การพัฒนาการควบคุมการผลิตระดับโรงงานในโรงงานทำเครื่องดนตรี

นาย เอกพัชร์ สิทธิไตรวัฒน์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
สาขาวิชาการจัดการทางวิศวกรรม ศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต
คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2550

SHOP FLOOR CONTROL IMPROVEMENT FOR A MUSIC INSTRUMENT FACTORY

Mr. Ekapach Sithitriwat

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Engineering Program in Engineering Management
The Regional Centre of Manufacturing Systems Engineering
Faculty of Engineering Chulalongkorn University
Academic Year 2007

Thesis Title	SHOP FLOOR CONTROL IMPROVEMENT FOR A MUSIC INSTRUMENT FACTORY
By	Mr. Ekapach Sithitriwat
Field of Study	Engineering Management
Thesis Advisor	Associate Professor Parames Chutima

Accepted by the Faculty of Engineering, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

..... Dean of the Faculty of Engineering
(Professor Direk Lavansiri, Ph.D.)

THESIS COMMITTEE

.....Chairman
(Professor Sirichan Thongprasert, Ph.D.)

.....Thesis Advisor
(Associate Professor Parames Chutima)

.....Member
(Associate Professor Jeirapat Ngaoprasertwong)

เอกพัชร์ สิทธิไตรวัฒน์: การพัฒนาการควบคุมการผลิตระดับโรงงานในโรงงานทำเครื่องดนตรี (SHOP FLOOR CONTROL IMPROVEMENT FOR A MUSIC INSTRUMENT FACTORY) อ.ที่ปรึกษา : รศ.ปารเมศ ชุติมา, 156 หน้า

งานวิจัยนี้มีวัตถุประสงค์เพื่อลดปัญหาภายในโรงงานผลิตเครื่องดนตรี โดยใช้วิธีการต่างๆ ที่เกี่ยวข้องกับการควบคุมการผลิตระดับโรงงานในการแก้ปัญหา ในสายการผลิตกลองคองก้า ปัญหาหลักสามประการของโรงงานตัวอย่างได้แก่ การจัดการองค์กรและความสัมพันธ์ภายในองค์กร กระบวนการผลิต ความล่าช้าในการจัดส่งสินค้า และค่าใช้จ่ายในการผลิตทั้งทางด้านแรงงานและ ค่าไฟฟ้า

งานวิจัยเริ่มต้นจากการวิเคราะห์และรวบรวมข้อมูลที่จำเป็นในการศึกษาหาต้นเหตุของปัญหาภายในโรงงาน หลังจากศึกษาสาเหตุของปัญหาแล้วจึงพัฒนาการควบคุมการผลิตโดยใช้เครื่องมือ วิธีการ ทฤษฎี ที่เกี่ยวข้องกับการควบคุมการผลิตเช่น การแบ่งหน้าที่อย่างชัดเจน การปรับปรุงกระบวนการผลิต การใช้เครื่องมือติดตามสถานะของสินค้า และกระบวนการผลิต การพัฒนาเริ่มตั้งแต่ การจัดผังองค์กรใหม่ การปรับเปลี่ยนผังโรงงานเพื่อให้สอดคล้องกับสายการผลิต การพัฒนากระบวนการผลิต ผลลัพธ์ที่ได้คือ ความล่าช้าจากการส่งสินค้าลดลงจาก 90 วัน เหลือเพียง 30 วัน ประสิทธิต่อคนงานเพิ่มขึ้น 5-20% ของเสียที่เกิดจากการผลิตลดลง 2-10% ในแต่ละกระบวนการผลิต ค่าใช้จ่ายในการใช้กระแสไฟฟ้าลดลงจาก 10,000 หน่วย เป็น 9,000 หน่วย

ศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต
สาขาวิชา การจัดการทางวิศวกรรม
ปีการศึกษา 2550

ลายมือชื่อนิสิต :.....
ลายมือชื่ออาจารย์ที่ปรึกษา : .....

4771638921 : MAJOR ENGINEERING MANAGEMENT
KEY WORD: SHOP FLOOR CONTROL IMPROVEMENT/ MUSIC INSTRUMENT FACTORY

EKAPACH SITHITRIWAT: SHOP FLOOR CONTROL IMPROVEMENT FOR A MUSIC INSTRUMENT FACTORY THESIS
ADVISOR: ASSOC.PROF.PARAMES CHUTIMA, PH.D., 156 pp

The objective of this research is to study and develop shop floor control system for the music instrument company in the case study. Find out the solution in production plan and assignment job clearly based on process to minimize all problems in the Conga Drum production line. There are three main problems which are organisation management and relationship, production, expenses and due date.

The research was started from defining clearly to the causes of the problems by collecting necessary data. Improvement process is starting from reorganization, production improvement, and relay out. The solutions is to applied theory, concepts and tools that related to shop floor control such as divide and assign job clearly, follow up tools, built-in quality concept. The results illustrate that company can set due date more accurate and reduce lateness due date from 90 days to 30 days. Defects reduce by 2-10%, therefore productivity per worker increase around 5-20%. The production cost in term of electricity used reduces from 10,000 units to 9,000 units.

The Regional Centre for Manufacturing Systems Engineering
Field of study: Engineering Management
Academic year 2007

Student's signature:.....
Advisor's signature:.....

ACKNOWLEDGEMENTS

The author would like to express his truly gratitude to those who are the author's supports for the thesis completion. First and foremost, grateful thanks are dedicated to the thesis advisor, Associate Professor Parames Chutima for his invaluable comments. Grateful thanks also are conveyed to the committees, Professor Sirichan Thongprasert and Associate Professor Jeirapat Ngaoprasertwong for their invaluable recommendations.

Special thanks to the PK Music team members for their contribution throughout the thesis accomplishment. Last but not least, his most sincere appreciations are dedicated to his beloved parents, family members, and friends indeed for their moral encouragements and kind assistants as a part of thesis fulfillment.

CONTENTS

Page

Page

Page

List of Tables

Page

Page

List of Figures

Page

ABBREVIATION

PK	=	PK Music CO., Ltd.
SFC	=	Shop Floor Control
WIP	=	Work-In-Process
BOM	=	Bill of Materials
MRP	=	Material Requirement Planning
PPC	=	Production Planning and Control
EDD	=	EDD Earliest Due Date
FCFS	=	First-Come-First-Serve
SPT	=	Shortest Processing Time
LPT	=	Longest Processing Time
HR	=	Human Resource
PAC	=	Production Activity Control
FC	=	Factory Coordination

CHAPTER I

INTRODUCTION

1.1 Background

1.1.1 Shop Floor Control and Made-To-Order manufacturing

Thailand is a developing country which have expanding in industrial. In fact that, there are a lot of companies in Thailand still lack of knowledge to manage and control production system. Therefore, comparing small and medium factory in Thailand with other developed country is still far away from standard. The knowledge, working culture and system from western play important roles because many factories in Thailand now making product for export and sell to developed countries such as USA and countries in Europe. Product from Thailand some of them is using a lot of experiences, processes, and skills to make such as furniture and music instrument which is hard to control production and lead time. The adaptation of factory in quality are using machine to done the part that didn't need skills labor.

In this case study, the order system is Make-To-Order manufacturing. Make-To-Order manufacturing is the system that factory starts all process after customers take place their orders; products are produced in small batches and varieties in each order. Thus, factory needs clear and good production plan to serve customer without delay. It is not only time to consider, cost is also important because in business competitors will reduce cost and increase their capacity and quality. First of all, factory should improve their internal production system. It is helpful for run more efficiency production plan to clearly job assignment and standard process. Moreover, group technology can apply to the production line in different products but using same machine and technology.

The benefits from shop floor control improvement in music instrument factory which lack of good production plan and system are, understand all factors which effected to production system, using resources (man, machines) at the maximum

capacity, more accurate lead time and forecasting shipment time, reduce cost and waste in production line.

1.1.2 Case Study Company

PK Music CO., Ltd. was established over 10 years. PK is a 100% family owned business which manufacture percussion music instrument over hundred of items such as Conga, Bongo, Djembe drums, Maracas, Tambourines, shaker and accessories. The main market is international market about 90%, the other 10% is domestic market. The different of domestic and international market is quality. There are about 30-50 workers in production line. Materials and quality specifications are different by customer requirements. Raw materials are wood, steel, and painting chemical. The factory has working area approximate 4,000 square meters, included warehouse and hardware shop.

1.1.2.1 Organisation

PK is a family business therefore the organisation structure has become a centralized structure as shown in the figure in figure 1.1.

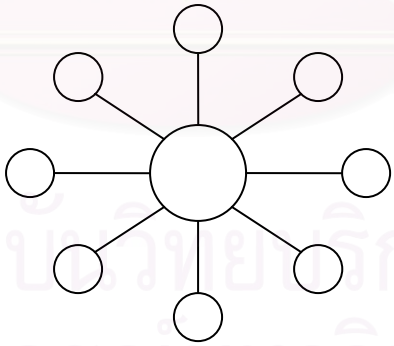

Figure 1.1 *Centralized Organisation Structure*

All decision and problems are solving by head in the middle which is not good for the organisation in order of responsibility. PK is a sample for non-standard process in production line and assigned job. The main two parts which can separate is office and production work. Office work responsibles for document, tax, order. Production work responsibles for making all products as order and under customer requirement. However, decision making in all office and production work always decide by

director. The production process and planning is not stable in each of order by varieties of product and production and capacity planning.

1.1.2.2 Products

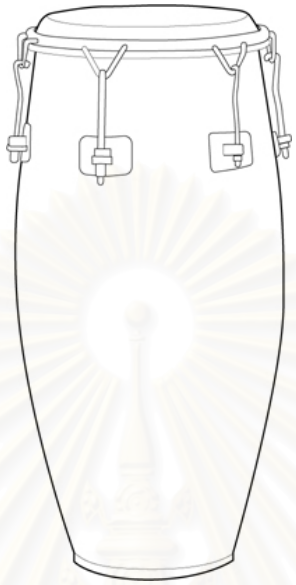

Figure 1.2 *Conga Drum*

There are several products in the case study company but the main production line in this case study is Conga Drum. Conga Drum is a wood percussion drum which is a main production line of the plant in case study. There are about six differences size and different hardware depend on customer. The main processes to making conga are body part called shell, hardware and assembly which main materials for conga is wood and steel. Shell preparing and assembly process will be the main study in this report. Assemble process is included packing and quality control at the last process.

For the hardware process will not consider because there are some hardware parts that outsourcing and cannot control and indicated cause of problems by internal.

1.1.2.3 Production Process and Capacity

The main product in this process is Conga drum. In each step company never calculate lead time. Bongo and Djembe drum have some different process and machines but there are also using the same machines with Conga drum such as glue and forming, and coloring to packing. Product schedule comes out after order take

place. It is only a rough schedule which has only quantity and due date such as Conga drum 120 pieces, due date next month. Workers are working with machines and manufacturing in batch for each order.

Capacity of the conga production line from the data found that ideal capacity is around 800-1000 pieces/month but approximate order per month is only 260. There is still delay problem which happen to each order about 1-3 weeks delay.

1.2 Statement of Problem

Company starting by family therefore organisation don't have system the production plan, standard work in shop floor, process controlling system. The order characteristic is Make-To-Order which is major causes of problems such as scheduling, controlling of process, cost and resources. In addition, there are only rough plan and approximate outcome for each order. The problems that occur in company are list follow:

1) Lack of production plan knowledge
2) Lack of cooperate between work station
3) Unclear and non-standard work process
4) Unclear organisation structure and management
5) High labour and variable cost; especially overtime cost
6) Delay shipment
7) Product quality and damaged on final product need to fix

1.3 Objective of Research

To study and develop shop floor control system for the company in the case study. Find out the solution in production plan and assignment job clearly based on process to minimize all problems.

1.4 Scope of Study

The scope of study will be focus on main production line which using same technology and occurs to the problems, job assignment, shop floor control, production plan, standard process and labour. Data in case study must be collect and approximate by observer and company. Decision has regard to management of company. The results can measure by expenses which happen in production line and shipment time.

The scope will not cover and consider on:

- Hardware problems which may cause by suppliers
- Other product line such as Tambourine, hand drum, and shaker

1.5 Benefits of the Study

Results of the study should directly benefits to company cover problems that mention above by applying tools, techniques, and plans. Benefits include:

1) Better production plan for each shipment by applying shop floor control.
2) Clearly understand for management level to the plan and identify clearly job to workers.
3) Clearly job assignment and work instruction.
4) Reduce expenses and cost that related to the study.
5) Reduce shipment delay from due date.
6) Better identify problems in shop floor.

1.6 Methodology

1) Study and collected literatures, theory, and technique that related to job assignment, work instruction, group technology, and production planning and control.
2) Study and collected general information from company such as machine capacity, workstations and material flow in production line, materials and variable cost.

3) Analyze data from current plan by statistic method.
4) Improve work instruction, job assignment and create production plan.
5) Implement production plan and compare the results; shipment time and expenses.
6) Monitor improvement performance, making summarize, and recommendation.
7) Preparing report and presentation.

CHAPTER II

THEORETICAL CONSIDERATIONS

This chapter discusses on theories, literature review, journal, and education paper which included techniques, tools, and rules that applied to case study, solutions, and improvement process which use to consider and implemented the real situation in case study.

2.1 **Organisation**

Organisation is important in divide responsibility for all position in organisation which also cover detailing in job description that have standard process and easy to follow up. Benefits of organisation management are easier in set up organisation concept and create balancing between functions, clearly and easier to set up job description in detail, avoiding overlap scope of work, increase relationship between functions, clearly target and understanding together in each function.

2.1.1 Principle of Orgaisation

Before improved organisation structure should consider in these topics; unity of command, hierarchy, span of control, line, staff, auxiliary, departmentation, authority, responsibility, accountability, coordination, and communication.

1) Unity of command is line of command should have only one of commander in each command to avoid confusing.
2) Clearly hierarchy is important for onganisation management when finding response people and scope of work in each function in organisation.
3) Span of control is balancing between numbers of people commander to avoid overload to take care of for commander.
4) Line, staff, Auxiliary are three function in organisation that line position is cover the main work in organisation, staff position is a professional and

consult in organisation, auxiliary is service and support to the main functions in organisation.

5) Departmentation divide into eight type, each of types is different and suitable in different organisation; function, territory, project, simple numbers, product and services, customers, process, time.
6) Authority, responsibility, accountability are relationship and decision making by upper management to lower line which need in organisation to cover target and controlling process.
7) Coordination is important to monitor every function that should work in the same target. Coordinated also need for change management in organisation.
8) Communication is important principle between function in organisation to finished task and reach the target.

2.1.2 Organisation Chart and Process of Organising

The orgnisation chart illustrated position and command line in organisation which show clearly by using square shape (box) and line to connect between individual boxes. After determine in principle and analyzed, the next process is to implement organizing. There are three main processes which are

1) Consider group of work and design job to all position, this process lead to division of labour that separate by using principle above.
2) Assign scope of work and responsibility to making decision under position level. This process is important when command, target, and task come from upper level delegate to under level and avoid complexity on scope of work.
3) Establishment of relationships, this process making system in coordinate procedure between each function.

Oganising process should cover objective and plans, authority of position level, environment in organisation, position level suitable with labor skilled and ability.

2.2 Production Process and Productivity

Production is a process to making product which added value to raw material through process to final product. Production also divides into five main characteristics; make-to-stock, assembly-to-order, design-to-order, make-to-order, engineer-to-order. Therefore, production process is important to have efficient production management, controlling system and planning to maximize productivity. Productivity is an indicator to illustrated efficiency of process which measure by output relative to input.

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

Productivity could calculate in different term such as labour productivity.

$$\text{Labour Productivity} = \frac{\text{Outcome}}{\text{Labor/Hrs. or Day}}.$$

Organization should understand clearly on their process and target to maximize their productivity. The efficient production process should consider on internal factors; labour, machines, production capacity and scheduling, production planning, plant layout, quality, timing. External factors are raw material, logistic and distribution, customer requirement. Organisation have different target on production process which can consider by customer satisfaction, delivery due date, product quality.

2.2.1 Production components

There are four main components that related directly to production; labour, machine & equipments, materials, supporting functions.

1) Labour can divide by their characteristic; direct and indirect, skilled and unskilled, permanent and temporary labour.
2) Machines divide by functions of them; production machine, auxiliary machines and equipment, maintenance equipment, material handling

equipment, service equipment, quality control equipment, measurement instrument and equipment.

3) Materials is also important with production, normally divide into three divisions; direct and indirect materials, raw material, work-in-process (WIP), and finished product.
4) Supporting functions is an assistant for production to run all the processes success as the set up target. There are many function area which related to production such as engineer design, production planning and control that planning capacity related to customer order, plant engineering set up plant layout, installation and maintenance machine, material handling, waste treatment, finance, inventory control.

2.2.2 Type of Processing

There are many types of processing that introduced by gurus, differentiate is consider by productivity, flexibility, product that suit with process, variety. There are several type which are job shop, batch, assembly, and continuous. These four processing have their own different characteristic. (Suthat, 2005)

1) Job Shop Processing – This is a process that has flexibility but can produce in small batch. Job shop is different in each lot of order and suitable with product that has a variety requirement.
2) Batch Processing – This is a process that product variety but using the same process in production line. In term of production plan batch processing scheduling in easier to plan than job shop processing with larger amount of productivity but less variety when compare with job shop. Batch processing is suitable for product that have standard but still need variety in detail.
3) Assembly Processing – Assembly processing is a process that run flow shop with labour mostly continuous. Therefore, when setting up production line is hard to change in detail but can produce in large batch.
4) Continuous Processing – This process is used in product that same in every piece. The production line runs by machine more than human. The characteristic of continuous processing is produced huge amount of product and automated by machine.

2.2.3 Defining and Measuring Capacity

Capacity measurement is an analysis which consider on maximum output. There are many measurement tools which using in the different case. It is hard to conclude on one measurement tools that suitable for every case. Design capacity and effective capacity are two definitions which related to capacity.

1) Design capacity is the capacity of the system which design and the maximum output rate in every operation could be reach.
2) Effective capacity is the allowance in each process on the system that designed.

The maximum output is an ideal number without other functions that effected to capacity such as quality (defects), machine breakdown, and lack of sources. Therefore, utilization on each process is applied knowledge to get the ideal number on capacity which should consider on causes and effects of the problems. The measurement could discuss on many results such as variable cost, labour cost, amount of finished goods.

Production process is cover all main making product processes included quality control, packing, manufacturing. Production process can illustrate into flow chart which using basic square shape means process or work station and arrow means transportation to next process. Thus, in production flow chart shows input and output between processes, machines. Production flow chart helps planner and observer easier to monitor each process. For example, there is the damage on product, observer can focus on process and or transportation point which show in flow chart.

2.3 Shop Floor Control and Planning

Basic process management is starting from planning, organizing, leading, and controlling which planning mostly from the top management. In addition, in some system need to have controlling system together to reach the target as planning.

Shop Floor Control (SFC) is the system monitor directly on production order, analyses efficiency and production problems. SFC focused track and report against production orders and schedules. SFC is a operation level on planning and control work-in-process (WIP), materials, and processes. The main procedure of SFC is using data communicate and updated status in shop floor, orders. SFC evaluated and updated resources status, labor, machine hour to support production planning, cost estimation, and scheduling. SFC can monitor and track production order from starting (material issue) to final product. Therefore, after implement SFC into production line, it is easier to track the problems from machine and labor which goal is to optimize resources, labor, and machine efficiency. In addition, tracking order status also included in SFC by supporting functions; routings, work centre data, capacity planning, and WIP.

In addition, lead time is a timeline which products are in production line. Therefore, lead time cover setup, operation, queuing, and transport time. SFC assist planner to reduce all waste in lead time with the quality control and tracking system of production order. To study deeply in the production line can divide to sub processes which are workstations. The efficient SFC system also included ability to reduce WIP, utilize labour and machines.

2.3.1 Production Activity Control

Production activity control (PAC) is a technique to plan production in short term such as day-to-day. Generally, PAC has five functions which are scheduler, dispatcher, monitor, mover, and producer. PAC focused on cell and workstation layer which under factory layer and above device layer. Each function relates in scope of work and communicates to each other to reach target.

1) Scheduler is a basic in planning follow requirements and time schedule which giving detailed schedule to dispatcher. Scheduler use lot of data from monitor to create schedule in practical which have many constraints related. Firstly, scheduler should consider on capacity, requirements, and environment. Secondly, analyse date to develop schedule with available capacity in each workstation. Then, push schedule to dispatcher to implement in production line.

2) Dispatcher is coordinator and controlling function in PAC. Dispatcher receiving schedule from scheduler then analyses for the solutions, and implement. Dispatcher deal with practical problems that happen from uncertainty. To deal with problems dispatcher need to has data support such as shop floor current status, choice of operations and detail, performance in each task. Therefore, dispatcher is the one who giving instruction to mover and producer in the system.
3) Monitor is an important function which giving consistent, accurately decision support data to scheduler and dispatcher because decision making under practical case need accurate information. In addition, data collecting and analysis in the main task for monitor. There are many data which related; product data, inspection data, defects data, rework data, workstation data, job and task status. Monitor take tracking responsibility in production line which monitoring on product, raw material, and quality. Data capture is a collecting process to making decision support in each level. To check WIP and workstation status should use different type of data such as WIP status collect job number, part name, current operation and location, due date, amount of work piece in operation. Moreover, workstation status collect workstation name, current status and job number, percentage in setup, processing and down time. Data from colleting use in analysis for scheduler and dispatcher which collected by monitor.
4) Mover mainly responsible for material handling and movement in and between workstation. Mover also creates and adjusts routing for all transport between workstations. Transportation data from mover could lead to solution implementation from dispatcher which reduce overlap transport; waste.
5) Producer is the function that giving detail of work when finished in each job to monitor and working follow dispatcher instructions. Producer is information receiver to generate in work.

2.3.2 Factory Coordination

Factory coordination (FC) is environment and controlling task which in the factory layer. FC relies on varieties of inputs (resources) and outputs (products). In addition, production environment task responsible for process planning and

manufacturing analysis which cover adjust layout by focus on product or process type. Production environment task improve efficiency to support production level and concern in maintenance and environment which effect to production. In the control task, scheduler, dispatcher, and monitor are doing the same task as PAC but in the larger layer. Therefore, scheduler create suitable schedule for factory layer and send to dispatcher to implement and control workflow. Monitor is giving data which suitable for decision making in factory layer. FC has changing data with PAC to making support decision data more accurately.

2.3.3 Standardization Process

Before controlling process the basic need of SFC is standard process. Standard process is not only the work instructions but standard process should consider on reach goals with using maximum efficiency with the standard process that setting up to serve customer requirements. Standard process is the analysis which continuous improvement is needed to maintain standard that already set up. There are six activities which related to standardization which are

1) Plant layout and machines location
2) Work study
3) Material handling
4) Improvement on tools and machines
5) Division of work; machines job and labour work
6) Avoid and protect defects

The improvement processes to reach standardization process can divide into steps to focus on which are:

Analyse problems

1) Survey for problem
2) Sourcing data which is problems and detail
3) Estimate benefit for solving problems

Set up goals

1) Priority problems which is the most important
2) Set up goals

Investigate on problems

1) Survey directly to the cause of problems (cause and effect diagram)
2) Collect data and analyse

Illustrated relationship of each function to the problems

1) Created chart or table (standard operation sheet)
2) Created detail document (visible data)

Create improvement process

1) Brainstorm people who related to problems
2) Create solutions and tools (standard work instructions)

Implementation

1) Implement solutions and tools to solve problem into production line

Set up standardization and goals

1) Monitor result after implementation and collect data
2) Solve the maintain problems by other solutions
3) Set up new goal and announce standardization

In addition, standardization process has a goal to reduce all wastes in production line. Continuous improvement loop (plan-do-check-act) will relate to create standardization process. The objectives of standardization process may consider on many aspects such as capacity, quality, and work-in-process.

After set up standardize process to production line, the next step is to maintain standard as set up at the first stage. These are guideline to maintain standardize process.

1) Implement standardization process to the whole production line which needs to have support from top management.
2) Making understand and create responsible from top management to labour in standardize process.
3) Leader in each function should have responsibility on teaching, commanding, and create motivation to lower level as the standardization process in every time.
4) Install visual display to remind responsibility of everyone that related to.
5) Making clearly work instructions and example for every process to worker to compared their work with.
6) Use middleman to coordinate between each functions.

7) Leader of each functions is a responsibility for standardize process of their area.
8) Remind to all related that continuous improvement is the core of standardization process.
9) Meeting between related time to time to create new idea in improvement and analyse problems.
10) Set up better standardization process under the system.

2.3.4 Seven Wastes

Wastes are non value added in the production which effect to productivity, quality, due date and profit. There are many reasons why wastes happening in the production such as controlling and planning inefficient, non standard process, tools or machines breakdown, quality control inefficient. There are seven wastes which could identified in production; overproduction, inventory, transportation, defect, processing, operation, idle time.

1) Overproduction means produces products in the wrong time, and over from use. There are many effects that relate to overproduction such as inventory problem, non flexibility in production scheduling, and useless in raw material. The reasons why overproduction are produces in large lot, inefficient forecasting, overlap workers and job in shop floor. The solutions to reduce overproduction are line balancing, pull production (Kanban), production planning and scheduling.
2) Inventory waste is number of parts, raw material, WIP, finished goods that keep in the warehouse and production line without using or making in value added. Inventory waste causes are related to overproduction in some parts such as inefficient forecasting, producing in large lot, defects. The solutions to control inventory level are production leveling, control raw materials order (MRP), pull production.
3) Transportation waste is the time that loses while work piece moving and also defects which happen between handling. Plan layout, material handling, inefficient flow productions are the reasons of transportation wastes. The

solutions are setup standard U-shape work flow, re-layout, controlling on work flow, improve tools and transporter for material handling.

4) Defects could happen in every workstation and process that work piece pass through. The causes of defects are too much attention on quality control at finished products stage, non standard process and quality control, material handling, operations, machines and tools breakdown. The solutions for reduce defects are initiate built-in quality means monitor and quality control in every process, setup standard process, reduce unnecessary movement, improve transporter, create protection tools.
5) Processing waste means the process that not necessary to work and making defect. To identified processing waste may come from non standard process, changing design, not enough knowledge in material, process and operation. The solutions are analyse process to find out cause and effect and design suitable process, create standard process and maintain.
6) Operation waste means unnecessary movement, motion that not generates work. There are many causes of operation wastes such as lack of skilled, workstation layout not suitable, inefficient controlling system. The solutions are setup training and initiate standardization in working process, create suitable workflow with production type.
7) Idle time is type of waste that comes from waiting and queuing in the production without generates any work. There are many reasons such as inefficient line balancing, plant location and machine position is not suitable. The solutions are re-layout and adjust line production, analyse all task and improve scheduling.

2.3.5 Pull Systems

Pull system is a reverse system of push system. Push system is the system that when process ends the finished goods will push the next workstation. On the opposite side, pull system pull the work piece from the previous workstation to product on their workstation at the suitable amount. Therefore, it is the most famous tool for pull system which is Kanban.

Kanban is Japanese work means signal which limit the order to produce and transport in each process or workstation. Kanban is use for reduce overproduction rate and waste in the system, improve factory efficiency, increase flexibility and easily to monitor idle time in the process, connect workstation together, reduce inventory and safety stock. There are six rules to use Kanban which are:

1) Only end process can withdraw work piece from previous process.
2) The previous process can produce only work pieces that have withdraw.
3) Receiving only perfect goods means no defect on pulled work piece from previous workstation.
4) Product leveling and line balancing is important in improving Kanban.
5) Kanban should stick with the work piece.
6) Keep reducing Kanban amount after implement in the system.

Before use Kanban, it is a lot of process and Kanban card and container which using in the system. Therefore, calculation and survey clearly is necessary process. To calculate number of Kanban card is using this fomula:

$$N = \frac{DT(1+X)}{C}$$

Where:

N = Total number of containers

D = Planned usage rate of using work center

T = average waiting time for replenishment of parts plus average production time for a container of parts

X = Policy variable set by management that reflects possible inefficiency in the system (the closer to 0, the more efficient the system)

C = Capacity of a standard container (should be no more than 10 percent of daily usage of the part).

Note: D and T must use the same units.

In addition, Kanban is one of the tools in visual systems. A visual system has benefits on using togther with pull system. Therefore, Kanban is only one tools that can applied to create pull system but to use Kanban effectively should setup Kanban

at the suitable level, controlling Kanban while using, and keep improve Kanban with the tools.

2.3.6 Documentation and Data Collection

Collecting and using a lot of data in SFC which useful for making decision, thus sourcing data and data analysis is important. The useful data should create on the same standard such as same type of unit, therefore people who involve with the data should understand in the same way. To get accurate data should identified exactly what information that need. There are many procedures in collecting data; mechanic automatically, operator record, counting by observer, job order.

1) Mechanic automatically is the data collection that machine has automatic mechanism to record data such as electric counter on the pressing machine.
2) Operator recording is the direct way to collect data from operator, it is only operator that can count and record how much the job done in hour or day.
3) Counting by observer, information collect by observer who walking and count on the job that done in each workstation.
4) Job order is the data collection that relies on job order card or command of order.

2.3.7 Line of Balance

Line of balance (LOB) is a technique that using graphic chart to helping in scheduling, controlling, illustrate progress of production order which related to due date and productivity. LOB control delivery date on short period such as week-by-week order which all activity in production line are related. LOB is a tools that planer using to compare schedule and actual progress in each period to concern about problems which effect to delivery. After checking the progress, planner could manage on time to solve delay that might happen and pull all schedule on track.

2.4 Plant Layout

Plant layout is analysis to manage resources in factory to maximum efficiency with suitable environment for worker. The benefits of plant layout are:

1) Reduce cost of transportation, maintenance which is one of the main problems. Material handling and transportation from maintenance service, and moving tools is a waste. Thus, plant layout is the basic analysis to get utilization in space.
2) Utilize space is a benefit from improvement plant layout, put the right position for machine which factory can have more space.
3) Improvement in production process and work, plant layout related to line balancing and work process. After production process and work improvement company have advantages on manage worker into production line.
4) Reduce lead time and defect by transportation.
5) Improve work environment, worker need to work at least eight hours per day which mean environment should suitable for work. Plant layout improve work environment to suit with work.

