	3000	1-Dec-10	12/5/2010	12/1/2010	29-May-10
YSTEMS	94716	General Trade Sales CHZ	0273003	10	300	3000	1-Nov-10	11/7/2010	11/1/2010	29-May-10
YSTEMS	94716	General Trade Sales CHZ	0273003	10	300	3000	1-Oct-10	10/3/2010	10/1/2010	29-May-10
YSTEMS	94716	General Trade Sales CHZ	0273003	10	300	3000	3-Sep-10	9/5/2010	9/1/2010	29-May-10
YSTEMS	94716	General Trade Sales CHZ	0273003	10	300	3000	2-Aug-10	8/8/2010	8/1/2010	29-May-10
YSTEMS	94716	General Trade Sales CHZ	0273003	10	300	3000	5-Jul-10	7/11/2010	7/1/2010	29-May-10
YSTEMS	94716	General Trade Sales CHZ	0273003	0	300	0	30-Jul-10	7/31/2010	7/1/2010	29-May-10
YSTEMS	92441	General Trade Sales CHZ	0273003	10	100	1000	11-Jun-10	6/13/2010	6/1/2010	29-May-10
YSTEMS	94716	General Trade Sales CHZ	0273003	10	300	3000	4-Jan-11	1/9/2011	1/1/2011	29-May-10
YSTEMS	104353	Inventory Sell Back CHZ	0272801	0.0799	5000	399.5	25-Jun-10	6/27/2010	6/1/2010	29-May-10
YSTEMS	104353	Inventory Sell Back CHZ	0272799	0.044	8000	352	25-Jun-10	6/27/2010	6/1/2010	29-May-10
YSTEMS	104353	Inventory Sell Back CHZ	0272798	0.0213	6000	127.8	25-Jun-10	6/27/2010	6/1/2010	29-May-10
YSTEMS	102483	General Trade Sales CHZ	0272785	23.05	200	4610	2-Sep-10	9/5/2010	9/1/2010	29-May-10

okup / Engineering Variables / Buying Variables / Graph /

Appendix 5 – Supply Chain Work Process



Appendix 6 – Engineering Work Process



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