Before starting plant layout, company should understand which type and characteristic of product is suitable for production line. There are general two characteristics and three type of layout use to match with the product.

1) Characteristic divide into two types which are continuous and intermittent production.
    a) Continuous production which is match for mass production and machine is fixed in the production line, rarely move. Product should have huge order; need to produce in mass, same in every piece.
    b) Intermittent production is a production that have flexible characteristic. This type of production is match for made-to-order, job shop production. Products should have high requirement, small amount.
2) Type of layout can divide into basic three types which are product, process, and fixed position layout.

a) Product layout is layout that machines position is in sequence of process step to step to produce products. This type of layout is suitable for huge amount of product, make for stock, has standard.
b) Process layout is layout which group of machines together and divide by functions of machine. This type of layout is suitable for varieties products, small amount, and changing design frequently.
c) Fixed position layout is layout that product is huge and hard to move. Therefore, tools and process set up on site to make product such as airplane, generator.

2.4.1 U-Shape Layout

There are many types of layout; one which is flexible and reduces material handling in the production is U-shape layout. U-shaped production line has many advantages such as minimize material handling, increase communication between workstation, and increase flexibility on the process. It is not all process which suitable with the U-shape, for example automation production which is straight production that doesn't need communication and flexibility in process.

Figure 2.1 *U-Shape Layout*

Plant layout is a starter step in improvement production line which before implementation should consider on relation ship between each function and space. Adjustment should run under many limit factors which need to have support data

from people who related to. Therefore, re-layout and plant layout improvement should consider carefully before improvement.

2.5 Material Requirement Planning (MRP)

MRP is a set of techniques that uses bill of material data, inventory data, and the master production schedule to calculate requirements for materials. It makes recommendations to reorder materials. Moreover, because it is time-phased, it makes recommendations to reschedule open orders when due dates and need dates are not in phase. Time-phased MRP begins with the items listed on the Master Production Schedule and determines the quantity of all components and materials required to compose those items and the date that the components and material are required. Time-phased MRP is accomplished by exploding the bill of material, adjusting for inventory quantities on hand or on order and offsetting the net requirements by the appropriate lead times.

The definition shows basic of input and out put in MRP system. Input of information in MRP mainly using BOM (Bill-Of-Materials) and inventory records. Output of MRP is the planned order and the reschedule by analyzing data from input. Planner using MRP because it have many benefits, for example lower inventory and associated cost, Fewer stock outs on components and materials resulting in improved attainment of schedules and shorter lead times, Capability to produce broader product lines, Provides an integrated plan for all end items and components. The purpose to use MRP is reducing inventory while keeping right material at the right time.

MRP also have many disadvantages, results by using MRP were almost invariably disappointing such as error in BOM or lead time are unrealistic, if stock figures are incorrect, MRP still even well managed systems while it cannot be expected to produce sensible plans then the expected benefits were not often achieved. Sales forecasts are often wrong, for example, MRP is driven from the sales forecast. If some or either forecasts are changed or not equal forecast, the level after that MRP run replans down through the levels. Then plan can change faster than those liable for releasing orders can responsible. With little synchronization between plans

at different stages the results likely to be confuse and disorder. The other weakness of MRP is plans are not necessarily: no capacity planning. MRP system is driven by materials needs. It is possible that suppliers cannot provide what is needed by the required date. This unrealistic plan can lead to poor customer service because company cannot produce products available on time. In other hand, stocks of intermediates and components become excessive because they were procured to support a level of usage which was never achieved. MRP systems without capacity planning frequently could lead to order overdue. Production does not follow the plan: no feed back. When planner using MRP, in realistic lead time is underestimated causing of many factors such as work loads, failure of machines. This is because many MRP systems were planned by planning department and production department were a little involved to plan. Unless there is a feedback mechanism and plans are conformed to allow for both positive and negative deviations, order quickly become overdue and the plans of little relevance.

Planner try to reduced drawback of MRP by added features such as MPS (Master Production Scheduling, Capacity Planning and Production Control and become to MRP-II (Manufacturing Resources Planning). In MRP-II any delays which menace achievement of the final completion date must be fed back to the planner. MRP-II is widely use because it is also helpful for sales and operation planning but the basic concept of MRP is barely changed.

2.5.1 Bill of Material

As mention above that when planner using MRP one of main tools is BOM (Bill of Material). BOM is a tool that shows product structure in detail of part list. Some of them also display assembly process of each part. As presented in figure 2 is the three levels BOM consists of name, code and number of component in each part.

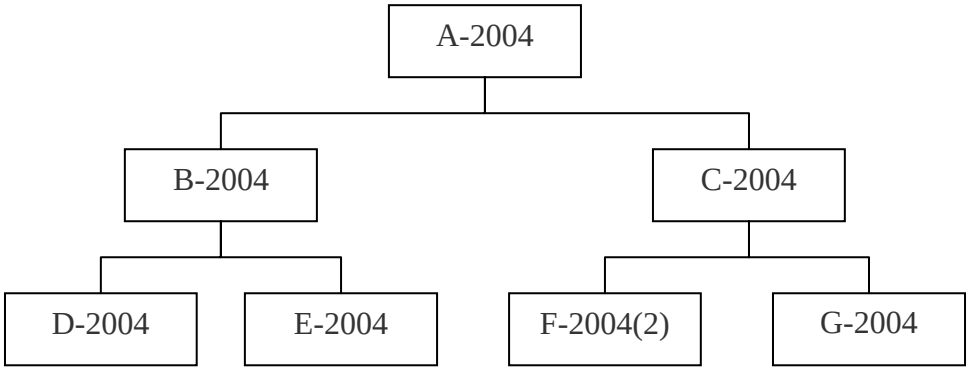

Figure 2.2 *Basic BOM*

Part A-2004 is the end items, B-2004 and C-2004 are the manufactured items. For D, E, F and G-2004 is also manufactured or purchased items but only F-2004 consists of two components. BOM show the levels of each part to the final product. In BOM shows only structure of product component however in term of time will be shown in MRP spread sheet or MPS data that link to lead time.

2.5.2 MRP Typical Spreadsheet

The most important data of MRP are part number, lot size, start date and due date or the date that product ready to delivery. All of data stored in form of spreadsheet, it is easy for planner to update the data and plan for each process in each items. The basic of spreadsheet consists of lead time, component number, start date and due date as show in the table 2.1.

Table 2.1 *MRP Typical spreadsheet*

LEVEL 0 ITEMS												
LT	**Finish Product**	0	1	2	3	4	5	6	7	8	9	10
1	Gross Requirements	0	0	0	0	0	500	0	0	0	0	500
	On hand / sched receipts	0	0	0	0	0	0	0	0	0	0	0
	Net requirements	0	0	0	0	0	500	0	0	0	0	500
	Planned order releases	0	0	0	0	500	0	0	0	0	500	0

LEVEL 1 ITEMS												
	Component A	0	1	2	3	4	5	6	7	8	9	10
2	Gross Requirements	0	0	0	0	500	0	0	0	0	500	0
	On hand / sched receipts	0	0	0	0	0	0	0	0	0	0	0
	Net requirements	0	0	0	0	500	0	0	0	0	500	0
	Planned order releases	0	0	500	0	0	0	0	500	0	0	0

1	**Component B**	0	1	2	3	4	5	6	7	8	9	10
	Gross Requirements	0	0	0	0	500	0	0	0	0	500	0
	On hand / sched receipts	0	0	0	0	0	0	0	0	0	0	0
	Net requirements	0	0	0	0	500	0	0	0	0	500	0
	Planned order releases	0	0	0	500	0	0	0	0	500	0	0

The tables show BOM consists of component A and B before finished product. Lead time for finish product and component B need one week only component A need two weeks for assembly. Products must finish and delivery on week fifth and tenth however there are no stocks of any component as can see in on hand items thus company must plan to produce and release on time by calculating lead time and capacity (net requirements). All of information is important for forecasting the start date to produced items.

2.6 Production Scheduling

Production scheduling are differentiate by production process such as continuous production process don’t need production scheduling because it is continuous and cannot change anything in production line. Therefore, production scheduling could apply to batch production, assembly line, and made-by-order which can adjust scheduling but different in long term and short term scheduling or project scheduling (categorize by product). Production scheduling for made-by-order is focused on scheduling to use maximum machine efficiency and reduce idle time.

The objective of production scheduling is to manage resources to suit tasks under timing issue (due date) to reach target (customer order and requirements). Goal or target for production scheduling should consider on resources, due date, production amount (capacity) and final result (product). There are many factors which effect directly to resources and scheduling efficiency; resources capacity, technology, production line. Therefore, main problems are decision making and planning on resources and work priority. In practical, efficiency of scheduling can measures by productivity, due date, and cost.

Productivity objective is a measurement that consider on productivity which can amount of product that serve requirements. Flow time is working time means the whole of time that using in work, one of main topic that involved in production scheduling.

Due date objective is a measurement tools consider on timing to serve final product to customer. This objective could be measurement by tardiness, number of tardy job if consider on amount of job. Due date objective mostly use with priority customer. For example, there are ten customers which could be affected from tardiness only two customers that can receive order on time. Lateness and tardiness become a data for decision making which customer company should serve first.

Cost objective is a measurement that consider on cost which related to production scheduling such as setup cost, WIP inventory cost, finished goods inventory cost, labour cost, water supply, electricity, and other variable cost. The efficient production scheduling should serve customer order and requirements under target expense which make company profit. The over expense in production line is mirrored inefficient production scheduling.

2.6.1 Gantt Chart

Visible scheduling should use efficient tools; Gantt chart is an efficient tool that can demonstrate scheduling in the figure. Gantt chart is using in machine scheduling start from one machine to multiple machines. Gantt chart illustrated working time, idle time, maintenance, job order, number of hour, and day schedule. Thus, Gantt chart could use for many aspect from hour, day, month and year plan.

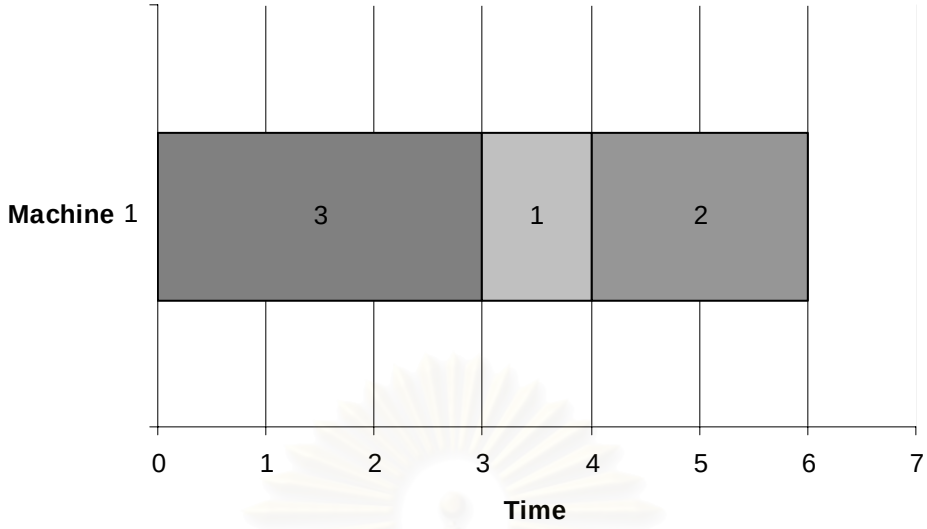

Figure 2.3 *Basic Gantt chart*

The figure above demonstrate basic Gantt chart that machine 1 have three job in order first job using three units of time, second job using one unit of time, third job using two units of time. This Gantt chart shows that machine don't have idle time because all job start when previous job finished.

2.6.2 Job Allocation and Sequencing

Limit resource, labour, machines, materials need to have plan to manage to serve customer order on the due date. Therefore, job allocation is analysis which applied linear programming to allocated suitable job to the machine. There are four main jobs sequencing which are First-Com-First-Serve (FCFS), Shortest Processing Time (SPT), Earliest Due Date (EDD), and Longest Processing Time (LPT) consider by calculation under time-based and due date based criteria.

1) First-Come-First-Serve is a sequencing that relies on queuing system. Job that comes first will operate first. After first job finished, next job will operate. This sequencing not considers on processing time and due date but just put all job on queue. FCFS is not suitable for the job that due date not on queue and product that varieties.

2) Shortest Processing Time is a sequencing that relies on processing time. This sequencing should rating processing time and start from shortest processing job. Job that has shortest processing time will be operated first. Then, next shortest processing time will start after finished first job.
3) Earliest Due Date is a sequencing that relies on due date. Therefore, first job start under earliest due date. Then, the next due date will started after first job finished and serve earliest due date. This is a sequencing that don't consider on queue of job but set the target of all job by due date.
4) Longest Processing Time is a sequencing that relies on the job that takes longest time to operate. This sequencing is an opposite procedure of SPT. Therefore, disadvantage of LPT also not serve due date.

2.7 Literature Review

Jirawan Kloypayan (1992) Topic of thesis is production planning in a garment factory by using the PERT LOB technique. The study divided in three parts. First part used Program Evaluation and Review Technique (PERT) in planning. This part showed how to set up networks and how to calculate completion times. Second part used live of balance (LOB) to show how to monitor and control work. Third part was to adjust production by considering total capacity and planning in each department to switch the production plan to prevent the problem that could happen. FOXPRO is a based program to build software which divided in three parts; PERT in this planning, LOB in follow up and schedule modification which will be used by management and related group in production to systematically help in planning and follow up the planning and whenever any problem occurs can immediately capable solve it. The research also suggested that similar production system can use ideas from the research to generate even different products.

Jirapat Rasree (1996) The thesis studies problem of production planning and inventory management of a polyethylene pipe factory and to propose suggestions in order to improve the production planning and inventory management. The result of this study lead to review the under organization chart and create the cooperation. Production planning and inventory management will provide the effective

management of materials and product stock control. The thesis propose suggestions of improving the organizational structure and job description and inventory management system by classifying of product, setting up storage system, inventory control system and improving production planning and scheduling. The improvement of average the reduction purchasing cost of raw material group A by 8.52 % or 1,362,165.31 bath, time reduction of order picking for raw material by 0.40 minute/pallet/time, and production planning efficiency improvement. The results clearly illustrate benefits of production planning and inventory management in term of cost and time.

Piyamaporn Chomsuwan (1997) This thesis involve in uncertainty study of production scheduling by considering machine breakdowns case which finding the reasons of machine breakdowns in term of time, frequency, and duration. The computer program are using for study in the case and cover input data for scheduling, scheduling, rescheduling, analysis and display. Program also cover analysis when machine breakdowns which effect to shceduling. planner can consider on efficiency of scheduling and illustrate in Gantt Chart. the measurement of scheduling efficiency by flowtime,lateness, tardiness, number of tardy jobs, and machine utilization. the rusults demonstate that smallest ratio by multipying total processing time (SMT), shortage processing time (SPT), earliest due date (EDD), and slack is suitable for sheduling and rescheduling. in addition, to use computer program for actual scheduling in the future.

Prakit Pattanajaroen (1998) This thesis involved in production planning system which using Heuristic approach to produce scheduling. Priority rule is the main method for scheduling; First In First Out (FIFO), Last In First Out (LIFO), Shortest Processing Time (SPT), Longest Processing Time (LPT), and Earliest Due Date (EDD). The results illustrate that Shortest Processing Time (SPT) is close to the case which should be the solution for the problems that have environment and conditions as mention in the case.

Preecha Laoboonlur (1999) The thesis is study on production scheduling system in knitted-fabric dyeing and finishing factory. To improvement of production scheduling system uses heuristic methodology that relies on dispatching rule, group scheduling and constraint-guided heuristic search. In each process, there are

operations among many machines. The main problems are high defects, WIP, long lead time, inefficient line balancing. Researcher suggest to making support data by create database. The results of production scheduling illustrate at the satisfied rate which measure by reducing of lead time, WIP, defects and improvement to machine utilization. This thesis is not cover results in term of inventory and MRP.

Ratiya Jarusriwanna (2000) this case study involve in production scheduling in yarn factory. The problems analysis which production have many machines cover many products that require for data support in flexible flow production utilize. Factory have many production processes and each products has their own processes flow which not necessary to pass through all process. Therefore, complexity in scheduling is high and at the present factory don't have clearly schedule. Only the planner who has experience and skill manage all schedule. There are many production and scheduling problems which effect to due date and inventory level. Author uses group technology, backward scheduling, just-in-time (JIT), and line balancing technique to help planner to create schedule. The results demonstrate improvement on scheduling, machine utilization, reduce inventory and delay on due date which not effect to machine set up.

Sittipoom Phrompoo (2001) The objectives of this thesis are developing information system for production planning, scheduling and control by using Microsoft Access. Thesis is cover order, production planning, capacity planning and inventory control. The results illustrate improvement of production planning and capacity planning which based on clear information effect to the plan. For example, preparing time for documents reduce over 80%, reducing workers which mean using increasing resources efficiency. This is an important statement to demonstrate the first process which is collect and understand data before set up the plan.

Chanoknun Pattachot (2002) Objectives of this thesis is to using computer program (Visual Basic 6.0) to developed production plan in plastic injection factory. Program is following planner concept in managing scheduling. Earliest due date is the sequencing that author chooses to use in case study. The process is to classify customer priority and order by due date. Then, setup scheduling for eleven plastic injectors by size of the mold and number of products which according to machine

utilize concept. Setup time and total lateness on each injector effect to the suitable production scheduling. The results illustrate differentiate of previous production plan and present one after evaluate that new production plan reduce lateness from 111 days to 82 days which is 25.86%. This is a positive result that help planner to create proper production scheduling to reduce problems in the plastic injection factory which have varieties products and orders. Planner can make accurate decision in production schedule with the data support and new production plan.

Jesda Assavarungsi (2002) This thesis research on production scheduling of corrugated box factory which has problems on delay shipment. This is because generally corrugated box business has short lead time of each shipment, it's affected to company to generate schedule which has efficiency enough to support all orders. The research studied heuristic methods which create new schedule for the plant. The results also demonstrate reducing of delay production, delivery, and lateness.

Udomrat Laichuthai (2002) The thesis is study on production scheduling system which has an objective to reduce delay from due date delivery. Researcher focused on inefficient production planning and factors that related. There are many internal problems in production capacity, inefficient planning scheduling. Many techniques has applied to the case study that try to setup standard lead time, calculate machine capacity, improve production scheduling and reduce delay due date. In case study, create database to helping in production scheduling system. The results of the improvement illustrate clearly in reduce overtime work reduce over 50% and delay due date delivery reduce over 70% from previous. Therefore, setup standard time and database helping planner to create efficient production scheduling system and also provide accurate data to management for decision making in the production and planning.

Aroonrad Praweenaporn (2003) This thesis involved in production planning system and sequencing job. Objectives of the problems are to minimize tardiness time. In case study, product has many parts and the processes are complicate. Therefore, this research uses the Visual Basic computer language to develop the program for help in job scheduling. The job scheduling is in accordance with five sequencing job rules; First Come First Served (FCFS), Shortest Processing Time

(SPT), Earliest Due Date (EDD), Least Slack (LS), and Slack per Remaining Operation (S/RO). The result of statistic is performing that EDD, LS, and S/RO are the most appropriate sequencing rule for case study's company.

CHAPTER III

CASE STUDY COMPANY

This chapter discusses on case study company overall situation and problems; organization structure, plant layout, production process, planning and control system. Monitor present problems before implementation shop floor control (SFC) into production line. There are some improvements in company which related to SFC, in preparing state such as organization structure and plant layout which also included in this chapter.

This is the first phase of the case study to collecting all related data to run problems analysis to find the causes and effect of the problems before implement solution to improve SFC. The timeline for all survey, implementation and get the results have shown in figure 3.1.

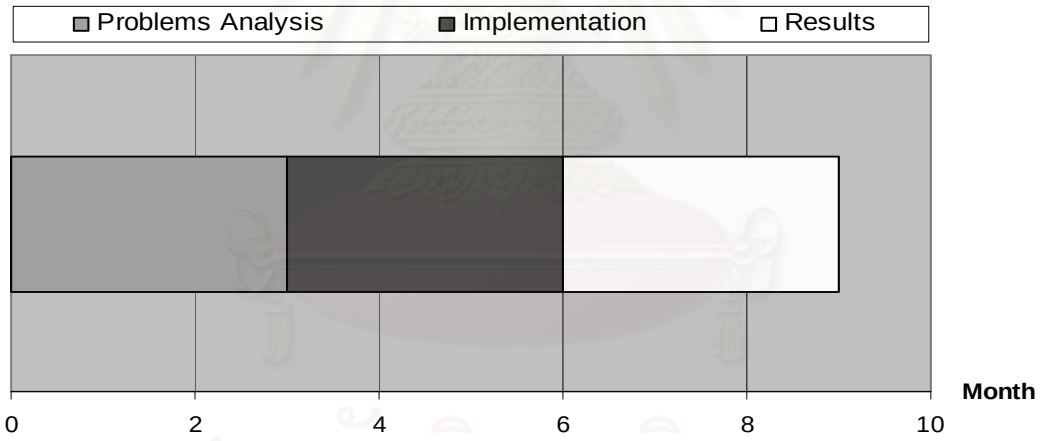

Figure 3.1 *Timeline*

3.1 Organisation Structure

As mentioned in first chapter that PK is a family business therefore, organisation structure is centralized type. Only president of company is making decision in every function such as production, stock, financial, improvement processes. Before implementation SFC into production line, PK doesn't have clearly organisation structure, president command direct to everyone in organisation. Thus,

setting up organisation chart is needed to expand command level and responsibility. At present, PK doesn't have clearly organization in term of responsibility person. There is only general manager who is an assistant for president as shown figure 3.2.

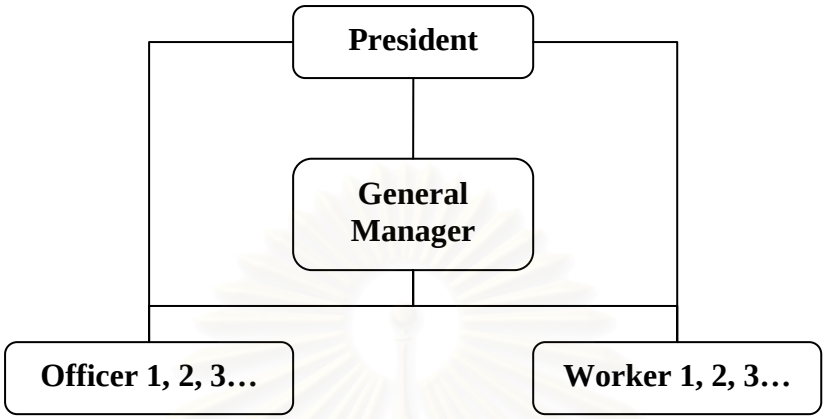

Figure 3.2 *Organisation Chart*

3.2 Products

PK is a company making music instrument and Conga Drum is the main products in production line. Production line is a transformer raw materials; wood and steel and assembly. Case study company focused on Conga Drum which cans categories into two shapes, four series, and four sizes of them; 10", 11", 12", 13". The other components are different; colour, parts, accessories, and etc. Therefore, there are over fifty characteristics on Conga Drum product. In this case study will focused on four main size and highest order colour, parts, which means special order will not cover in this case study. Ash wood and Para wood are the main material for making shell. In addition, there are other type of wood that can make Conga Drum as the order but mainly is Para wood and Ash wood. PK has a problem with order and customer requirements in detail. The different size is using different number of lugs. Data visible is need for product QC, making under requirements, monitor and follow up WIP. Thus, first step is to making table which demonstrate all product specifications. The tables 3.1 conclude Conga Drum specifications in different aspects.

Table 3.1 *Conga Drum shape & size table*

Conga Drum Shape and Size Table				
	Shape A	**Shape B**		
	Series A	**Series B**	**Series C**	**Series D**
10”				●
11”	●	●	●	●
12”	●	●	●	●
13”		●	●	●

Table above illustrate four series of Conga Drum which only series D has order in all sizes. Series B and C has the same size in order. Only series A that produce under with shape A, the other series is shape B. Conga Drum shape A is shorter than shape B about 2 inches. The size in the table means size at the top of the drum.

Table 3.2 *Conga Drum material table*

Conga Drum Material Table				
	Shape A	**Shape B**		
	Series A	**Series B**	**Series C**	**Series D**
Para wood	●	●	●	
Ash wood				●

Table above demonstrate two main materials for shell which only series D is made from Ash wood. The other is made from Para wood.

Table 3.3 *Conga Drum colour table*

Conga Drum Colour Table				
	Shape A	**Shape B**		
	Series A	**Series B**	**Series C**	**Series D**
Colour 1	●	●		
Colour 2	●			
Colour 3		●		
Colour 4		●		
Colour 5		●		
Colour 6				●

Table above illustrate Conga Drum colour table which series C doesn’t has colouring process. Colour 6 is making on series D only. There is only one colour that making on two series that is colour 1.

Table 3.4 *Conga Drum number of lugs table*

Conga Drum Number of Lugs Table				
	Shape A	**Shape B**		
	Series A	**Series B**	**Series C**	**Series D**
10”	5 Lugs	5 Lugs	5 Lugs	5 Lugs
11”	5 Lugs	6 Lugs	6 Lugs	6 Lugs
12”	6 Lugs	6 Lugs	6 Lugs	6 Lugs
13”	6 Lugs	6 Lugs	6 Lugs	6 Lugs

Table above illustrate Conga Drum number of lugs which all series in 10” size use five lugs, 12” and 13” size both are use six lugs. There is only series A size 11” use five lugs and other series in size 11” use six lugs.

There are the accessories which attach to the Conga Drum; stand, badge, hoop, and etc. All accessories not attach at the shell preparing process but add up together in assembly process. The tables 3.5 illustrate Conga Drum accessories in each series.

Table 3.5 *Conga Drum stand table*

Conga Drum Stand Table				
	Shape A	**Shape B**		
	Series A	**Series B**	**Series C**	**Series D**
Double Stand	●			
Basket Stand	●	●	●	

The table above demonstrate stand table which series D sell stand separate to the drum. Only series A that have two options on double stand and basket stand. Series B and C have basket stand as a standard package with drum.

Table 3.6 *Conga Drum hoop table*

Conga Drum Hoop Table				
	Shape A	**Shape B**		
	Series A	**Series B**	**Series C**	**Series D**
Hoop 1	●			
Hoop 2		●	●	●

The table above demonstrate hoop table which only series A using hoop type 1 and the other series using hoop type 2.

For the badges, it is different all of the series has their own badges type which cannot suit with other series. Thus, each Conga Drum will have logo and series badge attached on it.

3.3 Machines and Resources

3.3.1 Machine

In the shop floor, there are sixty-six machines. There are division of machine; main production machine, support machine, and maintenance machine. There are sixteenth types of machines and amount of all productions machines are twenty-four to making Conga Drum.

Table 3.7 *Conga production machine table*

Conga Production Machine		
Machine List	**Machine No.**	**Amount**
Band Saw dia.36"	No.1	1
Plane machine	No.2, 3	2
Double end saws	No.4	1
Hot press forming hydraulic machine	No.5	1
Double angle saws	No.6, 7	2
Hydraulic press clamp	No.8	1
Turning machine #1	No.9	1
Double cut saws	No.10	1
Router machine	No.11, 12	2
Rolling sanding machine	No.13, 14	2
Vibration sanding machine	No.15-17	3
Rolling Filler machine	No.18, 19	2
Auto spay machine	No.20, 21	2
Drilling machine 5 heads	No.22	1
Drilling machine 6 heads	No.23	1
Inserting lugs machine	No.24	1
Total		**24**

1) Band Saw dia.36” use for splitting lumber 1” thickness to half.
2) Plane machine use for plane wood both sides before gluing.
3) Double end saws use for cutting work piece to make a standard length.
4) Hot press forming hydraulic machine use for making curve on work piece by pressing after gluing two woods together.

5) Double angle saws use for making angle on work piece by cutting both side.
6) Hydraulic press clamp use for putting rings on the drum to forming drum shape.
7) Turning machine #1 use for peeling and making drum surface smooth.
8) Double cut saw use for cutting raw shell to make standard height of the drum.
9) Router machine use for chamfer and making angle inside drum at the top and bottom.
10) Rolling sanding machine use in preparing raw shell before painting process and making surface outside smooth.
11) Vibration sanding machine use for making surface smooth and protect scratch from rolling sanding machine.
12) Filler machine use for thorn filling and make the surface smooth and easier to paint without holes on surface.
13) Auto spray machine use for spray colour and clear top coat on the drum surface.
14) Drilling machine 5 heads use for drilling five holes to insert brackets on 10” drum and 11” drum series A.
15) Drilling machine 6 heads use for drilling six holes to insert brackets on 11” drum series B, C, D, 12” and 13” drum.
16) Inserting lug machine use for press at the top of the Conga Drum to keep work piece in the position. Then, insert lug with the brackets different by size.

3.3.2 Space and Facilities

PK has working area about 4,000 square meters which included office area, production line, hardware shop, warehouse, showroom, parking lot, and toilets. Office is in the front of all working area. The main building has three floors, on the first floor is an office and assembly department, second floor is box storage and third floor is hard ware and accessories storage. Main building is surrounding by production line, warehouse and hardware shop.

3.4 Labour and Expenses

3.4.1 Labour

PK have number of worker about 30-50; office 5-10, production line 25-40. The official working day is Monday-Saturday and one holiday on Sunday. Working hour start from 08.00 – 17.00 (8 Hours/Day) with one hour break at noon. Working after 17.00 is overtime which PK pay at the legal rate. There are two types of employees in PK.

1) Salary employee (monthly pay) is officer work in office and technician in shop floor. This type of employee doesn't have overtime.
2) Daily worker (daily pay), most of daily employee is worker in production line which mix of skilled and unskilled labour together. There is overtime pay when employees work over official working hour.

The table 3.8 illustrates number of employee daily and monthly payment; the percentage is compare under payment ratio between daily worker and monthly. In 2006 daily payment is 184 Baht/Day and 2007 is 191 Baht/Day.

Table 3.8 *Labour cost daily worker comparison table Jan'06-Mar'07*

Month	Number of Employee			Total Daily	Total Monthly	Total Wages	% Daily	% Monthly
	Daily	Monthly	Total					
Jan'06	31	9	40	138,354	62,100	200,454	69%	31%
Feb'06	29	9	38	117,777	61,921	179,698	66%	34%
Mar'06	30	9	39	133,390	61,777	195,167	68%	32%
Apr'06	25	9	34	97,498	62,100	159,598	61%	39%
May'06	25	10	35	103,893	68,600	172,493	60%	40%
Jun'06	26	10	36	104,846	68,600	173,446	60%	40%
Jul'06	27	10	37	115,026	68,600	183,626	63%	37%
Aug'06	30	10	40	111,303	68,277	179,580	62%	38%
Sep'06	33	10	43	124,438	68,600	193,038	64%	36%
Oct'06	29	10	39	121,854	68,600	190,454	64%	36%
Nov'06	27	11	38	113,528	70,250	183,778	62%	38%
Dec'06	23	11	34	99,237	78,500	177,737	56%	44%
Jan'07	24	11	35	102,802	78,500	181,302	57%	43%
Feb'07	24	13	37	98,952	82,250	181,202	55%	45%
Mar'07	30	13	43	139,369	82,250	221,619	63%	37%

The table demonstrate ratio of all labour cost which separate into two parts; daily and monthly. All daily worker is work in the production which maximum ratio is 69% and minimum is 55%. Means of the percentile is 62% for daily payment. This results should using with amount of production in each month to compare productivity rate under labour aspect relate to cost. For the monthly, the maximum payment compare with overall is 45% and minimum at 31%. Means of the monthly payment percentile is 38%. Therefore, average percentage of monthly payment in not over 40% of overall, the production is the main path of the payment at around 60%.

One of the main problems is labour cost which mostly from overtime. Therefore, labour cost involve to the overall cost problem which related to efficiency of labour productivity. In addition, at least five days a week that daily worker has to work overtime.

3.4.2 Expenses

For variable cost in this case study focuses on electricity which monitor on the units used because price is vary by FT value.

Table 3.9 *Electricity Expenses Aug'06-Mar'07*

	Units	**Cost**
August 2006	10,340	44,852.63
September 2006	12,008	50,065.98
October 2006	10,708	44,771.23
November 2006	11,460	47,636.73
December 2006	11,272	46,227.61
January 2007	11,104	46,812.63
February 2007	11,584	47,587.55
March 2007	12,464	50,205.21

The table illustrates units and cost of electricity on August 2006 to March 2007 which average electricity using unit is 11,367.5. In this case study divide time phase as survey, implementation and result after implementation which around three months therefore, mean October to December 2006 is 11,146.66 and January to March 2007 is 11,717.33 units. Electricity used may from number of machines hour, lighting in the overtime period.

3.5 Production Process

Made-to-Order is order process which production process starting after place order. Therefore, PK starting production order follow customer requirements, specification is assign by customer. There are standard products but different in options. PK general process after order coming has shown in figure 3.3.

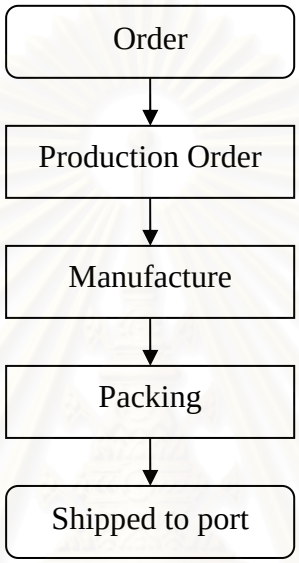

Figure 3.3 *PK General processes*

This thesis focused on only one production line which is Conga Drum. The production process differentiate by order from customers, thus some processes are using different type of materials and some processes. For example, Para-wood and ash wood which have different grain, colour, and hardness. Thus, preparing and making Ash wood needs more concentration than Para wood. In addition, packing process is a quality control stage but usually found defect on finished products. There are four main production processes; wood preparing, making shell, painting, assembly and packing.

3.5.1 Wood preparing

Input: Raw material (wood)

Output: Curve wood

This is a first process to preparing raw material (wood) before making shell. There are seven sub-processes as shown in next chart:

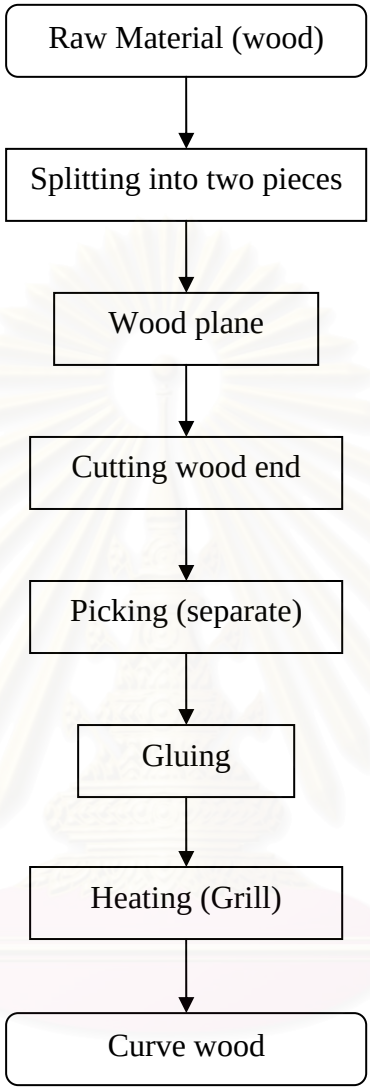

Figure 3.4 *Preparing Raw Material (wood)*

Process chart illustrate preparing wood before forming and making shell. Splitting process is using splitting machine to split wood thickness 1” to 0.5”. Second step is plane, put raw wood into plane machine both sides. Next step is cutting wood end, after plane work piece should put into cutter machine which cut at both side of the end to make standard length. Picking is a process to separate work piece by choosing on surface of wood. The wood surface divide into two types, perfect finished put on the outside part of the drum and other put on inside part. After separate two pieces of wood will stick together by gluing and put in heating machine to press and make a curve.

3.5.2 Making shell

Input: Curve wood

Output: Raw shell

Making raw shell is process that working with machines and need measuring and skill worker. The process start from angle cutting, put curve wood into machine and put the cutter via work piece to make an angle on the work piece. Next step is gluing curve wood and put into rings, each drum need three rings to forming. Secondly, put curve wood and rings on forming machine to press rings to fit with the shell and leave the shell a day for glue set up and shell forming.

The second process is making shell which has five sub-processes as shown in the figure 3.5.

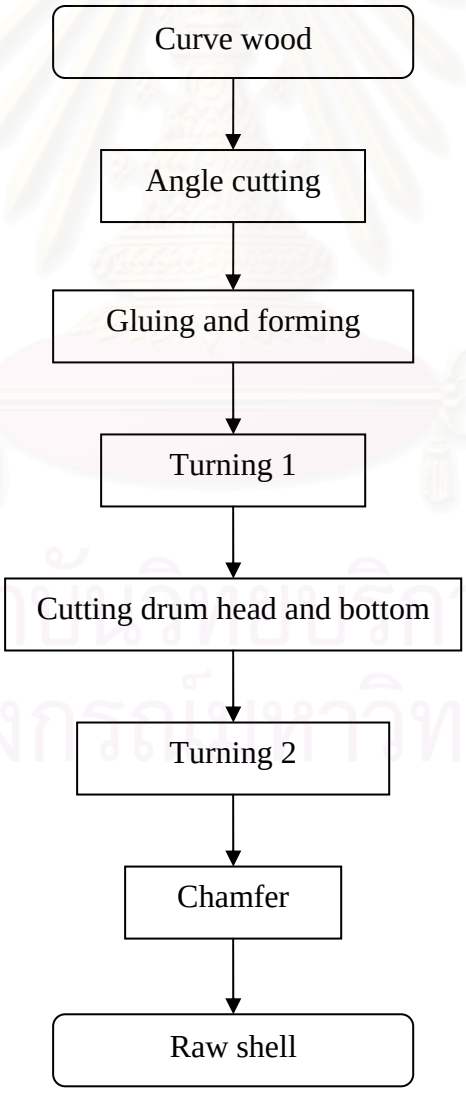

Figure 3.5 *Making Raw Shell*

3.5.3 Painting

Input: Raw shell

Output: Finished shell

Painting process has a long list of sub-process which need detailing inspection because it is easy for defect to happen on this stage. The process receives raw shell from making shell process and first step is sanding on rolling machine with sand paper. Secondly, sanding but on vibration sanding machine to make drum surface clean and smooth. Third step is thorn filling first time with filler. After filling first time turn back to sanding again with rolling machine. Next step is filling second time with clear filler then, sanding on rolling machine and vibration sanding machine. Preparing raw shell surface before painting is an important process to protect defect that might happen on painting process. Painting first time is for colour and leave painted drum for a day before hand sanding. The last painting process is spraying top coat on the work piece and leave it for a day before send to the assembly and packing. All the painting process is important in material handling because painted drum is easily to get defect from dust, and touching.

The third main process is painting which has ten sub-processes as shown in the next chart:

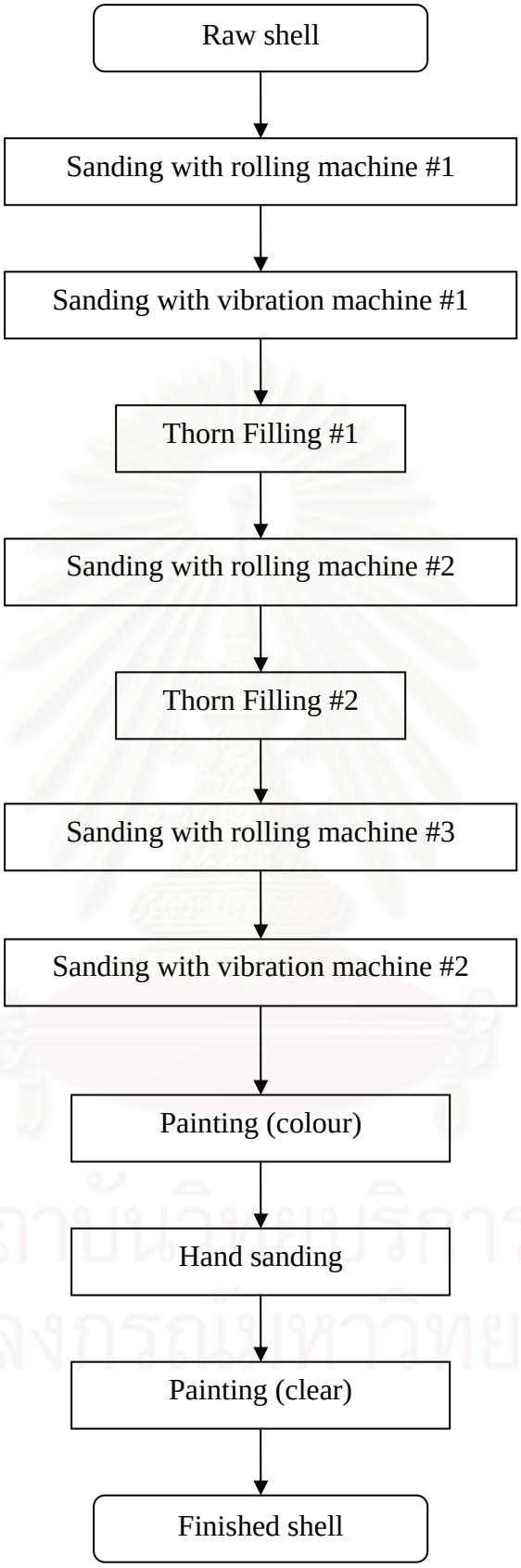

Figure 3.6 *Painting*

3.5.4 Assembly and Packing

Input: Finished shell

Output: Finished drum

The last main process is assembly and packing which has seven sub-processes as shown in the figure 3.7.

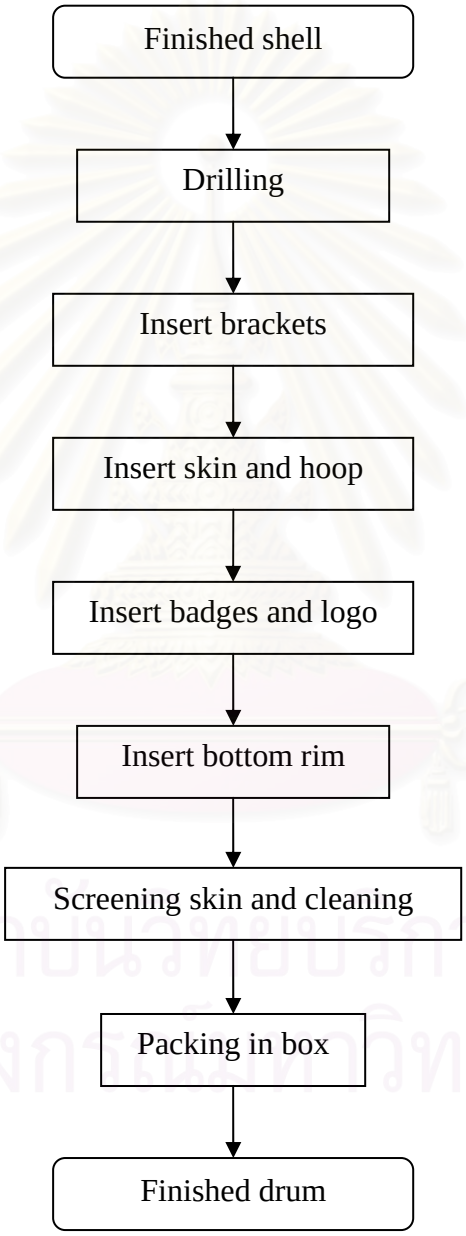

Figure 3.7 *Assembly and Packing*

Painted drum need to drill to insert brackets, number of hole depends on size of the drum and number of lugs. Skin, hoop, and lugs are inserting by fixed with

brackets. The process that has problems in detailing is badges and logo which always have problems with wrong position and series. Next step is insert bottom rim to the shell and fix by nail. Skin need to be clean before screening logo on the skin. Then, the last step is packing drum into the box by wrapping with plastic bag and put accessories into the box. The box also separate by series and size which totally different in each series.

3.6 Plant Layout

On 4,000 square meter working area three are combination of three functions area which is production, warehouse, hardware shop and office area. All functions are related together in term of management and production. Therefore, plant layout became important to utilize facilities and limit space.

As mentioned above that PK doesn't have system and unorganized in structure and production line therefore plant layout have lot of waste from transportation of materials and WIP that is a inefficient in flow process in production line. Firstly, Conga Drum production line is using the same technologies, machines, resources as other products; Bongo, Djembe which lose lot of setup time and cost. Secondly, there are central warehouse which use to keep WIP and damaged products. Thirdly, material receiving and shipped use the same entrance which material have to transport again to production line as shown in figure 3.8.

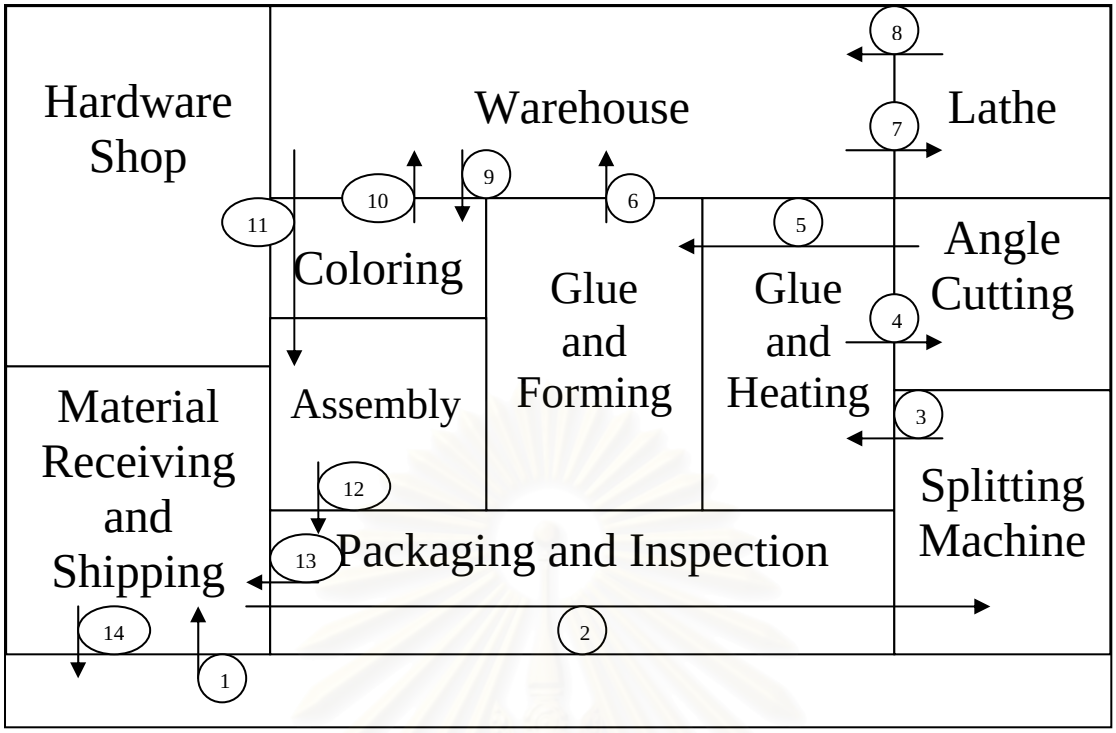

Figure 3.8 *Plant Layout Conga Drum Production Line on July'06*

3.7 Delivery

Normally, PK has order about one container per month which means there are at least 200 Conga Drums in each order with other items. The shipments always delay from the due date by many reasons. It is still cloudy to identify reasons why the shipments delay. One of the main reasons is production problems which cannot serve customers on time. There is a problem with follow up production order progress because factory doesn't have efficient tracking system to making forecasting finishing due date. Thus, Customers always complain and request for exactly due date to set up marketing plan. PK has a lot of problems with delivery on time which production always making order that should be shipped. For example, on October production should operate October order but in practical production line operate for September order which is a month late on the due date. The table 3.10 demonstrates order in each month, due date and lateness. The table illustrates lateness on each shipment from October 2006 – March 2007 which lateness is about one to two months. There are some shipments that postpone to three months. It is only on December that doesn't have any shipment from PK but collect product to ship on February.

Table 3.10 *Order due date and lateness table*

	Amount	Due Date	Shipped Date	Lateness
Oct'06	190	10/09	26/10	46 days
Nov'06	200	02/10	18/12	76 days
Dec'06	-	-	-	-
Jan'07	152	12/11	18/01	67 days
Feb'07	400	02/11	02/02	92 days
Mar'07	100	25/01	19/03	53 days

3.8 Problems

There are many problems which related to case study. All the problems related to production and planning efficiency, included defect and quality problems. This problem analysis cover only internal problems which could be solve and improve by applied techniques and tools from theoretical from the previous chapter, thus this topics not cover outsourcing and external problem that could not solve by internal management. Before improvement the understanding in causes and effect realize. The topics are conclusion situation and problems in the case study.

3.8.1 Organisation management and relationship

As mentioned above that PK is a family business characteristic which has a centralized organization structure. Company need to adapt and improve their organization and production to serve customer requirements. There are many problems in organisation aspects.

1) Span of control and work group

PK doesn't set up command level which means president command directly to all employees in company. This is over workload for president and cannot govern all employees in detail because not expand responsibility and decision making. In addition, between each function don't have communication. For example, machine breakdown in shop floor, worker directly contact to president. Then, president takes part in maintenance and command to maintenance team. There are also problem with overlap work in each process such as when production started if any process lack of workload,

president will command to increase workload by pulling from other process. In some case, there is pulling overload to increasing workload on the process.

2) Lack of knowledge, planning, and assign clearly task

The characteristic of family business is to keep all decision into centre management. Problems initiate from unclear job assignment and responsibility. Thus, it is hard to find causes and reasons of defects because all employees don't have their clearly task and responsibility. The problems at the present are each function doesn't have responsibility person (head of department) and flexible task for all employees. In addition, company doesn't have data collecting in document form. Therefore, it is hard to follow up and monitor on WIP, stock, and production order.

3.8.2 Production

There is only president and general manager who response for overall production which means doesn't have direct responsibility for production line. Therefore, company hasn't collecting data on production planning, machine detail, material planning which effect directly to productivity and efficiency.

1) Production planning is inefficient because only making product follow order which not consider on processes, scheduling, monitoring WIP, quality improvement. Only due date that important for the production planning but delay because machine breakdown and human error.

2) Lot of defects, there are lot of defects on WIP and finished product. This is waste of materials because machine lack of maintenance and don't have standard work instructions to control labour. For example, sanding process need to start with sand paper number 100 to 220 but sometimes confusing with number of sand paper and making defect on the drum surface. Therefore, defected drum need to fix before painting.

3) None standardization process, company never collect data and have training system which means new workers study from telling by previous worker, sharing there work experience and techniques. Lack of standard work

instructions and training system are causes of product defects and other detail errors.

4) Quality is not stable because company doesn't have standard work instructions and follow up tools to control production process. Thus, finished product have varies detailing problems such as wrong badges, accessories, defect on painting process and shell preparing. WIP defect is important because if found defects at finished product is too late and hard to fix.

5) There is no systematic production order, company launch production order consider on amount and due date. This leads to WIP problem and detailing defect in each process.
6) None of maintenance service, this problem is an effect from inefficient production planning which cannot plan exactly when machine is need maintenance.
7) It is hard to monitor and follow up production order because no responsibility person for production directly.

8) It is hard to set up production scheduling while company doesn't know lead time of each process and doesn't have standard work instructions. Lack of production data is affected directly to scheduling because company doesn't have enough data in making decision scheduling production.

9) Refers to inefficient production planning and scheduling, It is hard to forecast exactly that finished products will be ready on the due date.

10) Utilization on machines and labour, PK consider only on amount and due date of each order. In fact that, production process is important to serve on their aspects (amount and due date). Company never reaches at maximum efficiency of their machines and labour.

3.8.3 Expenses and Due Date

1) It is a high production cost when compare with output. PK doesn't have cost calculation in each product before. It is low efficiency when compare

production cost compare with the ideal productivity; there are a lot on defect, labour cost, and variable cost which is waste when calculate productivity.

2) Refer to the production problems, every shipment cannot set up the exactly due date and shipment always postpone from the due date.

CHAPTER IV

IMPLEMENTATION AND RESULTS

After problems analysis in chapter three, the main problems are organisation management, production process which don't have standard, high cost and lateness due date. This chapter discuss on implementation SFC into company and comparison results before and after implementation. This is a second and third phase after survey and problems analysis, implementation of solution take time in improvement before survey and getting results after implemented follow the timeline in previous chapter.

4.1 Organisation Improvement

Organisation structure is a basic of company which PK has problems; command order from top management, assign responsibility clearly, relationship between functions, group of work. Therefore, reorganization is an improvement to easier management and suitable to the present and future organisation structure.

4.1.1 Work identified and group

From problems analysis in case study, organization should divide by department and use functionality in office work and production process function in production line. This is a FC level which cover main task in the organisation structure. PK organisation divides into three departments which are administration, production, and machine shop. In each department, there are sub-functions in their area which group of similar work together and defined command order from top to bottom.

4.1.1.1 Administration

PK is a small company therefore officer should operate multi work functions which cover all administration work and accounting. Administration is cover human resource HR, accounting, documentation and administration, this department response for all documentation work, management and support data for the other department.

1) Human Resource is responsible for take care of all employee benefits and pay roll. This department control on recruit new employees, training and decision on probation term of employee.
2) Accounting is responsible for overall and general account which covers receiving order, ordering materials, invoice, and documentation work.

4.1.1.2 Production

Production is the main department of PK which combines with four main functions (processes); raw material preparing, making shell, painting, and assembly. Production is a department that responsibles for all process in production line; included product quality, utilize production line, defects, standardization process, production planning and scheduling. In each process, there are individual jobs which divide in each process. Case study can divide job by machine or sub processes. For example, material preparing has four main machines therefore each machine should call sub process.

1) Material preparing is responsible for transform raw wood to curve wood which should consider on surface of wood, angle on the curve wood, gluing line between two pieces of wood. This process has five main machines which are band saw, plane machine, double end saw, hot press forming hydraulic machine, and double angle saws. The quality control in this process is need of skilled labours that understand on wood character and colour as mention in chapter three.
2) Making shell (shell) is responsible for forming shell, shape, and surface of raw shell. Labour who works with machine in this department should understand on measurement and setting up machine while working such as turning machine is need to setup piece by piece of drum. Thus, this department is need standard training and follows up after starting job. Making shell process has five main machines which setup as a group in the production line.
3) Painting is responsible for painting raw shell. There are two processes which are preparing raw shell surface before paint and painting. Painting process is fixed in the mixture of paint thus, standardize process is important in this process. The colour easily changed if the mixture is not standard.

4) Assembly is responsible for combine parts together with shells. This department should consider on quality control and inspection in every step. For example, position of badges and series should exactly correct before packing drum into the box.

4.1.1.3 Machine Shop

This department covers maintenance service and making accessories and steel parts for Conga Drum. The main task for this department related to steel and machines work which take care of production department machines.

1) Maintenance is responsible for all maintenance service in the factory which include fixing, making tools and machines such as tray for material handling.
2) Parts are responsibleing for making and quality control accessories and steels part to support production department. There are two main origin of parts; internal made and outsourcing. For outsourcing, need quality control by checking before send to production department.

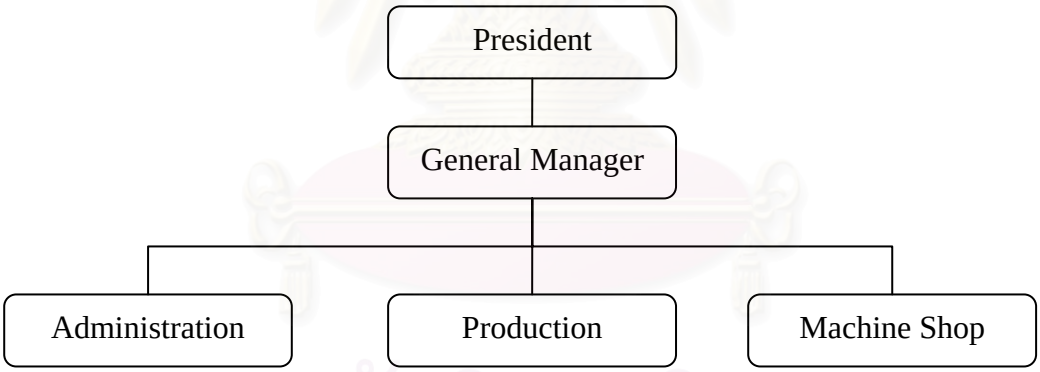

Figure 4.1 *Organisation Chart (Department)*

4.1.2 Design of individual job and scope of responsibility

After create organisation structure and divide workgroup, the next step is setup scope, responsibility, and assign individual task for every task. It is an important issue to create standardize in processes and workstations to clearly assign and setup scope of job. There are combinations of sub-processes in each department which specific individual task with the machine. Job assignment consider on skilled, type of machine, relationship between tasks, quality control. Job assignment related to PAC

which is the sub-level in the main processes. There are head of each function that responsible for all task and staffs in their area. Employee can divide into four level which start from trainee who is a new comer and training in each area, employee level one who is already train and start working in that area, employee level two is already work in their area more that one year and skilled, employee level three is working with skilled and train to trainee and responsible in the area when head of functions is not in charge.

4.1.2.1 Administration

There are head of HR and account who responsible in different scope, head of HR responsible for all employee benefits, training, recruit and payroll. Head of account is responsible for all documentation, order, and invoice.

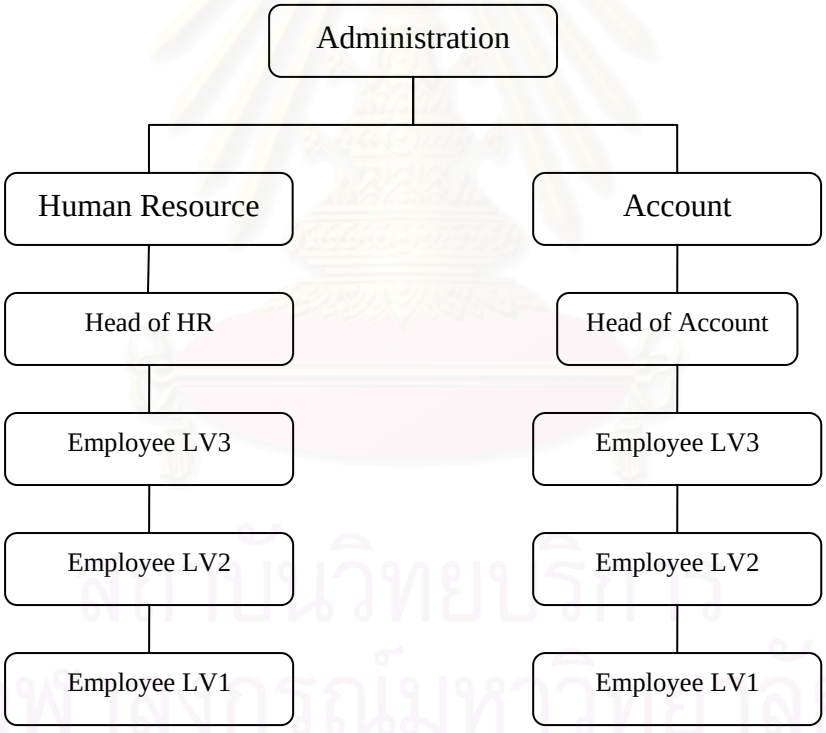

Figure 4.2 *Organisation Chart (Administration)*

4.1.2.2 Production

This is target department in this case study which divides into four main teams, consider by process of making Conga Drum. As mention above that each team has leader which responsible on their job task and staffs. In this case study, leader of each team responsible for quality control, produce as the order and control standardization process, training staffs, collecting data. The division of employee is the same as the other department. The entire task is using work breakdown structure model to divide job into particle.

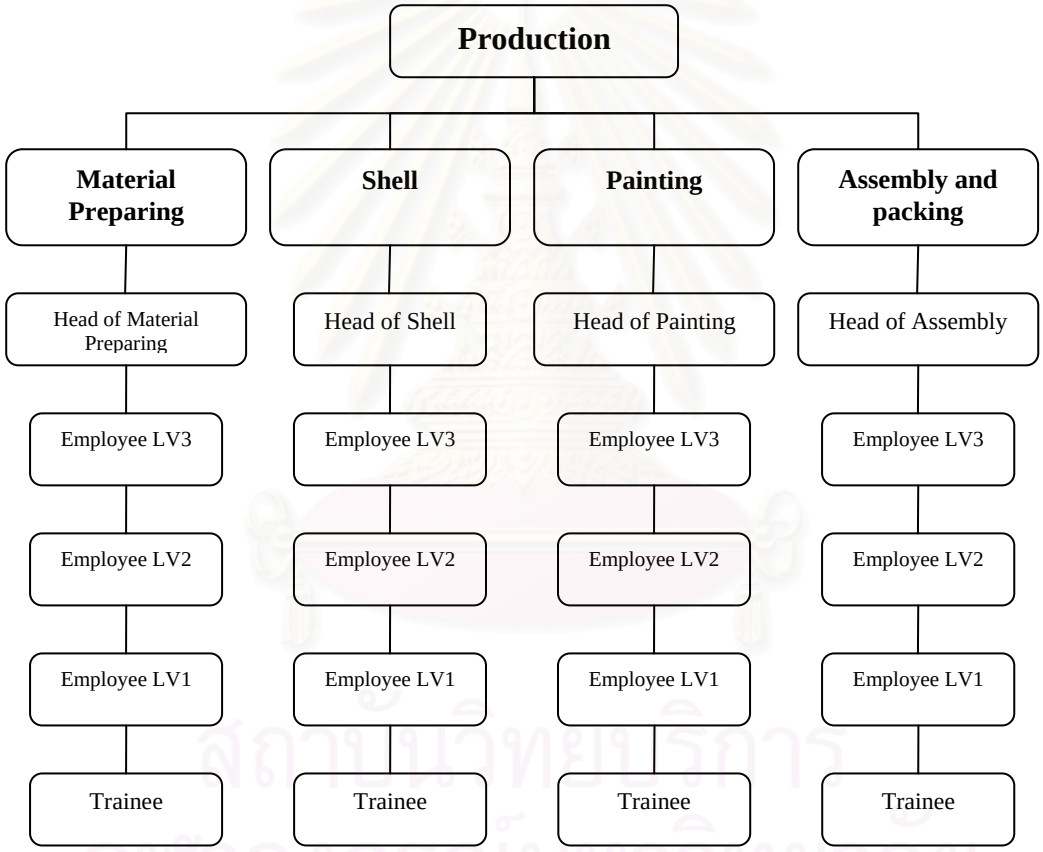

Figure 4.3 *Organisation Chart (Production)*

4.1.2.3 Machine Shop

There are only two teams which work together in the machine shop department; maintenance team and making steel parts and accessories. The team structure is similar to administration but the functions are different.

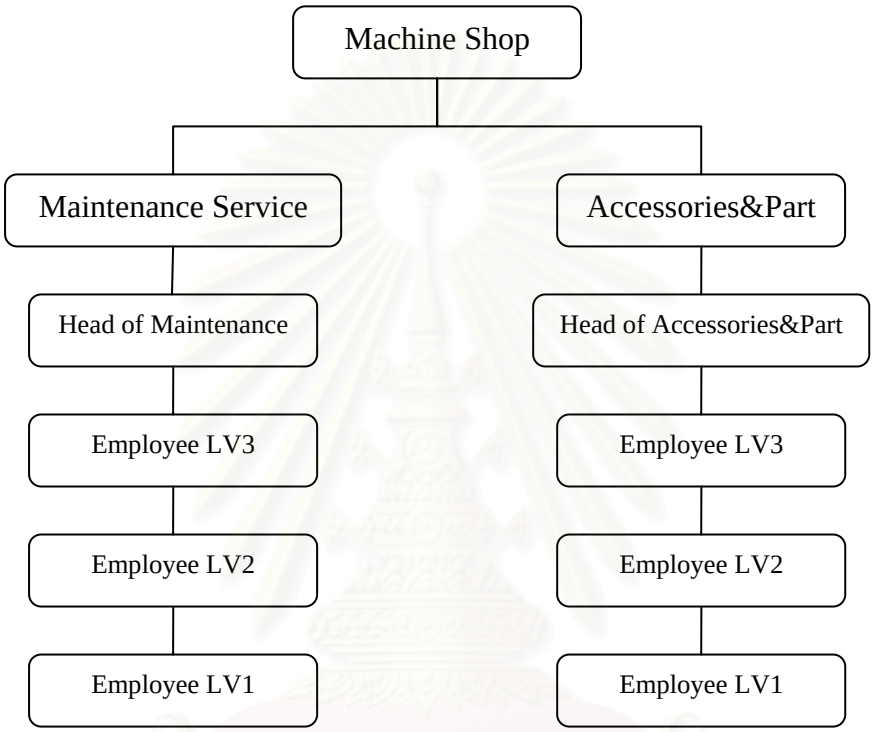

Figure 4.4 *Organisation Chart (Machine Shop)*

These are all organisation structure which divide by their functions and each of them has leader who responsible on task and staffs in their area. The structures illustrate command order from top to bottom therefore to follow up each production order could contact to leader of each functions. This is decentralized organisation structure which reduce responsible of president and distribute to all employees.

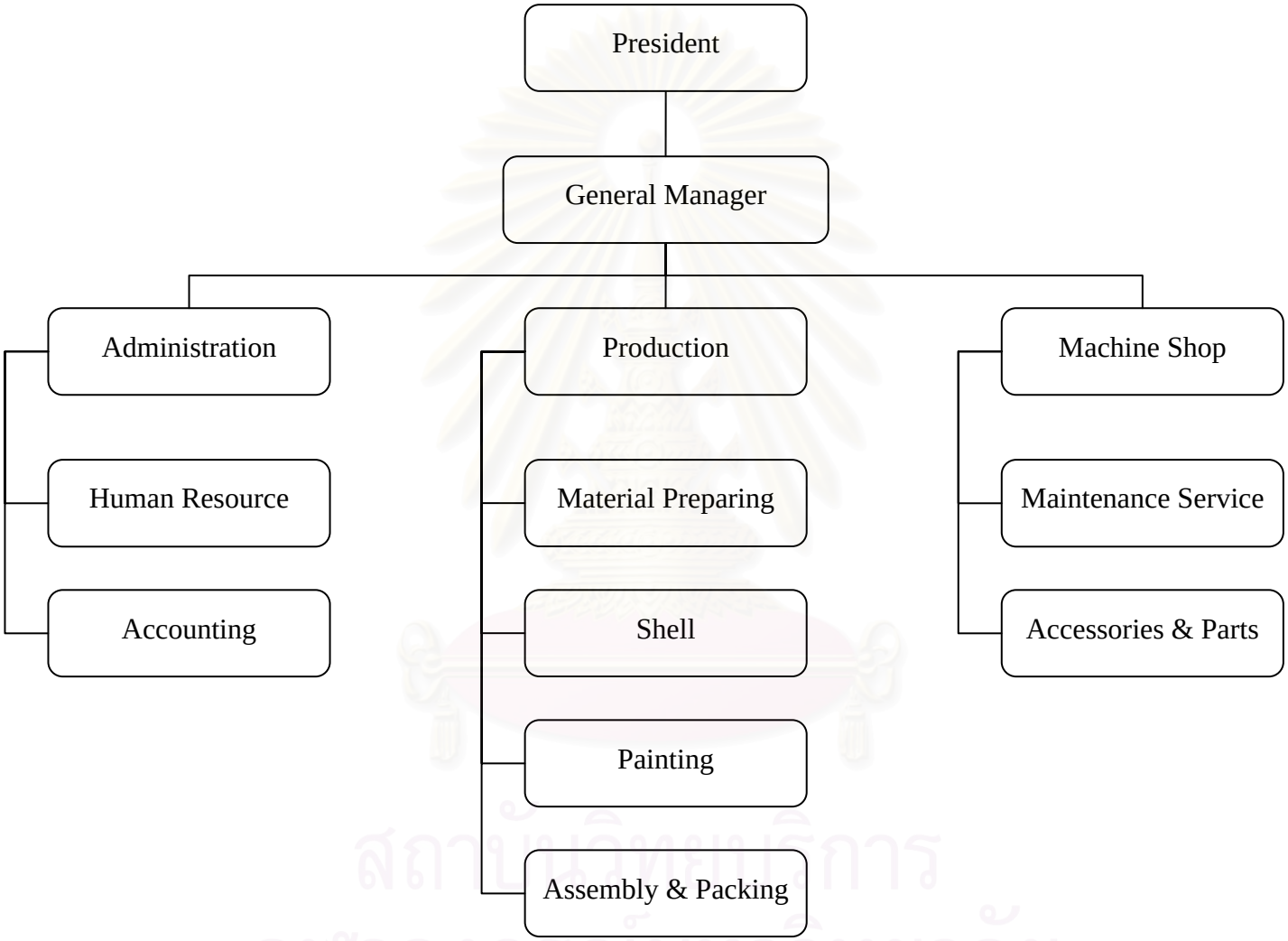

Figure 4.5 *Organisation Chart*

4.2 Plant layout improvement

The waste from plant layout from previous chapter has improved into next layout to reduce waste from transportation (overlap route) by changing to standard U-Shape flow process; changed material entrance separated to shipped, machine position re-layout by flow process from starting process to end process, remove central warehouse for WIP.

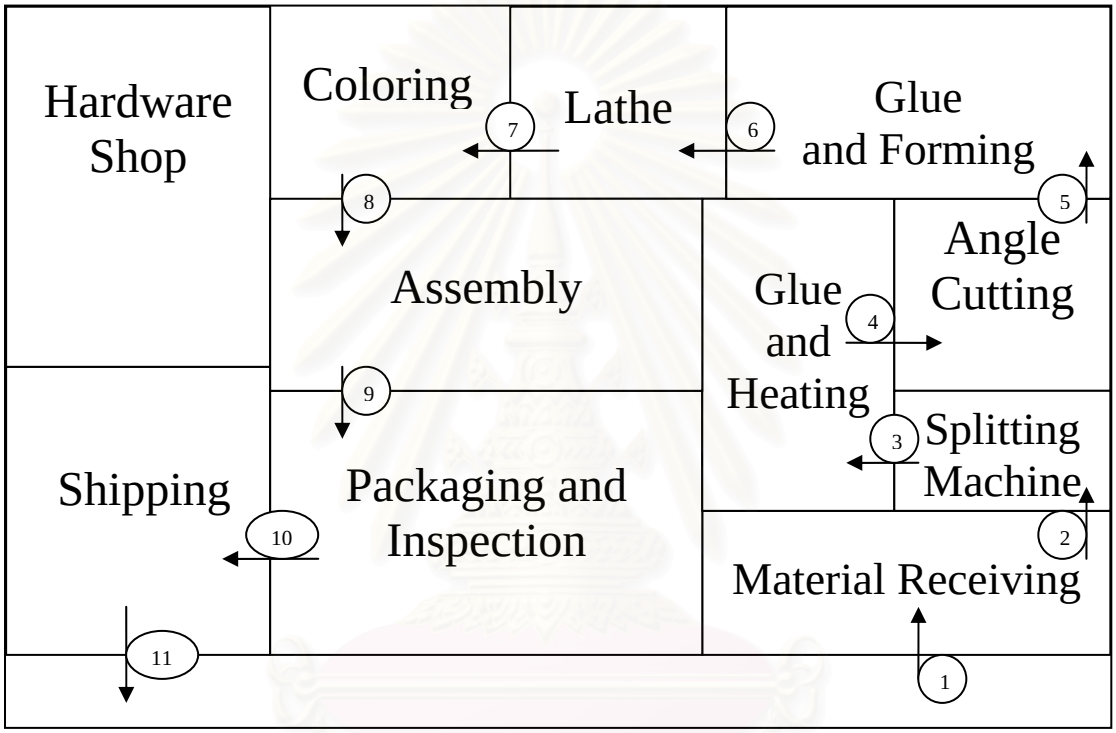

Figure 4.6 *Plant Layout Conga Drum Production Line on Oct'06*

The next layout improved by separated Conga Drum production line from Bongo, and Djembe production line. The benefits of this plant layout are materials and WIP don't mixing over the varieties product. It is easier to control and planning for production line and scheduling. Therefore, WIP and work piece are separate clearly from other products and easy to follow up progress production order. This layout improves while collecting data from production line.

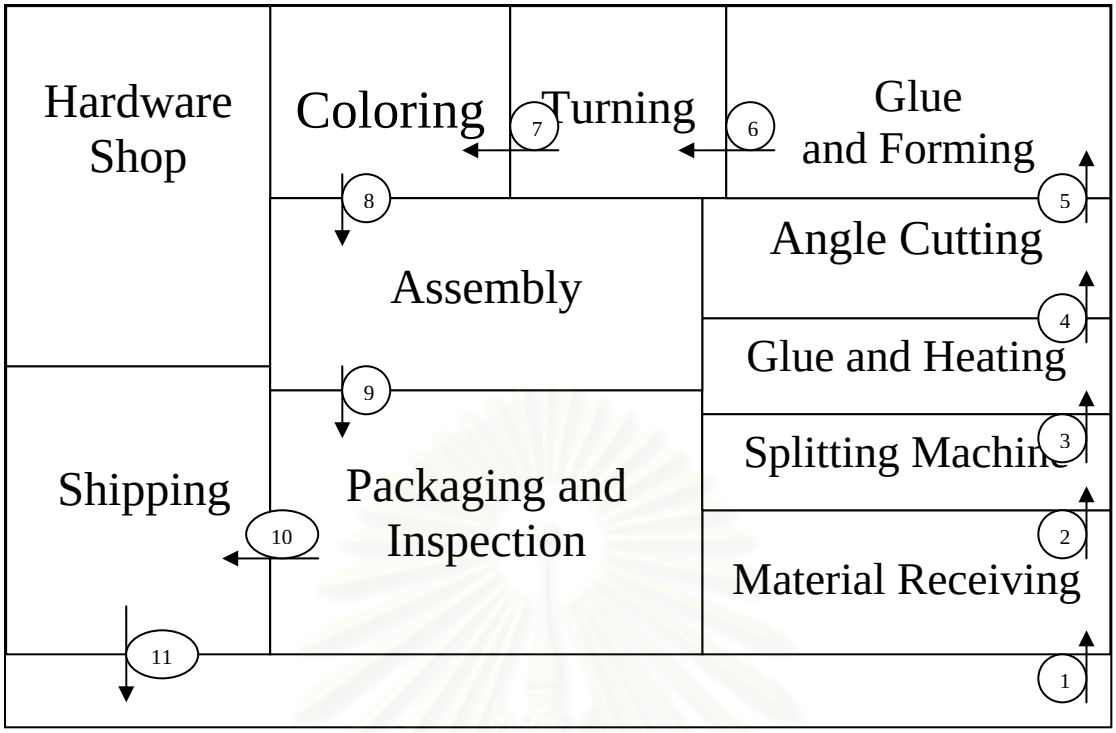

Figure 4.7 *Plant Layout Conga Drum Production Line on Mar'07*

There are continuing improvements from July'06 – Mar'07 which result after implementation collect after Mar'07. Changing layout in the case study has many benefits in reducing waste and creates work flow that visible as reducing number of transportation in table 4.1. There are other indirect benefits such as reduce rate of defects from material handling, over stock, utilize materials used, labour, and machine capacity. In PAC, this is an improvement to helping mover to reduce transportation time.

Table 4.1 *Comparison Layout*

	Jul'06	**Oct'06**	**Mar'07**
No. of transportation	14	11	11

4.3 Production Process Improvement

The survey in previous chapter demonstrates results from case study that there are some wastes which happen in the production line. There are many tools and techniques to improved production process such as setup standardization process,

making standard work instructions for each workstation, create database for decision making in order material and scheduling planning, initiate visible sign, improve training procedure, and improve machines in specific task. Techniques and tools most of them applying to reduce human error, for the machine error could be improve by fix and maintenance. Therefore, production process improvement is applying tools and techniques to reduce defects, lead time, cost, and inventory level, and utilize all resource in the factory.

4.3.1 Standard Work Instruction

Increasing production process efficiency could use varieties of tools and technique, one of the basic is setup standard work instruction. Machines breakdown might the reasons of the delay due date but in practical human error have more effect than the machine because machine can fix and setup standard easier. The procedure to create standard in process and quality control is setting up standard work instruction for every tasks. From case study, every workstation (process) should have standard work instruction which giving detail as table 4.1:

Table 4.2 *Work Instruction Table*

Process/Station Name	
Machine No./Tools:	**Materials:**
No. of Workers	
Work instruction 1. 2. 3. 4.	
Remark:	

1) Process name is the name of process/station such as turning, sanding, and painting.
2) Machine number or Tools is the specific machine or tools that operate in the process.
3) Materials are the input material and used material in the operation.
4) Number of workers is amount of workers that operate in the process.
5) Work instruction is giving step by step in operation in details.

6) Remark is the other information such as awareness to use machine, operation safety.

In addition, assembly is the process that need special work instruction and check list with picture to protect defects such as wrong badges and series when attach on the drum. The full standard work instruction is illustrate in APPENDIX B.

Standard work instruction is a tool which using in training procedure. It is easier to control working process and using of the machine when use work instruction as manual of the machines. Worker only doing step by step follow work instruction, thus machine damage which come from running machine without knowledge should be reduce. The standard work is a basic in controlling PAC level which work instruction is a powerful tool to control process.

4.3.2 Training Procedure

In case study, there is high turnover rate which effect directly to the work continuity, therefore the past PK has training process by teaching trainee directly by senior employee and president without standard work instruction. Therefore, there are many defects that maintain the same such as the band saw work step is only put the lumber into the machine then lumber split into two pieces, without standard work instructions there are many defects of thickness of the work pieces that too slim. To making standard work instruction helping working follow up their task and have an example. Thus, worker who operate band saw machine should realize to instructions, checking thickness for some defects lumber. Training system has changed to making worker realize on the responsible and proud to making music instrument. Orientation makes understanding organisation and responsibility in each area. Detailing work teach follow standard work instruction and built-in quality.

In addition, new worker should start their work under closely monitor by head of department or senior worker. New worker should run follow work instruction until they understand clearly on their process, input, output, and instructions.

4.3.3 Built-In Quality

Built-in quality means workstation could inspect their work piece by themselves. The concept of built-in quality is product inspection in the workstation before push to the next workstation. This is a basic quality control process which monitor in workstation, expand responsible to everyone in the production line the respond together with quality issue. The easiest tool is setup visible sign or document of input and output of the example at the workstation. In case study use picture of good and bad example of input and output to training and control process. The input and output table illustrate process name, clearly picture of good and bad input-output which this table use together with standard work instruction to create new working culture to aware that finished work piece should perfect before send to the next process and also reject bad input, send back to previous process. Therefore, built-in quality and the visual input-output table are the tools which reduce defects on WIP and protect defects at the end of production line which is hard to fix, rework. The table applied in every process but at the preparing material process is not inspection in every work piece, using random check. From forming shell process there is the shell that can generally check piece by piece.

Table 4.3 *Process Input-Output*

Process Name	
Good Input	**Good Output**
Picture 1, 2, 3…	Picture 1, 2, 3…
Bad Input	**Bad Output**
Picture 1, 2, 3…	Picture 1, 2, 3…

Table 4.4 *Splitting*

Splitting	
Good Input	**Good Output**
	

Table 4.5 *Forming*

Forming	
Good Input	**Good Output**
	

Table 4.6 *Cutting head and bottom*

Cutting head and bottom	
Good Input	**Good Output**
	

4.3.4 Follow Up Tools

SFC is using typical information which collects from production monitor such as WIP status, workstation status, and raw material status therefore, at each of workstation and lot of product should have sign or board which is visible to give status. Data collection is important for SFC because accurate data is resource for decision making support. Board is the tool that help monitor functions in PAC level to collect data for analysis. The objectives of using follow up tools are update progress of production order, defects in the system, status of overall process. There are two types of boards which implement into the case study.

1) Product Status Board: this board contains of general information which related to product such as date, job number, current location and operation, number of WIP, finished, and defects. From production order level, there are many types of product which separate to batch or lot of product. Each batch or lot should have product status board stick to the lot while product on processes. In case study use small white board stick with piece of wood and put in the drum, each batch.

Table 4.7 *Product Status Board*

Date	
Job No.:	**Job Detail:**
Machines/Workstation Name:	
No. of Finished: No. of Remaining:	
Remark:	

The product status board in the case study has shown in figure 4.8 that has product code, date, present process and next process, number of finished and remaining. Figure 4.9 illustrate product board when put in the set of product.

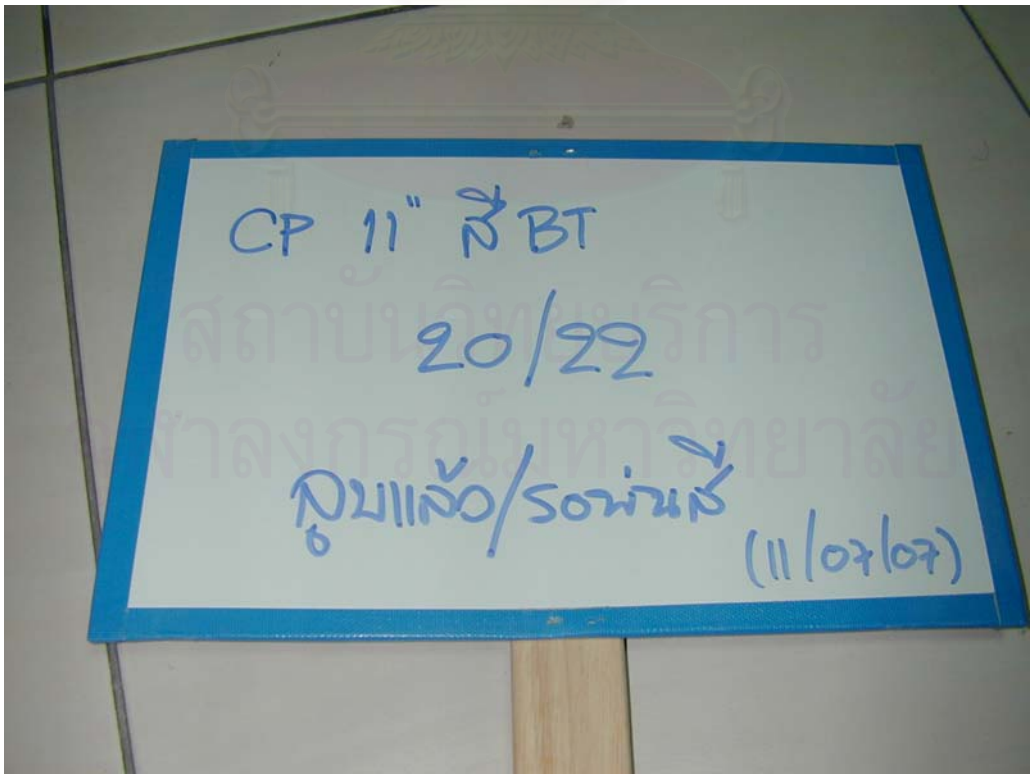

Figure 4.8 *Product status board*

Figure 4.9 *Product status board in shop floor*

2) Machine or workstation Status Board: this board concludes production information which operates via workstation. These board relate to product status board which giving workstation or process name, job number, amount of production on that day (finished and WIP in queue). The board may conclude many processes together in one board. Therefore, observer can check production efficiency on single day by checking workstation status board. This is a large white board attached on the workstation or working area (process group).

Table 4.8 *Process/Workstation Status Board*

Date
Machines/Workstation Name:
Job No.
No. of Finished: No. of Remaining:
Remark:

The figure 4.10 demonstrate process status board in the shop floor which giving necessary information for monitor such as WIP, product code, finished job and remaining.

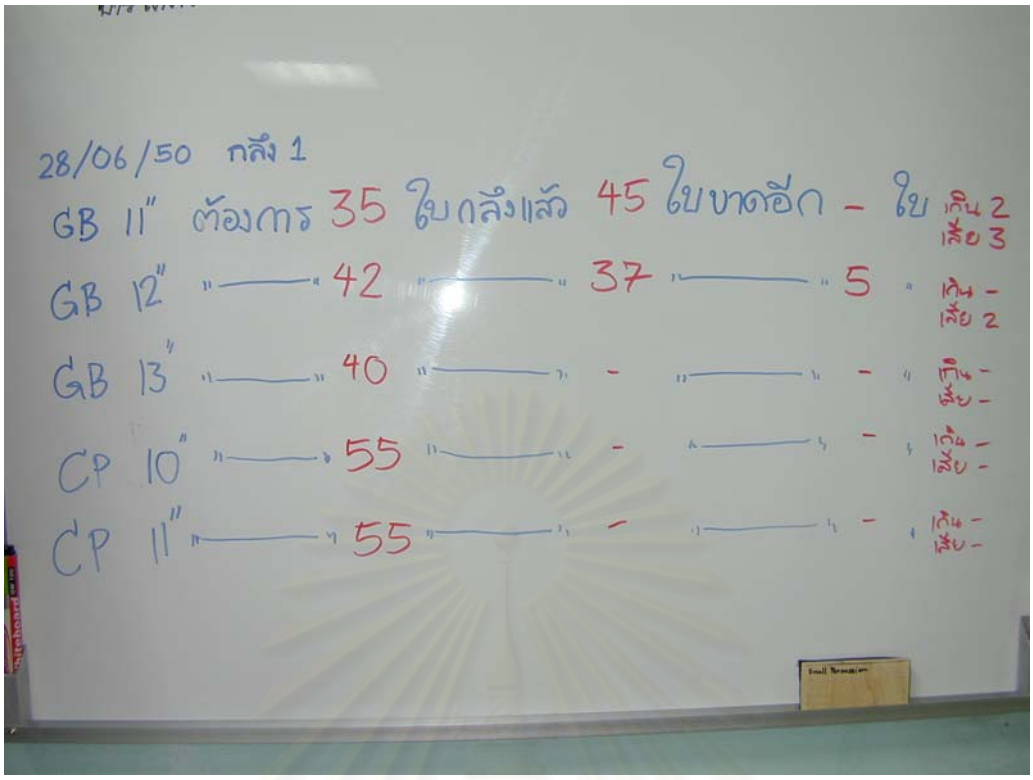

Figure 4.10 *Process status board*

The follow up tools is using to monitor effectively in term of production efficiency on each job order, workstation and processes. Visual system is the theoretical that use to create follow up tools which adapt with the practical use and suitable equipment on environment. All data collection could use for decision making on each production order more efficient. In addition, the follow up tools could be efficient if collecting right data which is necessary for planning, improvement and decision making.

4.3.5 Process Improvement

To improve overall production line, it is really important to identify problems in each process. After collect necessary data from each process, data analysis is using for finding the reasons of problems. Information in APPENDIX A illustrates data which separate lead time of making Conga Drum on each work station; setup, operation, and transportation time. Data in the table collect from October 2006 to July 2007 which divides into three phases.

1) Phase 1: Before improvement is a period that observers monitor and collect necessary data for support data analysis in the next phase. The raw data put in table which will be the same in all phase.
2) Phase 2: Improvement period is an analysis and improvement process together in the practical. This period expect progress in improvement, results may vary and different from the phase 1.
3) Phase 3: After improvement is a final period in this case study but not the last in improvement. The results expect to more stable and clearly demonstrate different from phase 1.

Process improvement is analyze on the data at the first period which can improve by implement tools and techniques, improve machines and equipment, changing working behavior, increase number of machines and workers. In this case study improved on main Conga Drum production machines which machines list has shown in the chapter III. In every process has the standard working instruction to control process, this work instruction improved all process and reduce defects. The objectives of process improve is to reduce defects, increase productivity, and utilize workforce.

1) Splitting wood into two pieces with band saw machine has improved by making work instruction and setup manual, fix on the adjusting machine, quality control in random of work piece. At first this process have defect about 15% which thickness is not thick enough. The solution is to setup at the middle range of the slot, each lumber don't have the same thickness. After changing thickness setup on the band saw machine and checking work piece randomly, defects reduce to 8-10%.
2) Plane is a process that using plane machine, work instruction help a bit on training process and quality control is using random check on each lot of work piece. The planer machine has some defects that wood not plane in some surface because thickness is not standard and cutter in planner machine is not sharp enough. The solutions are checking randomly of thickness and maintenance service to sharpen cutter.
3) Cutting end use double end saw to cut wood into the standard length, the defects on this process is bud on the wood. Operator on this process should

check carefully for bud on the work piece. Input-output table is helping operator to check the good and bad work piece.

4) Making wood curve is process that combine by several sub-processes; picking, gluing, and heating. Hot press forming machine is the machine using in this process. Defects from this process are breaking wood curve and burning mark on the work piece. In the pass there is not the standard temperature and operation time because using experience of operator to control the machine. To improve this process by setting up the standard temperature at 120°C and 20 minutes for operation time. This solution increase productivity from 1-2 loop of work to 2.5-3 loop of work. And also control quality of work piece in each lot.
5) Cutting angle is a process which using double angle saw which cut curve wood both sides to make an angle. Defects from this process is work piece is not in the middle position when pass through cutter. To improved this process is making jig to fixed work piece while pass through cutter.
6) Forming Conga Drum is combining with two sub-processes which are gluing and pressing on hydraulic forming machine. Defects on this process are from size of the wood in not match with the series of the drums. To make it is different amount piece of wood such as 13” using 18 pieces of wood while 10” using only 16 pieces of wood and using the different angle. Therefore, checking list of this process is to checking size of wood to reduce defects.
7) Turning is a process that operates by machine without skill on operation but using skill of operator on setup and measurement. Therefore, only operation time is fixed, setup and transportation time are vary. To improve this process by making jig for easier machine setup and more standard. Jig also reduces defects on this process from the operator setup.
8) Cutting top and bottom raw shell use double cut saw which is a better cutter than the past that used hand saw. This process improve a lot after implement double cut saw but still have problem on the drum; burning mark and thorn on the rim. The solutions are maintenance service for cutter and adjust cutter speed to reduce defects from burning mark and finished of the rim.
9) Chamfer is a process that has problems with non-standard angle on the rim and burning mark. The solutions are making jig and flat table and using suitable cutter with the required angle.

10) Sanding (rolling) is process that sanding on rolling sanding machine which in the past don't setup standard instruction to control number of sand paper and operation time. There are lot of time lose in this process, this is because worker using old sand paper to sanding and changing sand paper without knowledge. Setup standard instructions and sand paper number are solutions that reduce operation time and increase productivity with quality.
11) Sanding (vibration) use vibration sanding machine with operator skill to sanding drum. The problems similar to rolling machine that using old and wrong sand paper number, making lot of waste on operation time. Therefore, solutions on vibration sanding process and rolling sanding process are the same.
12) Thorn filling is a process that has problems on wasting thorn filler and operation time because in the past using operator experience without standard work instruction to control. The solution is setup standard loop of thorn filling while operate on the machine. For example, in the past some drums take six to eight loops on the machine, now standard instruction setup at four loops of work and check for the special case that drum has lot of thorn. Then, start another loop of work.
13) Spraying colour is process that depends on mixture colour formula and surface of the drum. To setup standard colour mixture formula is the way to reduce defects on colour not match with the requirement and setup time on preparing paint. The other solution is to spray clear coat to the drum surface and checking for defects before painting colour on the work piece.
14) Drilling bracket holes use five or six head drilling machine making more accuracy while drilling shell for brackets which improved from hand drilling process. The improvement on drilling machine is making standard jig and install to drilling machine. This is a solution to reduce setup time before operate drilling machine.
15) Assembly parts with shell involve by many sub-processes which use inserting lugs machine. Assembly is a detailing process which necessary to have material preparing system to control all parts which reduce defects from using wrong part on the wrong drum series. The inserting lug machine reduces operation time and increase quality. Work instructions and check list sheet is

an important tool for quality control in assembly process which worker can check easily with check list sheet for parts and drum series.

In addition, process improvement effect direct to worker in the production line which they should understand clearly on instructions. The management should support to the changed which can motivate all worker to change. Success from process improvement has many benefits, direct and indirect such as variable cost that more utilize in using, increase machine utilization efficiency, reduce defects, more accurate on due date.

4.4 Results Comparison

After improvement in PK, the results illustrate differentiation in each period. The results from improvement can classify into four topics which are efficiency and quality, labour cost, variable cost, lateness on due date. All results are comparing and demonstrate in table and chart which compare in three phase; before implement, implement, and improved.

4.4.1 Efficiency and Quality

Process improvement effected directly to work efficiency which measure by comparison productivity rate and defection rate. Productivity is an indicator to demonstrate comparison efficiency between before and after implementation. Comparison table illustrate in three phases, detail combine with lead time and amount of product, the results characteristic is different in each process. The data collect from October 2006 to July 2007; these are conclusion sheet which raw data is in APPENDIX A. the data calculation using same unit to comparison which is one drum per loop and capacity per day.

Table 4.9 *Band Saw Data Sheet*

NO.1	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.32	4.91	0.35	5.58	86.06
November 2006	0.33	4.91	0.35	5.59	85.87
December 2006	0.33	4.92	0.36	5.60	85.66
Total Average	0.33	4.91	0.35	5.59	85.87

NO.1	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.32	4.90	0.35	5.57	86.12
February 2007	0.31	4.90	0.36	5.57	86.24
March 2007	0.30	4.88	0.35	5.53	86.80
Total Average	0.31	4.89	0.36	5.56	86.39

NO.1	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	0.29	4.87	0.33	5.49	87.48
May 2007	0.29	4.85	0.33	5.47	87.82
June 2007	0.29	4.85	0.32	5.45	88.14
July 2007	0.28	4.83	0.31	5.42	88.59
Total Average	0.29	4.85	0.32	5.45	88.00

Splitting lumber on band saw is the first process to preparing material to produce Conga Drum which setup time and operation time improved by using work instruction and process input-output sheet to control quality. Setup and operation time reduce effect directly to the number of Conga Drum that can produce in a day is increased slightly from 85 to 88 drum per day. The transportation time decrease a little because of layout adjustment after March 2007. Therefore, band saw has capacity to preparing at least about 80 Conga Drum per day.

Table 4.10 *Planner Machine Data Sheet*

NO.2, 3	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.57	5.64	1.28	7.48	64.18
November 2006	0.57	5.66	1.24	7.47	64.26
December 2006	0.57	5.63	1.26	7.46	64.39
Total Average	0.57	5.64	1.26	7.47	64.28

NO.2, 3	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.56	5.66	1.28	7.50	64.07
February 2007	0.56	5.63	1.26	7.44	64.54
March 2007	0.55	5.68	1.30	7.53	63.80
Total Average	0.56	5.65	1.28	7.49	64.14

NO.2, 3	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	0.56	5.65	1.26	7.47	64.28
May 2007	0.54	5.65	1.25	7.44	64.58
June 2007	0.53	5.60	1.25	7.38	65.11
July 2007	0.52	5.63	1.28	7.42	64.76
Total Average	0.53	5.63	1.26	7.42	64.68

Planner machine is one of all machines that not improved in lead time but standard work instructions and process improvement from band saw reduce defects from planner. The table illustrate average number of lead time and production in a day that one planner machine has capacity to preparing material about 64 Conga Drum per day. The average did not change a lot because planner is a standard machine which not has problems in work instruction.

Table 4.11 *Double End Saw Data Sheet*

NO.4	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.30	4.66	1.73	6.69	71.85
November 2006	0.30	4.65	1.74	6.69	71.80
December 2006	0.30	4.68	1.70	6.68	71.96
Total Average	0.30	4.66	1.72	6.68	71.87

NO.4	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.30	4.65	1.69	6.64	72.35
February 2007	0.30	4.64	1.70	6.64	72.35
March 2007	0.30	4.68	1.71	6.69	71.79
Total Average	0.30	4.65	1.70	6.65	72.16

NO.4	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	0.30	4.75	1.59	6.64	72.40
May 2007	0.30	4.74	1.51	6.55	73.32
June 2007	0.30	4.51	1.49	6.30	76.28
July 2007	0.30	4.55	1.50	6.35	75.64
Total Average	0.30	4.64	1.52	6.46	74.41

Cutting standard length of lumber on double end saw improve in transportation time because implementation to use pallet and adjusting layout which easier to handling material to operate on machine. Standard work instruction and input-output sheet reduce operation time slightly.

Table 4.12 *Hot Press Forming Machine Data Sheet*

NO.5	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	1.88	6.38	3.00	11.25	42.67
November 2006	1.88	6.36	3.05	11.29	42.54
December 2006	1.88	6.40	3.00	11.28	42.59
Total Average	1.88	6.38	3.02	11.27	42.60

NO.5	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	1.88	5.48	3.11	10.46	45.92
February 2007	1.88	5.41	3.04	10.33	46.51
March 2007	1.88	5.43	3.09	10.39	46.22
Total Average	1.88	5.44	3.08	10.39	46.22

NO.5	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	1.88	5.38	2.14	9.39	51.12
May 2007	1.88	5.41	2.04	9.33	51.50
June 2007	1.88	5.35	2.07	9.29	51.66
July 2007	1.88	5.34	2.01	9.23	52.06
Total Average	1.88	5.37	2.07	9.31	51.59

After monitor and collecting data from this process found that operation time doesn’t has a standard which is temperature and machine run time depend on operator. The changed in operation time from January is setting up standard work instruction and machine setup from mix of 80-150°C and 25-45 minutes to 120°C and 20 minutes fixed. There is another tool to carried set of lumber put in the hot press forming machine which replace carrying piece-by-piece. The transportation time reduce in April after using this tool. Results demonstrate capacity on hot press forming machine after improvement increase from 42 to 51 Conga Drum per day which is about 21%.

Table 4.13 *Double Angle Saw Data Sheet*

NO.6, 7	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	2.00	5.59	5.44	13.03	36.84
November 2006	2.00	5.59	5.47	13.06	36.75
December 2006	2.00	5.59	5.46	13.05	36.79
Total Average	2.00	5.59	5.46	13.05	36.79

NO.6, 7	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	1.50	5.59	5.48	12.57	38.20
February 2007	1.50	5.59	5.49	12.58	38.16
March 2007	1.50	5.59	5.50	12.59	38.12
Total Average	1.50	5.59	5.49	12.58	38.16

NO.6, 7	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	1.50	5.59	3.30	10.39	46.20
May 2007	1.50	5.59	3.30	10.39	46.20
June 2007	1.50	5.59	3.31	10.40	46.18
July 2007	1.50	5.59	3.27	10.36	46.34
Total Average	1.50	5.59	3.29	10.38	46.23

Before improvement double angle saw has problem with put work piece in the machine and after operate angle not in the center therefore, process improvement is attach standard jig to hold work piece to be the same after operate every pieces. And reduce transportation time by using pallet to hold finished because previous process leave finished work piece into basket which is hard to carry. The table shows results that capacity increasing from 36 to 46 drums per day.

Table 4.14 *Hydraulic Press Clamp Data Sheet*

NO.8	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	2.42	8.08	2.45	12.95	33.62
November 2006	2.46	8.18	2.44	13.09	33.26
December 2006	2.42	8.11	2.44	12.97	33.56
Total Average	2.44	8.12	2.44	13.00	33.48

NO.8	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	2.41	8.21	2.45	13.06	33.32
February 2007	2.33	8.00	2.42	12.74	34.14
March 2007	2.30	7.77	2.43	12.50	33.93
Total Average	2.34	7.99	2.43	12.77	33.80

NO.8	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.28	7.50	2.39	12.17	35.78
May 2007	2.27	7.36	2.29	11.92	36.50
June 2007	2.26	7.20	2.25	11.71	37.15
July 2007	2.24	7.14	2.19	11.58	37.58
Total Average	2.26	7.30	2.28	11.84	36.75

Process improvement and standard work instruction show the decreasing of lead time in forming Conga Drum by using hydraulic press clamp from 13 minutes to 11 minutes. Setup time reduce by attach fixed jig on the machine for easier setup center of the drum. Thus, capacity per day to produced Conga Drum increase from 33 to 36 drums per day.

Table 4.15 *Turning Machine Data Sheet*

NO.9	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	1.17	7.50	3.00	11.67	37.28
November 2006	1.17	7.50	3.04	11.71	37.15
December 2006	1.16	7.50	3.01	11.65	37.34
Total Average	1.17	7.50	3.02	11.68	37.25

NO.9	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	1.17	7.50	3.06	11.73	37.10
February 2007	1.17	7.50	3.09	11.75	37.01
March 2007	1.17	7.50	3.02	11.69	37.23
Total Average	1.17	7.50	3.06	11.72	37.11

NO.9	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	1.16	7.50	3.00	11.66	37.32
May 2007	1.15	7.50	2.37	11.01	39.50
June 2007	1.16	7.50	2.15	10.81	40.24
July 2007	1.15	7.50	2.05	10.70	40.66
Total Average	1.15	7.50	2.39	11.05	39.43

Turning machine is semi-automatic machine which operator setup at the first time and start operate by machine, therefore operation time is fixed. The layout adjustment making more space and wok flow more comfortable. Thus, transportation time reduce three to two and a half minutes. Capacity increased from 37 to 39 drums.

Table 4.16 *Double Cut Saws Data Sheet*

NO.10	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.63	2.00	2.58	5.20	92.37
November 2006	0.65	2.00	2.59	5.24	91.69
December 2006	0.60	2.00	2.56	5.16	93.01
Total Average	0.63	2.00	2.58	5.20	92.36

NO.10	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.60	2.00	2.59	5.19	92.54
February 2007	0.59	2.00	2.54	5.13	93.71
March 2007	0.58	2.00	1.40	3.98	120.75
Total Average	0.59	2.00	2.18	4.76	102.33

NO.10	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	0.54	2.00	1.43	3.96	121.24
May 2007	0.55	2.00	1.30	3.85	124.71
June 2007	0.56	2.00	1.29	3.85	124.65
July 2007	0.59	2.00	1.24	3.83	125.51
Total Average	0.56	2.00	1.31	3.87	124.03

Double cut saw is a machine use for cut top and bottom rim of the raw shell which machine operated thus, operation time is fixed. Standard work instruction and re-layout concept reflect improvement in productivity from 92 to 124 drums which is increase about 34%.

Table 4.17 *Routers Machine Data Sheet*

NO.11, 12	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	1.33	1.46	1.39	4.18	114.92
November 2006	1.32	1.42	1.40	4.14	116.11
December 2006	1.35	1.42	1.43	4.20	114.55
Total Average	1.33	1.43	1.41	4.17	115.19

NO.11, 12	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	1.33	1.41	1.41	4.14	116.13
February 2007	1.32	1.34	1.41	4.06	118.31
March 2007	1.31	1.31	1.39	4.01	119.76
Total Average	1.32	1.35	1.40	4.07	118.07

NO.11, 12	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	1.29	1.31	1.40	3.99	120.31
May 2007	1.32	1.27	1.41	4.00	120.19
June 2007	1.30	1.26	1.39	3.95	121.56
July 2007	1.29	1.25	1.40	3.94	122.13
Total Average	1.30	1.27	1.40	3.97	121.05

Chamfer angle on the rim of raw shell using routers which process improvement develop jig and use cutter that suitable. Standard work instruction limit only one time cut per one work piece which operation time reduce from February after implementation improvement tool. The results illustrate clearly with 5% increasing in productivity after improvement.

Table 4.18 *Rolling Sanding Machine Data Sheet*

NO.13, 14	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	4.50	13.25	2.99	20.74	23.15
November 2006	4.54	13.32	2.95	20.82	23.06
December 2006	4.54	13.33	3.01	20.88	22.99
Total Average	4.53	13.30	2.98	20.81	23.07

NO.13, 14	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	4.49	12.71	2.98	20.17	23.80
February 2007	4.51	12.67	2.96	20.14	23.84
March 2007	4.53	12.64	2.99	20.15	23.82
Total Average	4.51	12.67	2.98	20.16	23.82

NO.13, 14	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	4.49	12.43	2.96	19.88	24.16
May 2007	4.52	12.47	2.95	19.94	24.08
June 2007	4.51	12.37	2.96	19.84	24.20
July 2007	4.59	12.27	2.98	19.83	24.21
Total Average	4.53	12.38	2.96	19.87	24.16

The process group on painting department has operator working with machine, tools and standard quality is hard to setup. For improvement is setup manual in using sand paper only four number which in fixed order from rough to fine sand paper. This reduce operation time and setup time because cut off unnecessary error such as using

fine sand paper before rough. The results illustrate that capacity in a day increase about

Table 4.19 *Vibration Sanding Data Sheet*

NO.15-17	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	2.53	13.58	1.43	17.53	27.40
November 2006	2.51	13.63	1.48	17.62	27.25
December 2006	2.61	13.55	1.43	17.59	27.31
Total Average	2.55	13.59	1.44	17.58	27.32

NO.15-17	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	2.59	12.64	1.43	16.65	28.84
February 2007	2.56	12.60	1.39	16.55	29.02
March 2007	2.59	12.51	1.36	16.46	29.17
Total Average	2.58	12.58	1.39	16.55	29.01

NO.15-17	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.53	12.45	1.39	16.36	29.35
May 2007	2.31	12.37	1.38	16.05	29.91
June 2007	2.24	12.29	1.41	15.94	30.12
July 2007	2.25	12.26	1.36	15.87	30.25
Total Average	2.33	12.34	1.38	16.06	29.91

Vibration sanding has similar problems with rolling sanding process. Therefore, the solutions and results are the same direction which operation time decrease and productivity increase. In addition, vibration sanding need to setup when change sand paper thus, setup time in vibration sanding slightly decreased from 2.53 to 2.33 minutes.

Table 4.20 *Rolling Filler Machine Data Sheet*

NO.18, 19	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	4.34	13.15	1.24	18.73	25.65
November 2006	4.57	12.98	1.23	18.77	25.61
December 2006	4.49	13.11	1.24	18.84	25.50
Total Average	4.47	13.08	1.23	18.78	25.59

NO.18, 19	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	4.52	13.04	1.22	18.78	25.57
February 2007	3.27	11.96	1.23	16.47	29.17
March 2007	3.24	12.16	1.22	16.63	28.89
Total Average	3.68	12.39	1.23	17.29	27.88

NO.18, 19	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	3.23	11.70	1.23	16.16	29.73
May 2007	3.21	11.70	1.22	16.13	29.80
June 2007	3.19	11.68	1.23	16.10	29.86
July 2007	3.19	11.66	1.22	16.07	29.92
Total Average	3.20	11.68	1.23	16.11	29.83

Thorn filler is a process that could make waste by operator which doesn't understand clearly with the process such as too much using thorn filler. Standard work instructions control operator to operate only four round of thorn filler and exception for some case that wood bud are deep. Thus, results illustrate improvement in operation time that effected to amount of drum per day from 25 to 29 drums which is around 16% increased.

Table 4.21 *Spraying Station Data Sheet*

NO.20, 21	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	2.90	3.00	3.49	9.39	51.20
November 2006	2.86	3.00	3.50	9.36	51.39
December 2006	2.80	3.00	3.50	9.30	51.64
Total Average	2.85	3.00	3.50	9.35	51.41

NO.20, 21	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	2.60	3.00	3.51	9.11	52.71
February 2007	2.41	3.00	3.49	8.90	53.99
March 2007	2.36	3.00	3.51	8.88	54.13
Total Average	2.46	3.00	3.50	8.96	53.61

NO.20, 21	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.31	3.00	3.49	8.80	54.58
May 2007	2.26	3.00	3.51	8.78	54.72
June 2007	2.23	3.00	3.51	8.74	54.99
July 2007	2.19	3.00	3.50	8.69	55.28
Total Average	2.25	3.00	3.50	8.75	54.89

Spraying by automatic painting machine has problems on mixture of paint that ratio of paint chemical non-standard. Standard work instruction setup the formula which is the same every time, improved setup time and reduce time to fix defects. The results illustrate that improvement increase productivity rate from 51 to 54 drums per day.

Table 4.22 *Five and Six drilling Data Sheet*

NO.22, 23	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	3.24	2.20	2.91	8.34	57.55
November 2006	3.26	2.20	2.86	8.33	57.68
December 2006	3.25	2.20	2.90	8.35	57.51
Total Average	3.25	2.20	2.89	8.34	57.58

NO.22, 23	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	3.15	2.20	2.88	8.23	58.39
February 2007	2.75	2.20	2.88	7.83	61.41
March 2007	2.58	2.20	2.89	7.67	62.64
Total Average	2.83	2.20	2.88	7.91	60.81

NO.22, 23	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.43	2.20	2.88	7.51	63.99
May 2007	2.36	2.20	2.87	7.43	64.62
June 2007	2.26	2.20	2.90	7.36	65.24
July 2007	2.25	2.20	2.86	7.31	65.72
Total Average	2.33	2.20	2.88	7.40	64.89

Process improvement in drilling holes for brackets are standard work instruction and standard jig to reduce setup time that increase productivity from 57 to 64 drums per day.

Table 4.23 *Inserting lugs Data Sheet*

NO.24	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.00	8.25	2.28	10.53	45.74
November 2006	0.00	8.38	2.38	10.75	44.78
December 2006	0.00	8.31	2.40	10.71	44.92
Total Average	0.00	8.31	2.35	10.66	45.15

NO.24	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.00	8.25	2.38	10.63	45.31
February 2007	2.09	4.63	2.24	8.95	53.79
March 2007	2.10	4.50	2.29	8.89	54.12
Total Average	1.40	5.79	2.30	9.49	51.07

NO.24	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.10	4.63	2.28	9.00	53.45
May 2007	2.09	4.44	2.28	8.80	54.64
June 2007	2.09	4.44	2.25	8.78	54.83
July 2007	2.09	4.38	2.28	8.74	55.04
Total Average	2.09	4.47	2.27	8.83	54.49

This process result comparison between machine and non-machine work in the first period there is non-machine work which doesn't has setup time but operation time is longer that machine work which has setup time. Results demonstrate that machine work has 9 Conga Drum produced per day.

In addition, study and monitor on lead time is a basic of LOB concept which can finding easily for bottle neck in the production line from data in all tables above. In all processes, hydraulic clamp and turning became the bottle neck of the Conga Drum production line at 36 and 39 Conga Drum produced per day when calculate on the same machine in each process. After July 2007, improvement in PK still continue which suggestion for bottle neck could be improve direct on process on order more machine to increase capacity.

Table 4.24 *Capacity per Day Data Sheet*

Conga Production		
Machine List	**Machine No.**	**Max. Capacity/Day**
Band Saw dia.36"	No.1	88
Plane machine	No.2, 3	128
Double end saws	No.4	74
Hot press forming hydraulic machine	No.5	51
Double angle saws	No.6, 7	92
Hydraulic press clamp	No.8	36
Turning machine #1	No.9	39
Double cut saws	No.10	124
Router machine	No.11, 12	242
Rolling sanding machine	No.13, 14	48
Vibration sanding machine	No.15-17	87

Rolling Filler machine	No.18, 19	58
Auto spay machine	No.20, 21	108
Drilling machine 5 and 6 heads	No.22, 23	128
Inserting lugs machine	No.24	108

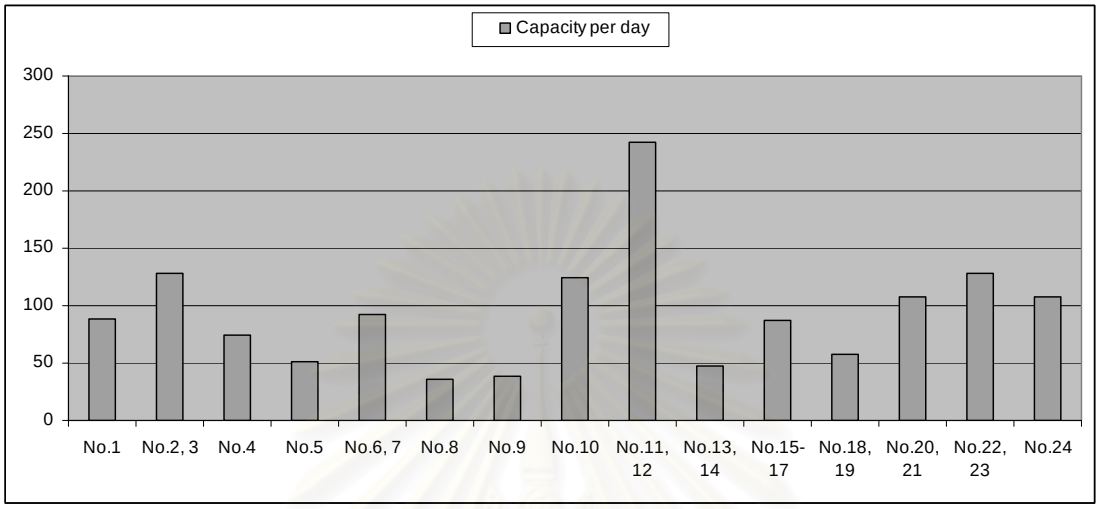

Figure 4.11 *Production Capacity Chart*

The figure demonstrates capacity of product per day on all machines which bottom neck is hydraulic press clamp and turning machine. Router machine has short operation time which should not operate all day. To balance production line might not balance only on lead time of each process, the solutions could be increase capacity by machines and man hour on bottle neck processes. Before improvement managing man hour don't have data support which could not utilize tasks in production line. Therefore, data sheet is a support data to make decision and scheduling production order easier.

In term of quality, there is improvement in quality control by using built-in quality concept, production line reduce defects and time to fix product. There is progress on defects reduction in each process. The defects reduce from each process around 5-10% depend on process improvement and changing in each process.

Table 4.25 *Production Defects*

Conga Production Defects			
Machine List	**Machine No.**	**Defects %**	
		Phase 1	**Phase 3**
Band Saw dia.36"	No.1	15%	7%
Plane machine	No.2, 3	18%	8%
Double end saws	No.4	12%	10%
Hot press forming machine	No.5	20%	8%
Double angle saws	No.6, 7	10%	7%
Hydraulic press clamp	No.8	12%	5%
Turning machine #1	No.9	10%	5%
Double cut saws	No.10	15%	5%
Router machine	No.11, 12	8%	5%
Rolling sanding machine	No.13, 14	-	-
Vibration sanding machine	No.15-17	-	-
Rolling Filler machine	No.18, 19	-	-
Auto spay machine	No.20, 21	5%	3%
Drilling machine 5 and 6 heads	No.22, 23	6%	2%
Inserting lugs machine	No.24	5%	2%

Table above demonstrate reducing defects from improvement. On preparing raw shell for painting process; rolling and vibration sanding and rolling filler process don’t have defects but loss of time to operate if raw shell is not well prepared. After painting process, there are lots of times that loss from quality control which needs to inspection in detail on product every item.

4.4.2 Labour Cost

As mention in previous chapter that labour cost is classify into two groups daily and monthly (salary). Daily worker will use into cost analysis directly because calculation in production efficiency is related to daily worker who work in production line directly. The amount of labour reflect work efficiency and productivity which using more people may not have great result if all task is not utilize.

Table 4.26 *Labour cost table*

Month	Number of Employee			Total Daily	Total Monthly	Total Wages	% Daily	% Monthly
	Daily	Monthly	Total					
Jan'06	31	9	40	138,354	62,100	200,454	69%	31%
Feb'06	29	9	38	117,777	61,921	179,698	66%	34%
Mar'06	30	9	39	133,390	61,777	195,167	68%	32%
Apr'06	25	9	34	97,498	62,100	159,598	61%	39%
May'06	25	10	35	103,893	68,600	172,493	60%	40%
Jun'06	26	10	36	104,846	68,600	173,446	60%	40%
Jul'06	27	10	37	115,026	68,600	183,626	63%	37%
Aug'06	30	10	40	111,303	68,277	179,580	62%	38%
Sep'06	33	10	43	124,438	68,600	193,038	64%	36%
Oct'06	29	10	39	121,854	68,600	190,454	64%	36%
Nov'06	27	11	38	113,528	70,250	183,778	62%	38%
Dec'06	23	11	34	99,237	78,500	177,737	56%	44%
Jan'07	24	11	35	102,802	78,500	181,302	57%	43%
Feb'07	24	13	37	98,952	82,250	181,202	55%	45%
Mar'07	30	13	43	139,369	82,250	221,619	63%	37%
Apr'07	28	13	41	104,326	81,950	186,276	56%	44%
May'07	22	14	36	91,271	88,250	179,521	51%	49%
Jun'07	22	14	36	99,458	88,250	187,708	53%	47%
Jul'07	23	14	37	103,336	88,250	191,586	54%	46%

Daily worker have higher turn over rate than monthly which means number of daily worker is vary in each period. Wage in 2006 is 184 baht and 2007 is 191 baht. Therefore, even reduce overtime cost in year 2007; the number of payment on daily worker is not illustrating big gap. In addition, policy to classify level of employees effect direct to labour cost to pay much more on employee level one to three but improving in production line efficiency effect direct to number of daily employee which demonstrate in the table and graph from thirty to no more than twenty-three daily workers. The number of worker in July 2007 is smaller but amount of finished goods is not reduced, this illustrate clearly on increasing productivity rate.

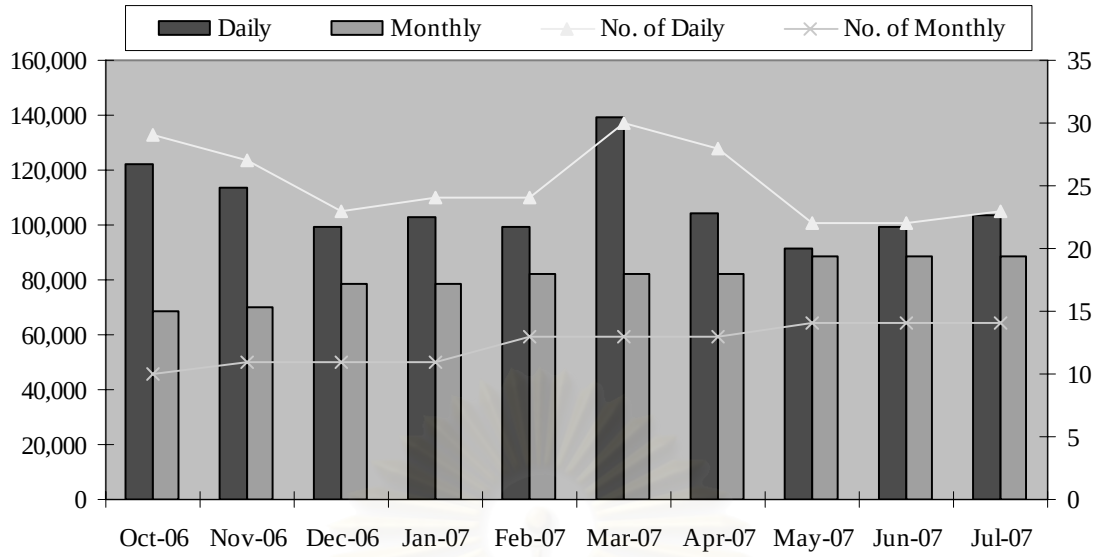

Figure 4.12 *Wages VS Number of Employee*

The table shows amount of daily and monthly payment worker, payment on labour cost each month from January 2006 to July 2007, percentage between daily and monthly payment term consider from overall paid. It is steady increase in monthly employees from nine to fourteenth but daily worker vary from 34 to 43 employees. Figure 4.8 shows payment and number of daily and monthly worker from October 2006 to July 2007. The monthly employees are more stable in increase number of worker and payment. On the opposite site, number of daily worker is fluctuating in each month.

4.4.3 Variable Expense (Electricity)

One of the measurements of improvement is variable cost, for this case study using electricity used to illustrate different results before and after implementation. The good results should demonstrate that amount of products increase or equal previous period with lower electricity used. The list of electricity used has shown in the table from August 2006 to July 2007 which mean of used units is 9977.913 units per month.

Table 4.27 *Electricity used table*

	Units	**Cost**
August 2006	10,340	44,852.63
September 2006	12,008	50,065.98
October 2006	10,708	44,771.23
November 2006	11,460	47,636.73
December 2006	11,272	46,227.61
January 2007	11,104	46,812.63
February 2007	11,584	47,587.55
March 2007	12,464	50,205.21
April 2007	9,032	39,696.21
May 2007	11,528	46,501.38
June 2007	10.956	43,674.58
July 2007	8,224	33,458.92

The electricity usages fluctuate between 8,000 to 12,500 units which vary by many factors. For example, April 2007 has many holidays, thus electricity usage impact direct from number of working day. After improvement illustrate electricity usage decreasing slightly from May to July because machine utilization and overtime working decreased as shown in the chart 4.10.

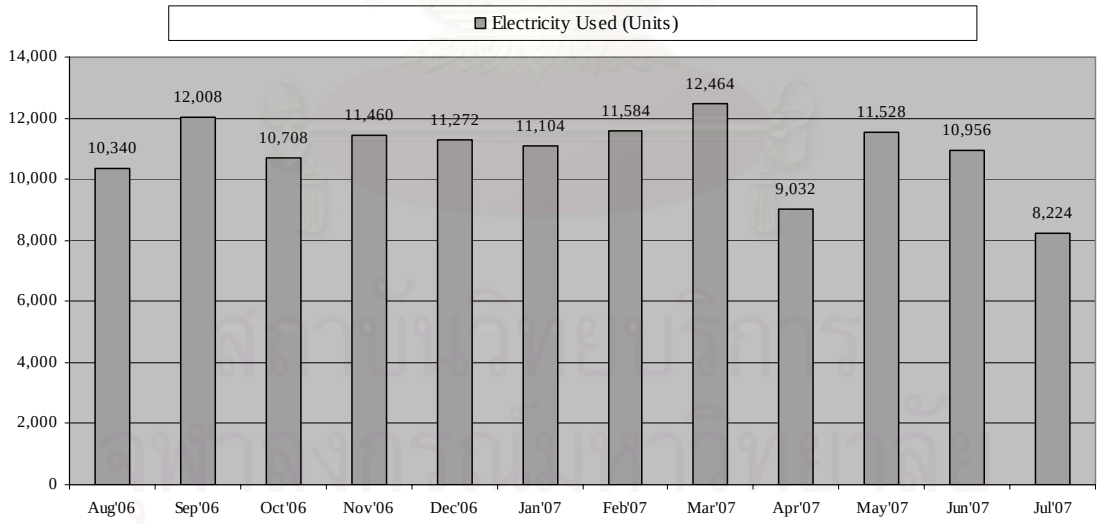

Figure 4.13 *Electricity Used*

4.4.4 Lateness on Due Date

After improvement, the results on efficiency and lateness are satisfied as the target. It is not totally reduce to non-lateness in the production order but factory in

case study serve customer more quickly. There are order from customers about 200-500 Conga Drum every month but PK cannot serve all orders; delay shipment and extension of due date happen on every order as shown in table.

Table 4.28 *Lateness on due date table*

	Amount	**Due Date**	**Shipped Date**	**Lateness**
Oct'06	190	10/09	26/10	46 days
Nov'06	200	02/10	18/12	76 days
Dec'06	-	-	-	-
Jan'07	152	12/11	18/01	67 days
Feb'07	400	02/11	02/02	92 days
Mar'07	100	25/01	19/03	53 days
Apr'07	200	01/02	23/04	50 days
May'07	270	05/03	25/05	81 days
Jun'07	380	29/05	03/07	35 days
Jul'07	444	23/06	20/07	27 days

On December, PK didn't ship any order therefore, all production in December will included in next shipments. This is because lack of spare parts and some accessories then PK produce only shell for assembly. As illustrate in February 2007, PK can ship 400 drums which some of them are in stock. In term of lateness, after improvement reduce delay from over 90 days to about 30 days which is reflect a good results for reducing delay.

In conclusion, this case study expect benefits is to reduce cost, time (due date), and defects that relate to production Conga Drum, making understand to management, and improve factory overall. The results demonstrate at satisfactory level delay on due date and productivity increase rapidly after improvement period and slightly reduce in cost aspect (labour and variable cost) which some of problems still need to improve.

4.5 SFC Model and Job Assignment

After overall improvement in many aspects (reorganization, re-layout, production process improvement), five functional in PAC; scheduler, dispatcher, monitor, mover, and producer have clearly scope to work together. There are order and information that flow in the system which start from customer order. Scheduler setup production order under customer order and manage products in stock.

Dispatcher receives production order from scheduler and distribute to each work cell in production; material preparing, shell, painting, assemble and packing. Mover and producer work under standard work instruction, built-in quality, and production order which control by head of each section. Overall model has shown in figure 4.14.

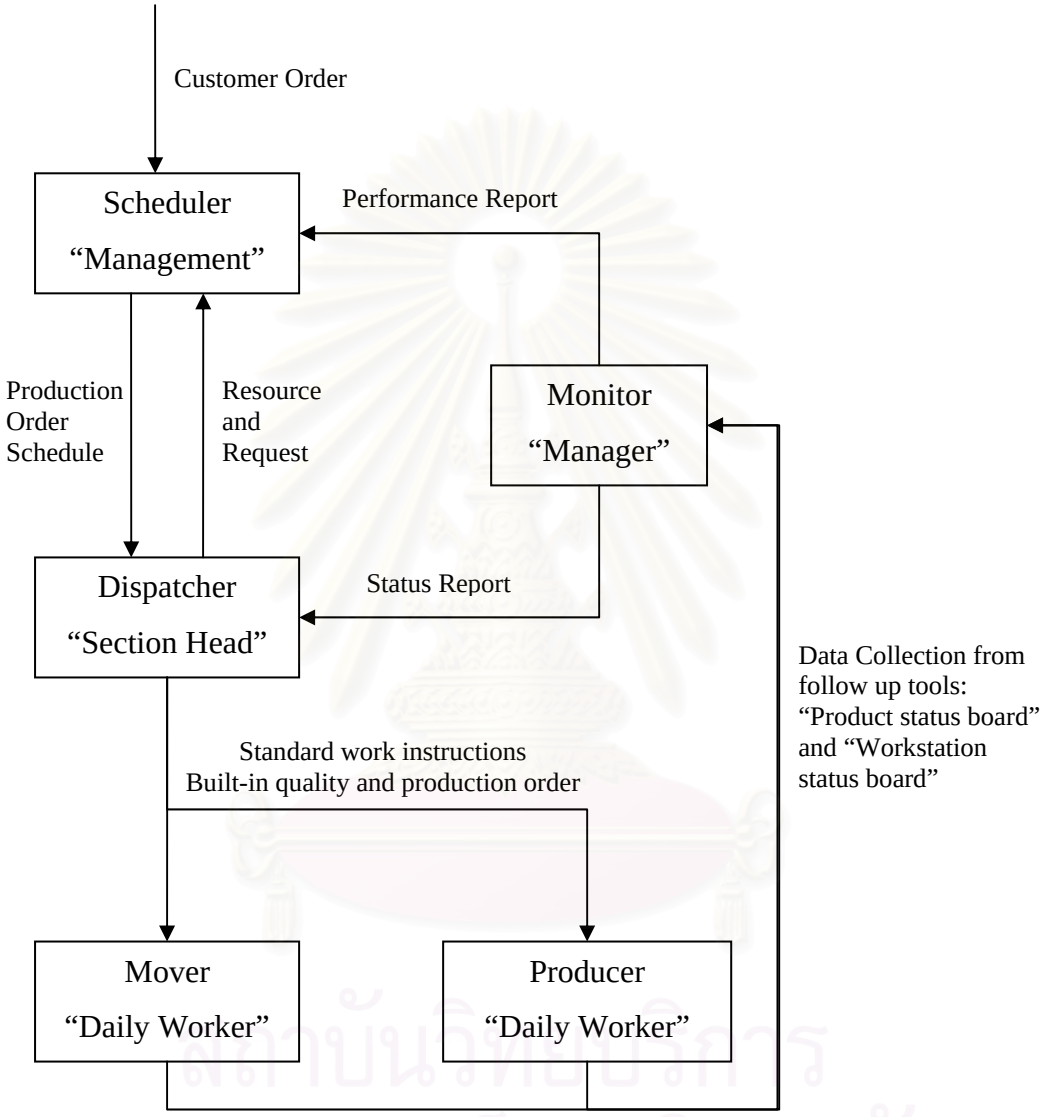

Figure 4.14 *Overall Production Activity Control in SFC*

Figure 4.14 shows the job assignment in SFC which fit with PAC concept that divides into five functional. Most of daily worker are participate in mover and producer function which control by standard work instruction, built-in quality in term of production process and production order in term of amount. Dispatcher and monitor is functional that response for manager and section head which observe above operation level. Scheduler setup production order by using information from

dispatcher and monitor which giving status of previous production order, resources, capacity and performance at the present. Scheduler can making decision in order raw material, setup production order, forecast due date, job assignment and rotate job for mover and producer functions.

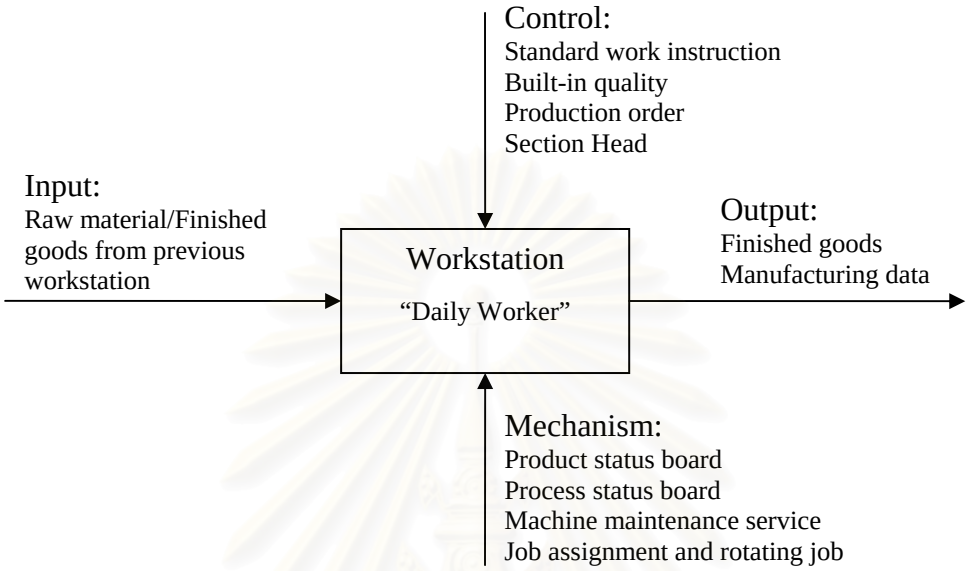

Figure 4.15 *Production process model in SFC*

For the individual process model in SFC shows in figure 4.15 which cover input, output, control, and mechanism functions. Each process has the responsibility in produce goods which generate by human and machine. Input is come from previous workstation, an output or finished goods are sending to the next workstation. Control and mechanism is the principle and guideline to control workstation run process properly.

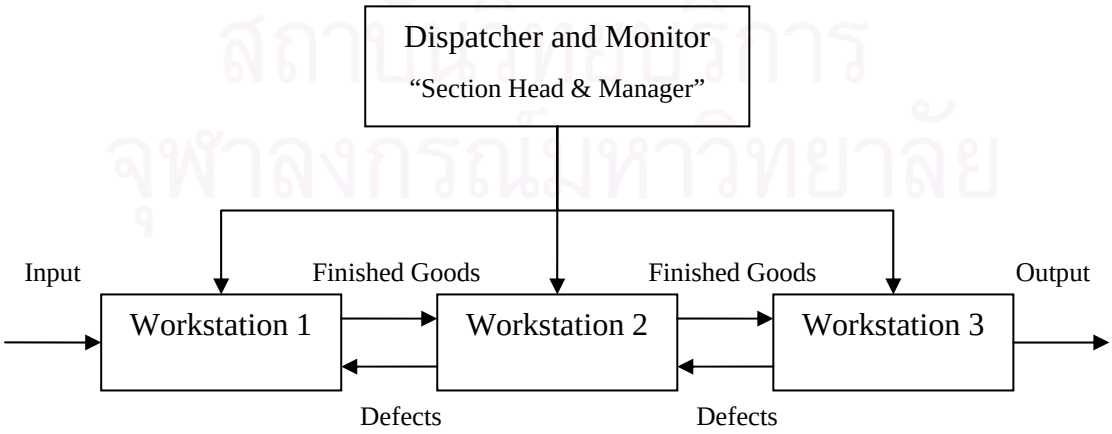

Figure 4.16 *Relationship between production process model in SFC*

All principles, techniques, and tools has implemented by management level which every single employee participate and using the same tools and techniques under guideline. The improvement is not cover only using but control and continue improvement is still. Figure 4.16 illustrates relationship between production process in section from receive production order and schedule. Job assignment is assigned by dispatcher which is section head or manager which follow schedule and production order from scheduler. It is important for built-in quality which protects defects at the last process. Built-in quality concept control the finished goods that should pass the quality check if not should fix in the section before forward to the next section.

In conclusion, every single data from each section helping scheduler to provide production order, forecast shipment due date, and order raw material in reasonable amount. Information also helps management to making decision in continue improvement in other issue such as MRP, re-layout, information technology. General concept in each functional and process is input and output which control by tools and techniques. Mechanism function is helping all process run smoothly and reduce problems.

CHAPTER V

DISCUSSIONS AND RECOMMENDATIONS

This chapter discusses and concludes SFC improvement which has been developed for music instrument (PK). Case study company has problems on delay shipment which cannot serve customer on time, defects in production line, cost, lack of monitor and follow up production order system. The expected benefits are target of improvement which should illustrate changing in solving all problems comparison to before improvement period. Recommendations for continuing improvement will discuss in this chapter.

5.1 Conclusion and Discussions

After monitor and collect data to analyse problems and solutions, there are improvement in three areas to serve SFC concept. Organisation, plant layout, and production process improvement are cover problems solving and expected benefits at the first stage which all improvement applying concepts, tools, techniques, and solutions.

Organisation improvement used decentralized, work breakdown model, and distribution work load concept to setup new organisation chart which also changing in culture and working style from family business. This is a FC level in SFC which effect directly to the overall planning, scheduling and direction. There are four main departments which are administration, production, and machine shop has setup under PAC concept to have all functional area; scheduler, dispatcher, monitor, mover, and producer. The benefits from organisation improvement demonstrate clearly on distribution responsibilities and assignment job. Allocation task clearly to the employee is important to reducing overlap and confusing in job. Everyone have their own tasks which already setting target under their responsibility.

Reorganization also improves relationship between departments to study and solving problems together. For example, follow up production order issue which in

the past control by president only but after improvement production order can follow up via production department which has responsibility to produce under scheduler and dispatcher order. In addition, management efficiency is increased to the certain point after reorganization. This is because everyone responds to their task and it is easier to find responsible person in the error which spot on scope of responsibility. The position level also creates and changes in the production department which is like a competition to be the leader in each process. Culture is changing to promote worker to be leader from measurement work efficiency. At the beginning of case study president monitor direct on the worker who will promote but after improvement using data support and monitor for work efficiency, key performance, and leadership before promote. This is a motivation tools for employee to pay more attention to do their job but the target to reduce labour cost is not totally successful because company still need to pay for the promoted employees and higher wages. The results illustrate that work efficiency (productivity) per worker are increased after improvement. Therefore, it is a business in long run to create new culture with standard to expand business size with efficient workers.

Layout improvement is one of the main factors that effect to the productivity. There is re-layout two times which at first time adjust production line into U-Shape and second time separate Conga Drum production line from other products. It is not only reducing transportation time but layout improvement separate clearly on process and function facilities. The benefits in layout improvement illustrate in the overall results that can reduce overlap route in materials and goods transportation in production line. Improved layout separate clearly on product and process which reduce setup time and confusing in the process. It is only some process that could use group technology concept to operate similar job for several product. Work process flow is improved which new layout also reduce defects from transportation. After layout improvement which changes to U-Shape, this increases communications and relationship among processes as the results demonstrate in decreasing defects rate about 5-10% in each process. Layout improvement includes managing space for WIP and remove center warehouse which is the waste in transportation. Facilities and space functional improvement also in the layout improvement stage to utilize space to maximize space usage with benefits.

Production process improvement shows clearly results in overall and individual process which after improvement period can reduce lead time and increase productivity. This is supporting shipment due date from over 90 days late to around 30 days late. Therefore, company can forecast more accurate on shipment due date, data collection is a supporting data to understand clearly on capacity. Company can manage working hour for production order more efficient by rotate and assign job under standard production time. Surveying individual process and initiate standard work instruction increase productivity rate for all processes around 5-20% depend on effect of solutions.

Comparison between before and after production process improvement found that old production process is nonsystematic which don’t have data support and cannot setup production plan and scheduling to serve customer requirement on time. Production process improvement creates new culture in organization; data collection and working style to be system. The benefit is cover reducing setup and operation time on work stations which scheduler can set group of similar product type or series to operate with suitable working hour. In term of quality, defects reduce from 2-10% in all processes which reflect a good respond after improvement techniques and tools to control work process and inspection process. There are other benefits in reduction production cost; labour and variable cost as show in the electrical usage table that number of units has decrease slightly at the last period. Standardization process shortens training time and cost which suitable for company that has high turnover rate. The other efficient tools in process improvement is follow up tool which is helping monitor in PAC collect data easier and more accurate.

In conclusion, shop floor control improvement in organization, layout, and production process are helping all areas in PAC to scheduling, planning, monitoring, and operating more efficient with reducing time and cost. Some problems are solving by SFC improvement but there are still some that need to consider under other aspects.

5.2 Problems

The results from SFC improvement perform at the satisfied level which concern with every people in company to improve together. Furthermore, there are many problems while implementing improvement tools and techniques which relate with employee, management level, cost and budget, difficulty of tools and techniques, time limit.

Employee especially labor level attitude is afraid of change and development even production process improvement helping them to work easier. Workers reject the process improvement and organisation change, this is because misunderstanding and confuse with the changed. Therefore, results from implement stage should not illustrate results at the maximum of change, thus in this case study monitor on three periods to collect results which might different in all phases. At the beginning of improvement has problem with employee attitude which lack of cooperate in improvement. At the implementation stage, there are problems with confusing and misunderstand to use tools and techniques in the case study. Giving information and teaching step by step is the solution for confusing and misunderstand employee. The adaptation of tools is the other solution which reduces some detail and unnecessary data collect which is too hard.

Unnecessary and nonsystematic data collection is a waste in this case study and also loss the time in analyzing. There are many data and information to collect for problem analysis, cost and time calculation, setup suitable concept, tools, and techniques which not all of them are necessary for the case. It is important to planning which information is necessary and focus on that point which can reduce time of study and helping monitor to get accurate data. The other problems are budget and cost in improvement which researcher should consider on limit resource and budget and the possibility to applied tools and techniques that suitable and effective with the case study.

5.3 Recommendations

After improvement, problems still maintain in production line which require for further improvement which should reduce number of problems. It is important in continuing improvement in data collection to be more accurate, keep improve organisation, distribute responsibility, and work load, layout and production process. For the further improvement should consider on flexibility and quick response with the situation, changing, and environment. This is cover cost estimation and selling price which is more accurately. The data support for decision making is needed to improve from the case study to be more accurate and efficient in problem analysis. it is important for the information to use as a base of knowledge and applied to other aspect such as aggregate planning, MRP, forecasting order, stock and inventory. Appling information technology to make data collection standardizes with technology such as create data base in computer program. These also improve and reduce error from unnecessary and incorrect data.

Study on other aspect for causes and effects of defects such as reducing defects by material handling improvement, machine maintenance schedule which also can reduce defects, human error and training procedure, outsourcing quality control. Further study should consider on absorb quick changed and increase flexibility. All improvement should setup the new targets which are continuing from previous study. For example, increase capacity with the better quality control and low inventory level which problems from implementation in this case study is an important data base. Focus on problem in PAC level which still maintain and select solution from previous data and improve solution which suitable to the problems. This is need supporting from management level to push continuing improvement. All studies could expand to other products such as Bongo and Djembe which could use same concept, tools, and techniques.

REFERENCES

Angsakul, Nattada. 2004. “Production Scheduling in a Process and Assembly Job Shop to Minimize Lateness.” Master’s thesis, Kasetsart University.

Assavarungsi, Jesda. 2002. “Production Scheduling in Corrugated Box Plant.” Master’s thesis, Chulalongkorn University.

Bauer, A.; Bowden, R.; Browne, J.; Duggan, J.; and Lyons, G. 1994. Shop Floor Control Systems: From design to implementation. London: Chapman & Hall.

Berbers, Yolande.; Steegmans, Elke.; and Hol Voet, Tom. [n.d.] “Agent-Based Shop Floor Control Using Jini.” KULeuven, Belgium.

Carstensen, Peter.; Schmidt, Kjeld.; and Kock Wiil, Uffe. [n.d.] “Supporting Shop Floor Intelligence: A CSCW Approach to Production Planning and Control in Flexible Manufacturing.” Computer Supported Cooperative Works, the Journal of Collaborative Computing.

Chomsuwan, Piyamaporn. 1997. “Production Scheduling/Rescheduling for Flexible Manufacturing Systems in the Case of Machine Breakdown.” Master’s thesis, Chulalongkorn University.

Dilworth, James B. 1989. Production and Operations Management. 4th ed. New York: McGraw-Hill.

Gupta, Amit K.; Sivakumar, Appa Iyer.; and Sarawgi, Sumit. 2002. “Shop Floor Scheduling with Simulation Based Proactive Decision Support.” In E. Yücesan, C.−H. Chen, J. L. Snowdon, and J. M. Charnes, eds. Proceedings of the 2002 Winter Simulation Conference. 1897-1902.

Heizer, J., and Barry, R. 2005. Operation Management. Pearson Education.

Heizer, J., and Barry, R. 1993. Production and Operation Management. Prentice Hall.

Jarusriwanna, Ratiya. 2000. “Production Scheduling in a Textured Yarn Factory.” Master’s thesis, Chulalongkorn University.

Jongchalermchai, Surasak. 2002. “Project Planning and Control For Thermal Fuse Production Capacity Expansion.” Master’s thesis, Chulalongkorn University.

Kaiyawan, Yuth. 2006. Production Planning and Control. Bangkok: Bangkok Software Technology House.

Kamonpatana, Kamonrat. 2001. “A Layout Improvement of Plastic Utensil Processing Line.” Master’s thesis, Chulalongkorn University.

Kim, Sambong.; Woo, Jungyoup.; Park, Sungsik.; Jung, Buhwan.; and Cho, Hyunbo. 2002. "Integrated Development of Nonlinear Process Planning and Simulation-Based Shop Floor Control." In E. Yücesan, C.−H. Chen, J. L. Snowdon, and J. M. Charnes, eds. Proceedings of the 2002 Winter Simulation Conference. 1465-1468.

Kloypayan, Jirawan. 1992. "Production Planning in a Garment Factory by Using the PERT LOB Technique." Master's thesis, Chulalongkorn University.

Laichuthai, Udomrat. 2002. Production Scheduling in Packaging Printing Factory. Master's thesis, Chulalongkorn University.

Lalitaporn, Pipop. 2002. Production Planning and Control. Bangkok: Technology Promotion Association (Thailand-Japan).

Laoboonlur, Preecha. 1999. "A Production Scheduling Method in a Knitted Fabric Dyeing and Finishing Factory." Master's thesis, Chulalongkorn University.

Meredith, Jack R. 1992. The Management of Operations: A Conceptual Emphasis. 4th ed. [n.p.], Wiley.

Mönch, Lars.; Rose, Oliver.; and Sturm, Roland. 2003. "A Simulation Framework for the Performance Assessment of Shop-Floor Control Systems." Simulation 79, 3: 1-8.

Pattachot, Chanoknun. 2002. "Production Planning for Plastic Injection Plant Not Over 150-Ton Injector." Master's thesis, Chulalongkorn University.

Pattanajaroen, Prakit. 1998. "Production Planning by Sequencing and Scheduling for Punch and Dies Factory." Master's thesis, Kasetsart University.

Pfadenhauer, Konrad.; Kittl, Burkhard.; Dustdar, Schahram.; and Levy, David. 2006. "Shop Floor Information Management and SOA." In J. Eder, S. Dustdar et al. (Eds.) BPM 2006 Workshops, LNCS 4103, 237-248.

Phrompoo, Sittipoom. 2001. "Production Planning and Control for the Air Conditioner
Spare Parts Industry." Master's thesis, Chulalongkorn University.

Praweenaporn, Aroonrad. 2003. "Production Planning in Customer-Order Driven Manufacturing: Case Study Delmax Mechinery Co., Ltd." Master's thesis, Kasetsart University

Productivity Press Development Team. 2006. Identifying Waste on the Shopfloor. Translated by Wittaya Suharitdumrong and Yupa Klonklang. Bangkok: E.I. Square Publishing.

Productivity Press Development Team. 2007. Standard Work for the Shopfloor. Translated by Pornthep Luasupsuk and Yupa Klonklang. Bangkok: E.I. Square Publishing.

Rasree, Jirapat. 1996. “Production Planning and Inventory Management of a Polyethylene Pipe Factory.” Master’s thesis, Chulalongkorn University.

Rattanaguakangwan, Suthat. 2005. Production & Operations Management. Bangkok: Chulalongkorn University.

Richardson, Charley. 2004. “Surrendering the Shop Floor Means Surrenderir.” [Online]. Available: http://labornotes.orgnode/633

Riggs, James L. 1970. Production Systems: Planning, Analysis, and Control. [n.p.], John Wiley and Sons.

Scholz-Reiter, Bernd.; Freitag, Michael.; de Beer, Christoph.; and Jagalski, Thomas. 2006. “Modeling and Simulation of a Pheromone Based Shop Floor Control.” Proceedings of CIRP-Digital Enterprise Technology. 1-7. Setúbal, Portugal.

Scholz-Reiter, B.; Freitag, M.; de Beer, Ch.; and Jagalski, Th. 2005. “Modeling and Analysis of Autonomous Shop Floor Control.” Proceedings of 38th CIRP International Seminar on Manufacturing Systems. Florianopolis, Brazil. [CD-ROM].

Sherwin, Marc.; Moore, Jason.; Hladek, Jeff.; and Roberts, Mike. 2001. “The Development of a Custom, Paperless Shop Floor Control System for Efficient Manufacturing.” CO: GaAs MANTECH.

Son, Y.; Venkateswaran, J.; Yaseen, K.; and Mopidevi, R. 2001. “Initial Research on Schedule Interface with Shop Floor Control System.” Arizona: The University of Arizona, U.S.A.

Stevenson, William J. 2005. “Operations Management.” 8th ed. New York: McGraw-Hill.

Suntayanonta, Chanaghan. 2000. “Process Improvement in Job-Machine Allocations for a Semiconductor Factory.” Master’s thesis, Kasetsart University.

Tantrakul, Sakkarit. 2000. “Plant Re-Layout Design: A Case Study of Motorcycle Parts Manufacture.” Master’s thesis, Chulalongkorn University.

Venkateswaran, Jayendran.; Manmohan, Maheer.; and Son, Young-Jun. [n.d.] “Virtual Manufacturing – Online Control of Shop Floor Operations.” 1-17. Arizona: The University of Arizona, U.S.A.

W.Schmenner, Rojer. 1993. Operation Management: Decision Making in the Operation Function. New York: McGraw-Hill.

Yoo, Taejong.; Kim, Daehong.; and Cho, Hyunbo. 2004. “A New Approach to Multi-Pass Scheduling in Shop Floor Control.” In R.G. Ingalls, M.D. Rossetti, J. S. Smith, and B. A. Peters, eds. Proceedings of the 2004 Winter Simulation Conference, 1109-1114.

Zülch, Gert.; Keller, Volker.; and Fischer, Axel. [n.d.] “Visual Representation Concept of Factory Information.” 1-6.

APPENDICES

APPENDIX A

PROCESS DATA SHEET

NO.1	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.34	4.86	0.35	5.55	86.49
2	0.32	4.95	0.34	5.61	85.56
3	0.33	4.90	0.34	5.57	86.18
4	0.31	4.87	0.35	5.53	86.80
5	0.32	4.95	0.36	5.63	85.26
6	0.33	4.90	0.34	5.57	86.18
7	0.31	4.87	0.36	5.54	86.64
8	0.32	4.95	0.35	5.62	85.41
Total Average	0.32	4.91	0.35	5.58	86.06

NO.1	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.35	4.87	0.33	5.55	86.49
2	0.35	4.92	0.35	5.62	85.41
3	0.31	4.95	0.35	5.61	85.56
4	0.33	4.86	0.36	5.55	86.49
5	0.31	4.97	0.33	5.61	85.56
6	0.32	4.88	0.34	5.54	86.64
7	0.33	4.89	0.36	5.58	86.02
8	0.32	4.97	0.37	5.66	84.81
Total Average	0.33	4.91	0.35	5.59	85.87

NO.1	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.33	4.88	0.36	5.57	86.18
2	0.31	4.94	0.35	5.60	85.71
3	0.32	4.97	0.33	5.62	85.41
4	0.33	4.98	0.37	5.68	84.51
5	0.35	4.92	0.38	5.65	84.96
6	0.34	4.86	0.35	5.55	86.49
7	0.33	4.89	0.34	5.56	86.33
8	0.31	4.93	0.36	5.60	85.71
Total Average	0.33	4.92	0.36	5.60	85.66

NO.1	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.34	4.92	0.35	5.61	85.56
2	0.33	4.95	0.34	5.62	85.41
3	0.35	4.89	0.38	5.62	85.41
4	0.30	4.86	0.35	5.51	87.11
5	0.32	4.88	0.36	5.56	86.33
6	0.31	4.91	0.33	5.55	86.49
7	0.29	4.94	0.38	5.61	85.56
8	0.31	4.86	0.34	5.51	87.11
Total Average	0.32	4.90	0.35	5.57	86.12

NO.1	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.32	4.84	0.38	5.54	86.64
2	0.33	4.96	0.35	5.64	85.11
3	0.30	4.92	0.34	5.56	86.33
4	0.28	4.90	0.38	5.56	86.33
5	0.30	4.88	0.36	5.54	86.64
6	0.31	4.86	0.38	5.55	86.49
7	0.29	4.89	0.36	5.54	86.64
8	0.32	4.95	0.33	5.60	85.71
Total Average	0.31	4.90	0.36	5.57	86.24

NO.1	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.29	4.93	0.35	5.57	86.18
2	0.30	4.91	0.33	5.54	86.64
3	0.28	4.86	0.38	5.52	86.96
4	0.29	4.85	0.34	5.48	87.59
5	0.31	4.83	0.37	5.51	87.11
6	0.32	4.88	0.39	5.59	85.87
7	0.32	4.85	0.34	5.51	87.11
8	0.28	4.91	0.33	5.52	86.96
Total Average	0.30	4.88	0.35	5.53	86.80

NO.1	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.29	4.84	0.33	5.46	87.91
2	0.28	4.87	0.35	5.50	87.27
3	0.30	4.86	0.36	5.52	86.96
4	0.29	4.93	0.31	5.53	86.80
5	0.28	4.91	0.32	5.51	87.11
6	0.29	4.85	0.32	5.46	87.91
7	0.28	4.83	0.31	5.42	88.56
8	0.30	4.86	0.34	5.50	87.27
Total Average	0.29	4.87	0.33	5.49	87.48

NO.1	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.30	4.87	0.34	5.51	87.11
2	0.30	4.83	0.33	5.46	87.91
3	0.28	4.88	0.33	5.49	87.43
4	0.29	4.90	0.32	5.51	87.11
5	0.30	4.82	0.35	5.47	87.75
6	0.29	4.84	0.33	5.46	87.91
7	0.29	4.81	0.31	5.41	88.72
8	0.28	4.83	0.31	5.42	88.56
Total Average	0.29	4.85	0.33	5.47	87.82

NO.1	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.28	4.90	0.32	5.50	87.27
2	0.29	4.86	0.33	5.48	87.59
3	0.29	4.81	0.28	5.38	89.22
4	0.28	4.82	0.31	5.41	88.72
5	0.30	4.86	0.35	5.51	87.11
6	0.29	4.85	0.33	5.47	87.75
7	0.28	4.82	0.29	5.39	89.05
8	0.28	4.84	0.31	5.43	88.40
Total Average	0.29	4.85	0.32	5.45	88.14

NO.1	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.28	4.86	0.31	5.45	88.07
2	0.29	4.85	0.33	5.47	87.75
3	0.27	4.84	0.31	5.42	88.56
4	0.27	4.85	0.35	5.47	87.75
5	0.29	4.85	0.29	5.43	88.40
6	0.28	4.78	0.29	5.35	89.72
7	0.27	4.85	0.29	5.41	88.72
8	0.28	4.79	0.28	5.35	89.72
Total Average	0.28	4.83	0.31	5.42	88.59

NO.1	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.32	4.91	0.35	5.58	86.06
November 2006	0.33	4.91	0.35	5.59	85.87
December 2006	0.33	4.92	0.36	5.60	85.66
Total Average	0.33	4.91	0.35	5.59	85.87

NO.1	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.32	4.90	0.35	5.57	86.12
February 2007	0.31	4.90	0.36	5.57	86.24
March 2007	0.30	4.88	0.35	5.53	86.80
Total Average	0.31	4.89	0.36	5.56	86.39

NO.1	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	0.29	4.87	0.33	5.49	87.48
May 2007	0.29	4.85	0.33	5.47	87.82
June 2007	0.29	4.85	0.32	5.45	88.14
July 2007	0.28	4.83	0.31	5.42	88.59
Total Average	0.29	4.85	0.32	5.45	88.00

NO.2, 3	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.57	5.70	1.2	7.47	64.26
2	0.59	5.60	1.4	7.59	63.24
3	0.56	5.50	1.3	7.36	65.22
4	0.55	5.40	1.4	7.35	65.31
5	0.59	5.60	1.2	7.39	64.95
6	0.57	5.70	1.3	7.57	63.41
7	0.58	5.80	1.2	7.58	63.32
8	0.53	5.80	1.2	7.53	63.75
Total Average	0.57	5.64	1.28	7.48	64.18

NO.2, 3	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.53	5.80	1.2	7.53	63.75
2	0.59	5.70	1.2	7.49	64.09
3	0.57	5.60	1.2	7.37	65.13
4	0.59	5.40	1.3	7.29	65.84
5	0.59	5.70	1.2	7.49	64.09
6	0.57	5.80	1.3	7.67	62.58
7	0.56	5.90	1.2	7.66	62.66
8	0.58	5.40	1.3	7.28	65.93
Total Average	0.57	5.66	1.24	7.47	64.26

NO.2, 3	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.58	5.40	1.3	7.28	65.93
2	0.57	5.80	1.2	7.57	63.41
3	0.56	5.50	1.3	7.36	65.22
4	0.57	5.70	1.3	7.57	63.41
5	0.59	5.60	1.2	7.39	64.95
6	0.57	5.50	1.3	7.37	65.13
7	0.56	5.80	1.3	7.66	62.66
8	0.55	5.70	1.2	7.45	64.43
Total Average	0.57	5.63	1.26	7.46	64.39

NO.2, 3	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.54	5.40	1.2	7.14	67.23
2	0.57	5.50	1.4	7.47	64.26
3	0.56	5.70	1.1	7.36	65.22
4	0.57	5.80	1.3	7.67	62.58
5	0.54	5.70	1.4	7.64	62.83
6	0.57	5.50	1.2	7.27	66.02
7	0.56	5.80	1.4	7.76	61.86
8	0.57	5.90	1.2	7.67	62.58
Total Average	0.56	5.66	1.28	7.50	64.07

NO.2, 3	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.54	5.50	1.4	7.44	64.52
2	0.56	5.90	1.3	7.76	61.86
3	0.55	5.80	1.3	7.65	62.75
4	0.57	5.70	1.2	7.47	64.26
5	0.58	5.50	1.3	7.38	65.04
6	0.53	5.40	1.1	7.03	68.28
7	0.57	5.70	1.3	7.57	63.41
8	0.55	5.50	1.2	7.25	66.21
Total Average	0.56	5.63	1.26	7.44	64.54

NO.2, 3	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.54	5.70	1.3	7.54	63.66
2	0.57	5.80	1.4	7.77	61.78
3	0.54	5.60	1.2	7.34	65.40
4	0.56	5.50	1.4	7.46	64.34
5	0.57	5.50	1.1	7.17	66.95
6	0.54	5.70	1.3	7.54	63.66
7	0.57	5.80	1.4	7.77	61.78
8	0.54	5.80	1.3	7.64	62.83
Total Average	0.55	5.68	1.30	7.53	63.80

NO.2, 3	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.56	5.80	1.2	7.56	63.49
2	0.54	5.60	1.3	7.44	64.52
3	0.56	5.70	1.4	7.66	62.66
4	0.57	5.50	1.2	7.27	66.02
5	0.54	5.60	1.3	7.44	64.52
6	0.57	5.50	1.2	7.27	66.02
7	0.58	5.70	1.2	7.48	64.17
8	0.54	5.80	1.3	7.64	62.83
Total Average	0.56	5.65	1.26	7.47	64.28

NO.2, 3	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.54	5.50	1.4	7.44	64.52
2	0.52	5.70	1.2	7.42	64.69
3	0.52	5.50	1.1	7.12	67.42
4	0.51	5.80	1.2	7.51	63.91
5	0.53	5.90	1.3	7.73	62.10
6	0.57	5.50	1.2	7.27	66.02
7	0.54	5.70	1.4	7.64	62.83
8	0.57	5.60	1.2	7.37	65.13
Total Average	0.54	5.65	1.25	7.44	64.58

NO.2, 3	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.52	5.50	1.2	7.22	66.48
2	0.53	5.60	1.4	7.53	63.75
3	0.52	5.60	1.2	7.32	65.57
4	0.53	5.70	1.3	7.53	63.75
5	0.54	5.40	1.3	7.24	66.30
6	0.52	5.70	1.2	7.42	64.69
7	0.52	5.80	1.3	7.62	62.99
8	0.53	5.50	1.1	7.13	67.32
Total Average	0.53	5.60	1.25	7.38	65.11

NO.2, 3	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.54	5.60	1.4	7.54	63.66
2	0.53	5.70	1.2	7.43	64.60
3	0.52	5.40	1.2	7.12	67.42
4	0.52	5.70	1.3	7.52	63.83
5	0.51	5.50	1.2	7.21	66.57
6	0.52	5.80	1.3	7.62	62.99
7	0.5	5.50	1.4	7.40	64.86
8	0.48	5.80	1.2	7.48	64.17
Total Average	0.52	5.63	1.28	7.42	64.76

NO.2, 3	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.57	5.64	1.28	7.48	64.18
November 2006	0.57	5.66	1.24	7.47	64.26
December 2006	0.57	5.63	1.26	7.46	64.39
Total Average	0.57	5.64	1.26	7.47	64.28

NO.2, 3	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.56	5.66	1.28	7.50	64.07
February 2007	0.56	5.63	1.26	7.44	64.54
March 2007	0.55	5.68	1.30	7.53	63.80
Total Average	0.56	5.65	1.28	7.49	64.14

NO.2, 3	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	0.56	5.65	1.26	7.47	64.28
May 2007	0.54	5.65	1.25	7.44	64.58
June 2007	0.53	5.60	1.25	7.38	65.11
July 2007	0.52	5.63	1.28	7.42	64.76
Total Average	0.53	5.63	1.26	7.42	64.68

NO.4	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.3	4.70	1.8	6.80	70.59
2	0.3	4.60	1.5	6.40	75.00
3	0.3	4.60	1.7	6.60	72.73
4	0.3	4.50	1.6	6.40	75.00
5	0.3	4.80	1.8	6.90	69.57
6	0.3	4.60	1.7	6.60	72.73
7	0.3	4.70	1.8	6.80	70.59
8	0.3	4.80	1.9	7.00	68.57
Total Average	0.30	4.66	1.73	6.69	71.85

NO.4	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.3	4.70	1.7	6.70	71.64
2	0.3	4.50	1.8	6.60	72.73
3	0.3	4.80	1.6	6.70	71.64
4	0.3	4.60	1.8	6.70	71.64
5	0.3	4.80	1.7	6.80	70.59
6	0.3	4.60	1.9	6.80	70.59
7	0.3	4.70	1.8	6.80	70.59
8	0.3	4.50	1.6	6.40	75.00
Total Average	0.30	4.65	1.74	6.69	71.80

NO.4	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.3	4.80	1.7	6.80	70.59
2	0.3	4.60	1.6	6.50	73.85
3	0.3	4.50	1.8	6.60	72.73
4	0.3	4.70	1.6	6.60	72.73
5	0.3	4.70	1.7	6.70	71.64
6	0.3	4.80	1.8	6.90	69.57
7	0.3	4.50	1.6	6.40	75.00
8	0.3	4.80	1.8	6.90	69.57
Total Average	0.30	4.68	1.70	6.68	71.96

NO.4	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.3	4.50	1.7	6.50	73.85
2	0.3	4.70	1.6	6.60	72.73
3	0.3	4.60	1.8	6.70	71.64
4	0.30	4.50	1.6	6.40	75.00
5	0.3	4.60	1.7	6.60	72.73
6	0.3	4.70	1.8	6.80	70.59
7	0.3	4.80	1.6	6.70	71.64
8	0.3	4.80	1.7	6.80	70.59
Total Average	0.30	4.65	1.69	6.64	72.35

NO.4	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.30	4.80	1.8	6.90	69.57
2	0.30	4.70	1.6	6.60	72.73
3	0.30	4.50	1.8	6.60	72.73
4	0.30	4.60	1.6	6.50	73.85
5	0.30	4.70	1.8	6.80	70.59
6	0.30	4.60	1.7	6.60	72.73
7	0.30	4.50	1.6	6.40	75.00
8	0.30	4.70	1.7	6.70	71.64
Total Average	0.30	4.64	1.70	6.64	72.35

NO.4	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.30	4.60	1.8	6.70	71.64
2	0.30	4.70	1.6	6.60	72.73
3	0.30	4.80	1.7	6.80	70.59
4	0.30	4.60	1.8	6.70	71.64
5	0.30	4.50	1.7	6.50	73.85
6	0.30	4.80	1.6	6.70	71.64
7	0.30	4.70	1.7	6.70	71.64
8	0.30	4.70	1.8	6.80	70.59
Total Average	0.30	4.68	1.71	6.69	71.79

NO.4	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.30	4.80	1.7	6.80	70.59
2	0.30	4.90	1.5	6.70	71.64
3	0.30	4.70	1.6	6.60	72.73
4	0.30	4.90	1.7	6.90	69.57
5	0.30	4.60	1.5	6.40	75.00
6	0.30	4.50	1.4	6.20	77.42
7	0.30	4.70	1.6	6.60	72.73
8	0.30	4.90	1.7	6.90	69.57
Total Average	0.30	4.75	1.59	6.64	72.40

NO.4	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.30	4.80	1.6	6.70	71.64
2	0.30	4.90	1.5	6.70	71.64
3	0.30	4.70	1.4	6.40	75.00
4	0.30	4.80	1.5	6.60	72.73
5	0.30	4.90	1.6	6.80	70.59
6	0.30	4.70	1.4	6.40	75.00
7	0.30	4.60	1.5	6.40	75.00
8	0.30	4.50	1.6	6.40	75.00
Total Average	0.30	4.74	1.51	6.55	73.32

NO.4	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.30	4.80	1.4	6.50	73.85
2	0.30	4.70	1.5	6.50	73.85
3	0.30	4.60	1.6	6.50	73.85
4	0.30	4.50	1.4	6.20	77.42
5	0.30	4.30	1.5	6.10	78.69
6	0.30	4.20	1.4	5.90	81.36
7	0.30	4.60	1.6	6.50	73.85
8	0.30	4.40	1.5	6.20	77.42
Total Average	0.30	4.51	1.49	6.30	76.28

NO.4	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.3	4.60	1.4	6.30	76.19
2	0.3	4.50	1.6	6.40	75.00
3	0.3	4.70	1.5	6.50	73.85
4	0.3	4.40	1.4	6.10	78.69
5	0.3	4.50	1.6	6.40	75.00
6	0.3	4.40	1.4	6.10	78.69
7	0.3	4.60	1.6	6.50	73.85
8	0.3	4.70	1.5	6.50	73.85
Total Average	0.30	4.55	1.50	6.35	75.64

NO.4	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.30	4.66	1.73	6.69	71.85
November 2006	0.30	4.65	1.74	6.69	71.80
December 2006	0.30	4.68	1.70	6.68	71.96
Total Average	0.30	4.66	1.72	6.68	71.87

NO.4	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.30	4.65	1.69	6.64	72.35
February 2007	0.30	4.64	1.70	6.64	72.35
March 2007	0.30	4.68	1.71	6.69	71.79
Total Average	0.30	4.65	1.70	6.65	72.16

NO.4	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	0.30	4.75	1.59	6.64	72.40
May 2007	0.30	4.74	1.51	6.55	73.32
June 2007	0.30	4.51	1.49	6.30	76.28
July 2007	0.30	4.55	1.50	6.35	75.64
Total Average	0.30	4.64	1.52	6.46	74.41

NO.5	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.875	6.20	3.2	11.28	42.57
2	1.875	6.20	3.3	11.38	42.20
3	1.875	6.30	3.2	11.38	42.20
4	1.875	6.40	3.1	11.38	42.20
5	1.875	6.50	2.7	11.08	43.34
6	1.875	6.50	2.8	11.18	42.95
7	1.875	6.30	2.9	11.08	43.34
8	1.875	6.60	2.8	11.28	42.57
Total Average	1.88	6.38	3.00	11.25	42.67

NO.5	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.875	6.30	3.1	11.28	42.57
2	1.875	6.50	3.2	11.58	41.47
3	1.875	6.60	2.9	11.38	42.20
4	1.875	6.10	2.8	10.78	44.55
5	1.875	6.50	3.1	11.48	41.83
6	1.875	6.40	2.8	11.08	43.34
7	1.875	6.30	3.3	11.48	41.83
8	1.875	6.20	3.2	11.28	42.57
Total Average	1.88	6.36	3.05	11.29	42.54

NO.5	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.875	6.10	3.2	11.18	42.95
2	1.875	6.60	3.1	11.58	41.47
3	1.875	6.30	2.8	10.98	43.74
4	1.875	6.50	2.7	11.08	43.34
5	1.875	6.50	3.3	11.68	41.11
6	1.875	6.40	3.2	11.48	41.83
7	1.875	6.60	2.8	11.28	42.57
8	1.875	6.20	2.9	10.98	43.74
Total Average	1.88	6.40	3.00	11.28	42.59

NO.5	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.875	5.20	2.9	9.98	48.12
2	1.875	5.60	3.3	10.78	44.55
3	1.875	5.30	3.2	10.38	46.27
4	1.88	5.50	2.9	10.28	46.72
5	1.875	5.70	3.5	11.08	43.34
6	1.875	5.20	3.2	10.28	46.72
7	1.875	5.60	3.1	10.58	45.39
8	1.875	5.70	2.8	10.38	46.27
Total Average	1.88	5.48	3.11	10.46	45.92

NO.5	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.88	5.70	3.1	10.68	44.96
2	1.88	5.50	3.2	10.58	45.39
3	1.88	5.30	2.9	10.08	47.64
4	1.88	5.60	2.9	10.38	46.27
5	1.88	5.20	3	10.08	47.64
6	1.88	5.10	3.1	10.08	47.64
7	1.88	5.40	3.3	10.58	45.39
8	1.88	5.50	2.8	10.18	47.17
Total Average	1.88	5.41	3.04	10.33	46.51

NO.5	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.88	5.50	3.2	10.58	45.39
2	1.88	5.10	3.3	10.28	46.72
3	1.88	5.40	3.1	10.38	46.27
4	1.88	5.60	3	10.48	45.82
5	1.88	5.40	2.8	10.08	47.64
6	1.88	5.50	2.9	10.28	46.72
7	1.88	5.30	3.3	10.48	45.82
8	1.88	5.60	3.1	10.58	45.39
Total Average	1.88	5.43	3.09	10.39	46.22

NO.5	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.88	5.40	2.3	9.58	50.13
2	1.88	5.60	2.1	9.58	50.13
3	1.88	5.10	2.2	9.18	52.32
4	1.88	5.30	1.95	9.13	52.60
5	1.88	5.60	2	9.48	50.66
6	1.88	5.20	2.2	9.28	51.75
7	1.88	5.30	2.1	9.28	51.75
8	1.88	5.50	2.3	9.68	49.61
Total Average	1.88	5.38	2.14	9.39	51.12

NO.5	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.88	5.70	1.9	9.48	50.66
2	1.88	5.50	2	9.38	51.20
3	1.88	5.20	2.1	9.18	52.32
4	1.88	5.30	1.9	9.08	52.89
5	1.88	5.60	2	9.48	50.66
6	1.88	5.50	2.3	9.68	49.61
7	1.88	5.20	1.9	8.98	53.48
8	1.88	5.30	2.2	9.38	51.20
Total Average	1.88	5.41	2.04	9.33	51.50

NO.5	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.88	5.30	2.25	9.43	50.93
2	1.88	5.40	1.95	9.23	52.03
3	1.88	5.20	2.1	9.18	52.32
4	1.88	5.20	2.05	9.13	52.60
5	1.88	5.50	2	9.38	51.20
6	1.88	5.30	1.9	9.08	52.89
7	1.88	5.40	2.1	9.38	51.20
8	1.88	5.50	2.2	9.58	50.13
Total Average	1.88	5.35	2.07	9.29	51.66

NO.5	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.875	5.00	2	8.88	54.08
2	1.875	5.30	1.9	9.08	52.89
3	1.875	5.70	2	9.58	50.13
4	1.875	5.60	1.9	9.38	51.20
5	1.875	5.20	2.2	9.28	51.75
6	1.875	5.40	2	9.28	51.75
7	1.875	5.30	2.1	9.28	51.75
8	1.875	5.20	2	9.08	52.89
Total Average	1.88	5.34	2.01	9.23	52.06

NO.5	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	1.88	6.38	3.00	11.25	42.67
November 2006	1.88	6.36	3.05	11.29	42.54
December 2006	1.88	6.40	3.00	11.28	42.59
Total Average	1.88	6.38	3.02	11.27	42.60

NO.5	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	1.88	5.48	3.11	10.46	45.92
February 2007	1.88	5.41	3.04	10.33	46.51
March 2007	1.88	5.43	3.09	10.39	46.22
Total Average	1.88	5.44	3.08	10.39	46.22

NO.5	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	1.88	5.38	2.14	9.39	51.12
May 2007	1.88	5.41	2.04	9.33	51.50
June 2007	1.88	5.35	2.07	9.29	51.66
July 2007	1.88	5.34	2.01	9.23	52.06
Total Average	1.88	5.37	2.07	9.31	51.59

NO.6, 7	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2	5.59	5.59	13.18	36.42
2	2	5.59	5.52	13.11	36.61
3	2	5.59	5.45	13.04	36.81
4	2	5.59	5.35	12.94	37.09
5	2	5.59	5.38	12.97	37.01
6	2	5.59	5.39	12.98	36.98
7	2	5.59	5.48	13.07	36.73
8	2	5.59	5.35	12.94	37.09
Total Average	2.00	5.59	5.44	13.03	36.84

NO.6, 7	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2	5.59	5.4	12.99	36.95
2	2	5.59	5.38	12.97	37.01
3	2	5.59	5.6	13.19	36.39
4	2	5.59	5.55	13.14	36.53
5	2	5.59	5.36	12.95	37.07
6	2	5.59	5.45	13.04	36.81
7	2	5.59	5.52	13.11	36.61
8	2	5.59	5.5	13.09	36.67
Total Average	2.00	5.59	5.47	13.06	36.75

NO.6, 7	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2	5.59	5.65	13.24	36.25
2	2	5.59	5.43	13.02	36.87
3	2	5.59	5.48	13.07	36.73
4	2	5.59	5.52	13.11	36.61
5	2	5.59	5.36	12.95	37.07
6	2	5.59	5.38	12.97	37.01
7	2	5.59	5.5	13.09	36.67
8	2	5.59	5.35	12.94	37.09
Total Average	2.00	5.59	5.46	13.05	36.79

NO.6, 7	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.5	5.59	5.45	12.54	38.28
2	1.5	5.59	5.36	12.45	38.55
3	1.5	5.59	5.5	12.59	38.13
4	1.50	5.59	5.48	12.57	38.19
5	1.5	5.59	5.39	12.48	38.46
6	1.5	5.59	5.63	12.72	37.74
7	1.5	5.59	5.52	12.61	38.07
8	1.5	5.59	5.48	12.57	38.19
Total Average	1.50	5.59	5.48	12.57	38.20

NO.6, 7	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.50	5.59	5.63	12.72	37.74
2	1.50	5.59	5.47	12.56	38.22
3	1.50	5.59	5.58	12.67	37.88
4	1.50	5.59	5.39	12.48	38.46
5	1.50	5.59	5.5	12.59	38.13
6	1.50	5.59	5.61	12.70	37.80
7	1.50	5.59	5.35	12.44	38.59
8	1.50	5.59	5.38	12.47	38.49
Total Average	1.50	5.59	5.49	12.58	38.16

NO.6, 7	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.50	5.59	5.54	12.63	38.00
2	1.50	5.59	5.38	12.47	38.49
3	1.50	5.59	5.6	12.69	37.83
4	1.50	5.59	5.39	12.48	38.46
5	1.50	5.59	5.44	12.53	38.31
6	1.50	5.59	5.49	12.58	38.16
7	1.50	5.59	5.56	12.65	37.94
8	1.50	5.59	5.61	12.70	37.80
Total Average	1.50	5.59	5.50	12.59	38.12

NO.6, 7	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.50	5.59	3.35	10.44	45.98
2	1.50	5.59	3.27	10.36	46.33
3	1.50	5.59	3.18	10.27	46.74
4	1.50	5.59	3.14	10.23	46.92
5	1.50	5.59	3.42	10.51	45.67
6	1.50	5.59	3.52	10.61	45.24
7	1.50	5.59	3.38	10.47	45.85
8	1.50	5.59	3.15	10.24	46.88
Total Average	1.50	5.59	3.30	10.39	46.20

NO.6, 7	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.50	5.59	3.55	10.64	45.11
2	1.50	5.59	3.26	10.35	46.38
3	1.50	5.59	3.15	10.24	46.88
4	1.50	5.59	3.25	10.34	46.42
5	1.50	5.59	3.18	10.27	46.74
6	1.50	5.59	3.39	10.48	45.80
7	1.50	5.59	3.45	10.54	45.54
8	1.50	5.59	3.18	10.27	46.74
Total Average	1.50	5.59	3.30	10.39	46.20

NO.6, 7	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.50	5.59	3.25	10.34	46.42
2	1.50	5.59	3.24	10.33	46.47
3	1.50	5.59	3.15	10.24	46.88
4	1.50	5.59	3.5	10.59	45.33
5	1.50	5.59	3.42	10.51	45.67
6	1.50	5.59	3.36	10.45	45.93
7	1.50	5.59	3.18	10.27	46.74
8	1.50	5.59	3.35	10.44	45.98
Total Average	1.50	5.59	3.31	10.40	46.18

NO.6, 7	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.5	5.59	3.5	10.59	45.33
2	1.5	5.59	3.35	10.44	45.98
3	1.5	5.59	3.25	10.34	46.42
4	1.5	5.59	3.29	10.38	46.24
5	1.5	5.59	3.27	10.36	46.33
6	1.5	5.59	3.25	10.34	46.42
7	1.5	5.59	3.15	10.24	46.88
8	1.5	5.59	3.1	10.19	47.11
Total Average	1.50	5.59	3.27	10.36	46.34

NO.6, 7	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	2.00	5.59	5.44	13.03	36.84
November 2006	2.00	5.59	5.47	13.06	36.75
December 2006	2.00	5.59	5.46	13.05	36.79
Total Average	2.00	5.59	5.46	13.05	36.79

NO.6, 7	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	1.50	5.59	5.48	12.57	38.20
February 2007	1.50	5.59	5.49	12.58	38.16
March 2007	1.50	5.59	5.50	12.59	38.12
Total Average	1.50	5.59	5.49	12.58	38.16

NO.6, 7	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	1.50	5.59	3.30	10.39	46.20
May 2007	1.50	5.59	3.30	10.39	46.20
June 2007	1.50	5.59	3.31	10.40	46.18
July 2007	1.50	5.59	3.27	10.36	46.34
Total Average	1.50	5.59	3.29	10.38	46.23

NO.8	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.23	7.50	2.45	12.18	35.71
2	2.25	8.00	2.35	12.60	34.52
3	2.55	8.20	2.55	13.30	32.71
4	2.54	8.50	2.45	13.49	32.25
5	2.56	7.59	2.35	12.50	34.80
6	2.45	8.25	2.45	13.15	33.08
7	2.35	8.15	2.55	13.05	33.33
8	2.45	8.45	2.45	13.35	32.58
Total Average	2.42	8.08	2.45	12.95	33.62

NO.8	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.54	7.76	2.35	12.65	34.39
2	2.45	8.27	2.45	13.17	33.03
3	2.55	8.54	2.55	13.64	31.89
4	2.38	8.25	2.5	13.13	33.13
5	2.45	8.46	2.35	13.26	32.81
6	2.65	8.19	2.4	13.24	32.85
7	2.25	7.93	2.5	12.68	34.31
8	2.43	8.05	2.45	12.93	33.64
Total Average	2.46	8.18	2.44	13.09	33.26

NO.8	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.48	8.47	2.3	13.25	32.83
2	2.53	8.04	2.45	13.02	33.41
3	2.38	8.16	2.5	13.04	33.36
4	2.29	8.05	2.55	12.89	33.75
5	2.35	7.65	2.35	12.35	35.22
6	2.54	7.83	2.35	12.72	34.20
7	2.44	8.27	2.45	13.16	33.05
8	2.36	8.42	2.55	13.33	32.63
Total Average	2.42	8.11	2.44	12.97	33.56

NO.8	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.35	7.85	2.4	12.60	34.52
2	2.45	8.65	2.5	13.60	31.99
3	2.29	8.28	2.45	13.02	33.41
4	2.34	8.34	2.4	13.08	33.26
5	2.55	8.19	2.35	13.09	33.23
6	2.48	8.23	2.45	13.16	33.05
7	2.43	7.79	2.55	12.77	34.06
8	2.35	8.31	2.5	13.16	33.05
Total Average	2.41	8.21	2.45	13.06	33.32

NO.8	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.35	7.76	2.55	12.66	34.36
2	2.32	8.28	2.45	13.05	33.33
3	2.29	8.14	2.4	12.83	33.90
4	2.38	8.26	2.3	12.94	33.62
5	2.36	8.01	2.35	12.72	34.20
6	2.33	7.89	2.35	12.57	34.61
7	2.28	7.58	2.45	12.31	35.34
8	2.32	8.05	2.5	12.87	33.80
Total Average	2.33	8.00	2.42	12.74	34.14

NO.8	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.35	7.85	2.55	12.75	33.25
2	2.30	7.45	2.35	12.10	35.04
3	2.26	7.98	2.35	12.59	33.68
4	2.28	7.69	2.45	12.42	34.14
5	2.27	7.74	2.55	12.56	33.76
6	2.29	7.64	2.4	12.33	34.39
7	2.31	7.87	2.3	12.48	33.97
8	2.32	7.95	2.5	12.77	33.20
Total Average	2.30	7.77	2.43	12.50	33.93

NO.8	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.31	7.46	2.25	12.02	36.19
2	2.29	7.83	2.35	12.47	34.88
3	2.28	7.44	2.3	12.02	36.19
4	2.25	7.32	2.3	11.87	36.65
5	2.23	7.28	2.2	11.71	37.15
6	2.25	7.49	2.25	11.99	36.28
7	2.29	7.65	2.35	12.29	35.39
8	2.30	7.54	3.15	12.99	33.49
Total Average	2.28	7.50	2.39	12.17	35.78

NO.8	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.25	7.34	2.35	11.94	36.43
2	2.26	7.41	2.3	11.97	36.34
3	2.29	7.65	2.35	12.29	35.39
4	2.31	7.52	2.2	12.03	36.16
5	2.25	7.41	2.35	12.01	36.22
6	2.24	7.23	2.3	11.77	36.96
7	2.28	7.16	2.25	11.69	37.21
8	2.29	7.18	2.2	11.67	37.28
Total Average	2.27	7.36	2.29	11.92	36.50

NO.8	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.24	7.10	2.25	11.59	37.53
2	2.28	7.18	2.35	11.81	36.83
3	2.25	7.24	2.2	11.69	37.21
4	2.29	7.28	2.3	11.87	36.65
5	2.25	7.16	2.35	11.76	36.99
6	2.26	7.18	2.25	11.69	37.21
7	2.24	7.22	2.15	11.61	37.47
8	2.25	7.25	2.15	11.65	37.34
Total Average	2.26	7.20	2.25	11.71	37.15

NO.8	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.23	7.25	2.15	11.63	37.40
2	2.23	7.15	2.15	11.53	37.73
3	2.26	7.10	2.25	11.61	37.47
4	2.24	7.11	2.25	11.60	37.50
5	2.23	7.15	2.15	11.53	37.73
6	2.26	7.15	2.25	11.66	37.31
7	2.24	7.10	2.2	11.54	37.69
8	2.23	7.12	2.15	11.50	37.83
Total Average	2.24	7.14	2.19	11.58	37.58

NO.8	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	2.42	8.08	2.45	12.95	33.62
November 2006	2.46	8.18	2.44	13.09	33.26
December 2006	2.42	8.11	2.44	12.97	33.56
Total Average	2.44	8.12	2.44	13.00	33.48

NO.8	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	2.41	8.21	2.45	13.06	33.32
February 2007	2.33	8.00	2.42	12.74	34.14
March 2007	2.30	7.77	2.43	12.50	33.93
Total Average	2.34	7.99	2.43	12.77	33.80

NO.8	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.28	7.50	2.39	12.17	35.78
May 2007	2.27	7.36	2.29	11.92	36.50
June 2007	2.26	7.20	2.25	11.71	37.15
July 2007	2.24	7.14	2.19	11.58	37.58
Total Average	2.26	7.30	2.28	11.84	36.75

NO.9	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.18	7.50	3	11.68	37.24
2	1.17	7.50	2.9	11.57	37.60
3	1.16	7.50	3	11.66	37.31
4	1.16	7.50	3.1	11.76	36.99
5	1.17	7.50	2.9	11.57	37.60
6	1.18	7.50	3	11.68	37.24
7	1.18	7.50	3.1	11.78	36.93
8	1.16	7.50	3	11.66	37.31
Total Average	1.17	7.50	3.00	11.67	37.28

NO.9	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.19	7.50	3.2	11.89	36.59
2	1.17	7.50	2.9	11.57	37.60
3	1.18	7.50	2.8	11.48	37.89
4	1.19	7.50	3	11.69	37.21
5	1.16	7.50	3.2	11.86	36.68
6	1.16	7.50	3.1	11.76	36.99
7	1.17	7.50	3.1	11.77	36.96
8	1.16	7.50	3	11.66	37.31
Total Average	1.17	7.50	3.04	11.71	37.15

NO.9	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.16	7.50	2.9	11.56	37.63
2	1.17	7.50	3.2	11.87	36.65
3	1.16	7.50	3.1	11.76	36.99
4	1.16	7.50	3	11.66	37.31
5	1.17	7.50	2.8	11.47	37.93
6	1.16	7.50	3.1	11.69	37.21
7	1.16	7.50	3.2	11.75	37.02
8	1.16	7.50	2.8	11.46	37.96
Total Average	1.16	7.50	3.01	11.65	37.34

NO.9	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.17	7.50	3.2	11.87	36.65
2	1.18	7.50	3.1	11.78	36.93
3	1.16	7.50	2.9	11.56	37.63
4	1.17	7.50	3	11.67	37.28
5	1.15	7.50	3.1	11.75	37.02
6	1.17	7.50	3.2	11.87	36.65
7	1.15	7.50	3.1	11.75	37.02
8	1.17	7.50	2.9	11.57	37.60
Total Average	1.17	7.50	3.06	11.73	37.10

NO.9	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.16	7.50	3.2	11.86	36.68
2	1.17	7.50	3.15	11.82	36.80
3	1.18	7.50	3.2	11.88	36.62
4	1.15	7.50	3.1	11.75	37.02
5	1.16	7.50	3.1	11.76	36.99
6	1.18	7.50	3	11.68	37.24
7	1.17	7.50	2.95	11.62	37.44
8	1.16	7.50	3	11.66	37.31
Total Average	1.17	7.50	3.09	11.75	37.01

NO.9	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.16	7.50	2.95	11.61	37.47
2	1.17	7.50	3.1	11.77	36.96
3	1.16	7.50	3.1	11.76	36.99
4	1.16	7.50	3.2	11.86	36.68
5	1.17	7.50	3	11.67	37.28
6	1.18	7.50	2.85	11.53	37.73
7	1.18	7.50	2.95	11.63	37.40
8	1.16	7.50	3	11.66	37.31
Total Average	1.17	7.50	3.02	11.69	37.23

NO.9	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.17	7.50	3	11.67	37.28
2	1.16	7.50	2.9	11.56	37.63
3	1.15	7.50	3	11.65	37.34
4	1.14	7.50	3.1	11.74	37.05
5	1.15	7.50	2.9	11.55	37.66
6	1.15	7.50	3.1	11.75	37.02
7	1.17	7.50	3	11.67	37.28
8	1.16	7.50	3	11.66	37.31
Total Average	1.16	7.50	3.00	11.66	37.32

NO.9	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.15	7.50	2.3	10.95	39.73
2	1.17	7.50	2.5	11.17	38.94
3	1.15	7.50	2.5	11.15	39.01
4	1.16	7.50	2.4	11.06	39.33
5	1.13	7.50	2.5	11.13	39.08
6	1.11	7.50	2.45	11.06	39.33
7	1.16	7.50	2.1	10.76	40.43
8	1.13	7.50	2.2	10.83	40.17
Total Average	1.15	7.50	2.37	11.01	39.50

NO.9	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.16	7.50	2.1	10.76	40.43
2	1.17	7.50	2.2	10.87	40.02
3	1.16	7.50	2.1	10.76	40.43
4	1.15	7.50	2.2	10.85	40.09
5	1.17	7.50	2.1	10.77	40.39
6	1.16	7.50	2.2	10.86	40.06
7	1.15	7.50	2.1	10.75	40.47
8	1.16	7.50	2.2	10.86	40.06
Total Average	1.16	7.50	2.15	10.81	40.24

NO.9	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.15	7.50	2.1	10.75	40.47
2	1.17	7.50	1.95	10.62	40.96
3	1.16	7.50	1.95	10.61	41.00
4	1.12	7.50	2	10.62	40.96
5	1.17	7.50	2.2	10.87	40.02
6	1.15	7.50	2.1	10.75	40.47
7	1.14	7.50	2	10.64	40.88
8	1.14	7.50	2.1	10.74	40.50
Total Average	1.15	7.50	2.05	10.70	40.66

NO.9	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	1.17	7.50	3.00	11.67	37.28
November 2006	1.17	7.50	3.04	11.71	37.15
December 2006	1.16	7.50	3.01	11.65	37.34
Total Average	1.17	7.50	3.02	11.68	37.25

NO.9	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	1.17	7.50	3.06	11.73	37.10
February 2007	1.17	7.50	3.09	11.75	37.01
March 2007	1.17	7.50	3.02	11.69	37.23
Total Average	1.17	7.50	3.06	11.72	37.11

NO.9	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	1.16	7.50	3.00	11.66	37.32
May 2007	1.15	7.50	2.37	11.01	39.50
June 2007	1.16	7.50	2.15	10.81	40.24
July 2007	1.15	7.50	2.05	10.70	40.66
Total Average	1.15	7.50	2.39	11.05	39.43

NO.10	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.7	2.00	2.5	5.20	92.31
2	0.6	2.00	2.6	5.20	92.31
3	0.6	2.00	2.6	5.20	92.31
4	0.7	2.00	2.7	5.40	88.89
5	0.8	2.00	2.5	5.30	90.57
6	0.6	2.00	2.6	5.20	92.31
7	0.5	2.00	2.4	4.90	97.96
8	0.5	2.00	2.7	5.20	92.31
Total Average	0.63	2.00	2.58	5.20	92.37

NO.10	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.7	2.00	2.5	5.20	92.31
2	0.6	2.00	2.6	5.20	92.31
3	0.6	2.00	2.5	5.10	94.12
4	0.8	2.00	2.6	5.40	88.89
5	0.6	2.00	2.7	5.30	90.57
6	0.7	2.00	2.5	5.20	92.31
7	0.7	2.00	2.7	5.40	88.89
8	0.5	2.00	2.6	5.10	94.12
Total Average	0.65	2.00	2.59	5.24	91.69

NO.10	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.5	2.00	2.5	5.00	96.00
2	0.4	2.00	2.6	5.00	96.00
3	0.7	2.00	2.5	5.20	92.31
4	0.6	2.00	2.6	5.20	92.31
5	0.5	2.00	2.7	5.20	92.31
6	0.7	2.00	2.5	5.20	92.31
7	0.8	2.00	2.5	5.30	90.57
8	0.6	2.00	2.6	5.20	92.31
Total Average	0.60	2.00	2.56	5.16	93.01

NO.10	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.6	2.00	2.6	5.20	92.31
2	0.7	2.00	2.5	5.20	92.31
3	0.6	2.00	2.5	5.10	94.12
4	0.50	2.00	2.7	5.20	92.31
5	0.6	2.00	2.6	5.20	92.31
6	0.7	2.00	2.5	5.20	92.31
7	0.6	2.00	2.7	5.30	90.57
8	0.5	2.00	2.6	5.10	94.12
Total Average	0.60	2.00	2.59	5.19	92.54

NO.10	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.60	2.00	2.5	5.10	94.12
2	0.60	2.00	2.6	5.20	92.31
3	0.50	2.00	2.4	4.90	97.96
4	0.70	2.00	2.6	5.30	90.57
5	0.50	2.00	2.7	5.20	92.31
6	0.70	2.00	2.4	5.10	94.12
7	0.50	2.00	2.5	5.00	96.00
8	0.60	2.00	2.6	5.20	92.31
Total Average	0.59	2.00	2.54	5.13	93.71

NO.10	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.50	2.00	1.5	4.00	120.00
2	0.60	2.00	1.45	4.05	118.52
3	0.40	2.00	1.35	3.75	128.00
4	0.60	2.00	1.45	4.05	118.52
5	0.70	2.00	1.35	4.05	118.52
6	0.50	2.00	1.45	3.95	121.52
7	0.60	2.00	1.35	3.95	121.52
8	0.70	2.00	1.32	4.02	119.40
Total Average	0.58	2.00	1.40	3.98	120.75

NO.10	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.50	2.00	1.51	4.01	119.70
2	0.60	2.00	1.49	4.09	117.36
3	0.40	2.00	1.45	3.85	124.68
4	0.60	2.00	1.35	3.95	121.52
5	0.70	2.00	1.45	4.15	115.66
6	0.40	2.00	1.35	3.75	128.00
7	0.50	2.00	1.45	3.95	121.52
8	0.60	2.00	1.35	3.95	121.52
Total Average	0.54	2.00	1.43	3.96	121.24

NO.10	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.40	2.00	1.35	3.75	128.00
2	0.50	2.00	1.45	3.95	121.52
3	0.60	2.00	1.35	3.95	121.52
4	0.70	2.00	1.29	3.99	120.30
5	0.60	2.00	1.25	3.85	124.68
6	0.50	2.00	1.24	3.74	128.34
7	0.60	2.00	1.23	3.83	125.33
8	0.50	2.00	1.25	3.75	128.00
Total Average	0.55	2.00	1.30	3.85	124.71

NO.10	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.50	2.00	1.45	3.95	121.52
2	0.60	2.00	1.35	3.95	121.52
3	0.50	2.00	1.24	3.74	128.34
4	0.70	2.00	1.23	3.93	122.14
5	0.60	2.00	1.29	3.89	123.39
6	0.50	2.00	1.29	3.79	126.65
7	0.50	2.00	1.24	3.74	128.34
8	0.60	2.00	1.23	3.83	125.33
Total Average	0.56	2.00	1.29	3.85	124.65

NO.10	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0.5	2.00	1.24	3.74	128.34
2	0.6	2.00	1.23	3.83	125.33
3	0.7	2.00	1.28	3.98	120.60
4	0.6	2.00	1.24	3.84	125.00
5	0.5	2.00	1.23	3.73	128.69
6	0.5	2.00	1.24	3.74	128.34
7	0.7	2.00	1.23	3.93	122.14
8	0.6	2.00	1.22	3.82	125.65
Total Average	0.59	2.00	1.24	3.83	125.51

NO.10	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.63	2.00	2.58	5.20	92.37
November 2006	0.65	2.00	2.59	5.24	91.69
December 2006	0.60	2.00	2.56	5.16	93.01
Total Average	0.63	2.00	2.58	5.20	92.36

NO.10	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.60	2.00	2.59	5.19	92.54
February 2007	0.59	2.00	2.54	5.13	93.71
March 2007	0.58	2.00	1.40	3.98	120.75
Total Average	0.59	2.00	2.18	4.76	102.33

NO.10	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	0.54	2.00	1.43	3.96	121.24
May 2007	0.55	2.00	1.30	3.85	124.71
June 2007	0.56	2.00	1.29	3.85	124.65
July 2007	0.59	2.00	1.24	3.83	125.51
Total Average	0.56	2.00	1.31	3.87	124.03

NO.11, 12	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.5	1.47	1.35	4.32	111.24
2	1.15	1.51	1.42	4.08	117.65
3	1.35	1.50	1.47	4.32	111.11
4	1.4	1.47	1.5	4.37	109.84
5	1.45	1.40	1.29	4.14	115.94
6	1.35	1.39	1.33	4.07	117.94
7	1.2	1.41	1.41	4.02	119.40
8	1.25	1.50	1.38	4.13	116.22
Total Average	1.33	1.46	1.39	4.18	114.92

NO.11, 12	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.15	1.38	1.34	3.87	124.03
2	1.45	1.41	1.42	4.28	112.15
3	1.25	1.52	1.5	4.27	112.41
4	1.2	1.33	1.37	3.90	123.08
5	1.15	1.46	1.45	4.06	118.23
6	1.45	1.42	1.5	4.37	109.84
7	1.4	1.35	1.3	4.05	118.52
8	1.5	1.50	1.34	4.34	110.60
Total Average	1.32	1.42	1.40	4.14	116.11

NO.11, 12	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.1	1.50	1.43	4.03	119.11
2	1.5	1.42	1.5	4.42	108.60
3	1.45	1.32	1.34	4.11	116.79
4	1.35	1.57	1.32	4.24	113.21
5	1.45	1.45	1.38	4.28	112.15
6	1.5	1.34	1.49	4.33	110.85
7	1.2	1.28	1.5	3.98	120.60
8	1.25	1.47	1.45	4.17	115.11
Total Average	1.35	1.42	1.43	4.20	114.55

NO.11, 12	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.4	1.48	1.5	4.38	109.59
2	1.25	1.36	1.36	3.97	120.91
3	1.3	1.33	1.45	4.08	117.65
4	1.50	1.43	1.32	4.25	112.94
5	1.35	1.27	1.48	4.10	117.07
6	1.4	1.50	1.33	4.23	113.48
7	1.25	1.43	1.31	3.99	120.30
8	1.15	1.45	1.5	4.10	117.07
Total Average	1.33	1.41	1.41	4.14	116.13

NO.11, 12	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.25	1.30	1.4	3.95	121.52
2	1.30	1.25	1.45	4.00	120.00
3	1.50	1.32	1.5	4.32	111.11
4	1.40	1.45	1.32	4.17	115.11
5	1.25	1.34	1.31	3.90	123.08
6	1.20	1.44	1.4	4.04	118.81
7	1.15	1.32	1.37	3.84	125.00
8	1.50	1.29	1.5	4.29	111.89
Total Average	1.32	1.34	1.41	4.06	118.31

NO.11, 12	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.30	1.28	1.3	3.88	123.71
2	1.40	1.33	1.4	4.13	116.22
3	1.45	1.35	1.35	4.15	115.66
4	1.30	1.38	1.44	4.12	116.50
5	1.10	1.28	1.5	3.88	123.71
6	1.25	1.27	1.34	3.86	124.35
7	1.20	1.30	1.39	3.89	123.39
8	1.50	1.29	1.4	4.19	114.56
Total Average	1.31	1.31	1.39	4.01	119.76

NO.11, 12	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.20	1.32	1.44	3.96	121.21
2	1.15	1.30	1.35	3.80	126.32
3	1.35	1.28	1.38	4.01	119.70
4	1.40	1.25	1.35	4.00	120.00
5	1.50	1.29	1.46	4.25	112.94
6	1.15	1.35	1.42	3.92	122.45
7	1.35	1.38	1.37	4.10	117.07
8	1.20	1.30	1.41	3.91	122.76
Total Average	1.29	1.31	1.40	3.99	120.31

NO.11, 12	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.50	1.28	1.33	4.11	116.79
2	1.25	1.29	1.46	4.00	120.00
3	1.30	1.24	1.5	4.04	118.81
4	1.15	1.28	1.45	3.88	123.71
5	1.45	1.30	1.31	4.06	118.23
6	1.40	1.26	1.39	4.05	118.52
7	1.30	1.25	1.49	4.04	118.81
8	1.20	1.27	1.32	3.79	126.65
Total Average	1.32	1.27	1.41	4.00	120.19

NO.11, 12	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.45	1.25	1.49	4.19	114.56
2	1.35	1.29	1.36	4.00	120.00
3	1.20	1.29	1.32	3.81	125.98
4	1.25	1.24	1.31	3.80	126.32
5	1.15	1.26	1.46	3.87	124.03
6	1.30	1.28	1.4	3.98	120.60
7	1.40	1.25	1.5	4.15	115.66
8	1.30	1.23	1.3	3.83	125.33
Total Average	1.30	1.26	1.39	3.95	121.56

NO.11, 12	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	1.2	1.25	1.5	3.95	121.52
2	1.1	1.23	1.39	3.72	129.03
3	1.3	1.24	1.35	3.89	123.39
4	1.4	1.32	1.39	4.11	116.79
5	1.2	1.22	1.33	3.75	128.00
6	1.3	1.26	1.4	3.96	121.21
7	1.5	1.21	1.41	4.12	116.50
8	1.35	1.23	1.4	3.98	120.60
Total Average	1.29	1.25	1.40	3.94	122.13

NO.11, 12	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	1.33	1.46	1.39	4.18	114.92
November 2006	1.32	1.42	1.40	4.14	116.11
December 2006	1.35	1.42	1.43	4.20	114.55
Total Average	1.33	1.43	1.41	4.17	115.19

NO.11, 12	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	1.33	1.41	1.41	4.14	116.13
February 2007	1.32	1.34	1.41	4.06	118.31
March 2007	1.31	1.31	1.39	4.01	119.76
Total Average	1.32	1.35	1.40	4.07	118.07

NO.11, 12	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	1.29	1.31	1.40	3.99	120.31
May 2007	1.32	1.27	1.41	4.00	120.19
June 2007	1.30	1.26	1.39	3.95	121.56
July 2007	1.29	1.25	1.40	3.94	122.13
Total Average	1.30	1.27	1.40	3.97	121.05

NO.13, 14	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.76	13.15	3	20.91	22.96
2	4.65	13.24	2.7	20.59	23.31
3	4.44	13.25	3	20.69	23.20
4	4.68	13.52	2.8	21.00	22.86
5	4.32	13.10	2.9	20.32	23.62
6	4.25	13.50	3.2	20.95	22.91
7	4.55	13.12	3.1	20.77	23.11
8	4.37	13.11	3.2	20.68	23.21
Total Average	4.50	13.25	2.99	20.74	23.15

NO.13, 14	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.36	13.43	3	20.79	23.09
2	4.57	13.18	3.2	20.95	22.91
3	4.64	13.26	2.8	20.70	23.19
4	4.23	13.42	2.9	20.55	23.36
5	4.39	13.36	3	20.75	23.13
6	4.78	13.34	3	21.12	22.73
7	4.77	13.15	2.8	20.72	23.17
8	4.61	13.43	2.9	20.94	22.92
Total Average	4.54	13.32	2.95	20.82	23.06

NO.13, 14	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.27	13.34	2.9	20.51	23.40
2	4.74	13.50	3.1	21.34	22.49
3	4.62	13.22	2.8	20.64	23.26
4	4.59	13.19	3.2	20.98	22.88
5	4.41	13.46	2.9	20.77	23.11
6	4.48	13.31	3.2	20.99	22.87
7	4.55	13.21	3.1	20.86	23.01
8	4.63	13.43	2.9	20.96	22.90
Total Average	4.54	13.33	3.01	20.88	22.99

NO.13, 14	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.8	12.57	2.8	20.17	23.80
2	4.52	12.76	3	20.28	23.67
3	4.21	12.65	3	19.86	24.17
4	4.54	12.87	3.2	20.61	23.29
5	4.34	12.64	3.1	20.08	23.90
6	4.75	12.86	2.8	20.41	23.52
7	4.46	12.91	2.9	20.27	23.68
8	4.26	12.43	3	19.69	24.38
Total Average	4.49	12.71	2.98	20.17	23.80

NO.13, 14	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.76	12.84	3.1	20.70	23.19
2	4.56	12.91	2.8	20.27	23.68
3	4.25	12.57	2.8	19.62	24.46
4	4.32	12.60	3.2	20.12	23.86
5	4.44	12.53	3	19.97	24.04
6	4.80	12.44	2.9	20.14	23.83
7	4.41	12.76	2.9	20.07	23.92
8	4.53	12.71	3	20.24	23.72
Total Average	4.51	12.67	2.96	20.14	23.84

NO.13, 14	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.66	12.43	2.9	19.99	24.01
2	4.46	12.74	3	20.20	23.76
3	4.81	12.46	3.1	20.37	23.56
4	4.35	12.51	2.9	19.76	24.29
5	4.51	12.87	2.9	20.28	23.67
6	4.63	12.45	2.8	19.88	24.14
7	4.30	12.77	3.2	20.27	23.68
8	4.52	12.85	3.1	20.47	23.45
Total Average	4.53	12.64	2.99	20.15	23.82

NO.13, 14	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.32	12.41	2.9	19.63	24.45
2	4.33	12.55	3	19.88	24.14
3	4.52	12.49	3.2	20.21	23.75
4	4.74	12.37	2.8	19.91	24.11
5	4.53	12.47	3	20.00	24.00
6	4.81	12.34	3.1	20.25	23.70
7	4.34	12.22	2.8	19.36	24.79
8	4.29	12.57	2.9	19.76	24.29
Total Average	4.49	12.43	2.96	19.88	24.16

NO.13, 14	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.52	12.36	2.8	19.68	24.39
2	4.73	12.59	2.9	20.22	23.74
3	4.53	12.47	3	20.00	24.00
4	4.44	12.18	3.1	19.72	24.34
5	4.26	12.53	2.8	19.59	24.50
6	4.31	12.65	3.2	20.16	23.81
7	4.79	12.46	3	20.25	23.70
8	4.58	12.52	2.8	19.90	24.12
Total Average	4.52	12.47	2.95	19.94	24.08

NO.13, 14	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.57	12.56	3.2	20.33	23.61
2	4.25	12.43	2.8	19.48	24.64
3	4.69	12.34	3	20.03	23.96
4	4.34	12.54	3	19.88	24.14
5	4.52	12.14	2.9	19.56	24.54
6	4.53	12.43	2.9	19.86	24.17
7	4.85	12.33	2.8	19.98	24.02
8	4.31	12.18	3.1	19.59	24.50
Total Average	4.51	12.37	2.96	19.84	24.20

NO.13, 14	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.55	12.41	3	19.96	24.05
2	4.45	12.33	2.8	19.58	24.51
3	4.23	12.00	3	19.23	24.96
4	4.56	12.46	2.8	19.82	24.22
5	4.75	12.15	2.9	19.80	24.24
6	4.85	12.45	3	20.30	23.65
7	4.75	12.23	3.1	20.08	23.90
8	4.56	12.13	3.2	19.89	24.13
Total Average	4.59	12.27	2.98	19.83	24.21

NO.13, 14	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	4.50	13.25	2.99	20.74	23.15
November 2006	4.54	13.32	2.95	20.82	23.06
December 2006	4.54	13.33	3.01	20.88	22.99
Total Average	4.53	13.30	2.98	20.81	23.07

NO.13, 14	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	4.49	12.71	2.98	20.17	23.80
February 2007	4.51	12.67	2.96	20.14	23.84
March 2007	4.53	12.64	2.99	20.15	23.82
Total Average	4.51	12.67	2.98	20.16	23.82

NO.13, 14	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	4.49	12.43	2.96	19.88	24.16
May 2007	4.52	12.47	2.95	19.94	24.08
June 2007	4.51	12.37	2.96	19.84	24.20
July 2007	4.59	12.27	2.98	19.83	24.21
Total Average	4.53	12.38	2.96	19.87	24.16

NO.15-17	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.7	13.55	1.4	17.65	27.20
2	2.8	13.50	1.5	17.80	26.97
3	2.3	13.70	1.3	17.30	27.75
4	2.4	13.25	1.4	17.05	28.15
5	2.5	13.40	1.5	17.40	27.59
6	2.6	13.80	1.6	18.00	26.67
7	2.4	13.65	1.2	17.25	27.83
8	2.5	13.75	1.5	17.75	27.04
Total Average	2.53	13.58	1.43	17.53	27.40

NO.15-17	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.3	13.79	1.5	17.59	27.29
2	2.4	13.51	1.3	17.21	27.89
3	2.6	13.63	1.7	17.93	26.77
4	2.7	13.72	1.4	17.82	26.94
5	2.1	13.22	1.6	16.92	28.37
6	2.5	13.74	1.6	17.84	26.91
7	2.7	13.89	1.5	18.09	26.53
8	2.8	13.57	1.2	17.57	27.32
Total Average	2.51	13.63	1.48	17.62	27.25

NO.15-17	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.7	13.54	1.5	17.74	27.06
2	2.9	13.33	1.5	17.73	27.07
3	2.5	13.75	1.2	17.45	27.51
4	2.5	13.82	1.7	18.02	26.64
5	2.8	13.91	1.4	18.11	26.50
6	2.6	13.46	1.6	17.66	27.18
7	2.4	13.33	1.3	17.03	28.19
8	2.5	13.26	1.2	16.96	28.30
Total Average	2.61	13.55	1.43	17.59	27.31

NO.15-17	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.6	12.63	1.2	16.43	29.21
2	2.7	12.79	1.7	17.19	27.92
3	2.5	12.46	1.5	16.46	29.16
4	2.90	12.93	1.4	17.23	27.86
5	2.6	12.56	1.5	16.66	28.81
6	2.5	12.54	1.6	16.64	28.85
7	2.3	12.46	1.3	16.06	29.89
8	2.6	12.74	1.2	16.54	29.02
Total Average	2.59	12.64	1.43	16.65	28.84

NO.15-17	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.40	12.45	1.3	16.15	29.72
2	2.70	12.74	1.6	17.04	28.17
3	2.80	12.34	1.2	16.34	29.38
4	2.30	12.47	1.4	16.17	29.68
5	2.90	12.57	1.2	16.67	28.79
6	2.40	12.61	1.5	16.51	29.07
7	2.50	12.77	1.2	16.47	29.14
8	2.50	12.83	1.7	17.03	28.19
Total Average	2.56	12.60	1.39	16.55	29.02

NO.15-17	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.40	12.55	1.2	16.15	29.72
2	2.60	12.36	1.2	16.16	29.70
3	2.60	12.29	1.4	16.29	29.47
4	2.80	12.44	1.41	16.65	28.83
5	2.90	12.65	1.6	17.15	27.99
6	2.30	12.46	1.5	16.26	29.52
7	2.50	12.62	1.4	16.52	29.06
8	2.60	12.71	1.2	16.51	29.07
Total Average	2.59	12.51	1.36	16.46	29.17

NO.15-17	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.60	12.51	1.5	16.61	28.90
2	2.70	12.63	1.2	16.53	29.04
3	2.80	12.41	1.6	16.81	28.55
4	2.40	12.33	1.2	15.93	30.13
5	2.20	12.28	1.5	15.98	30.04
6	2.50	12.39	1.4	16.29	29.47
7	2.60	12.56	1.5	16.66	28.81
8	2.40	12.49	1.2	16.09	29.83
Total Average	2.53	12.45	1.39	16.36	29.35

NO.15-17	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.20	12.51	1.4	16.11	29.80
2	2.60	12.49	1.4	16.49	29.11
3	2.70	12.24	1.7	16.64	28.85
4	2.30	12.31	1	15.61	30.75
5	2.10	12.35	1.5	15.95	30.09
6	2.00	12.45	1.3	15.75	30.48
7	2.40	12.27	1.5	16.17	29.68
8	2.20	12.31	1.2	15.71	30.55
Total Average	2.31	12.37	1.38	16.05	29.91

NO.15-17	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.50	12.18	1.6	16.28	29.48
2	2.30	12.21	1.3	15.81	30.36
3	2.00	12.36	1.5	15.86	30.26
4	2.20	12.41	1.2	15.81	30.36
5	2.50	12.19	1.3	15.99	30.02
6	2.30	12.41	1.2	15.91	30.17
7	2.10	12.43	1.6	16.13	29.76
8	2.00	12.13	1.6	15.73	30.51
Total Average	2.24	12.29	1.41	15.94	30.12

NO.15-17	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.1	12.23	1.3	15.63	30.71
2	2.3	12.45	1.2	15.95	30.09
3	2	12.35	1.5	15.85	30.28
4	2.2	12.15	1.4	15.75	30.48
5	2.3	12.32	1.2	15.82	30.34
6	2.4	12.21	1.6	16.21	29.61
7	2.3	12.22	1.4	15.92	30.15
8	2.4	12.13	1.3	15.83	30.32
Total Average	2.25	12.26	1.36	15.87	30.25

NO.15-17	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	2.53	13.58	1.43	17.53	27.40
November 2006	2.51	13.63	1.48	17.62	27.25
December 2006	2.61	13.55	1.43	17.59	27.31
Total Average	2.55	13.59	1.44	17.58	27.32

NO.15-17	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	2.59	12.64	1.43	16.65	28.84
February 2007	2.56	12.60	1.39	16.55	29.02
March 2007	2.59	12.51	1.36	16.46	29.17
Total Average	2.58	12.58	1.39	16.55	29.01

NO.15-17	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.53	12.45	1.39	16.36	29.35
May 2007	2.31	12.37	1.38	16.05	29.91
June 2007	2.24	12.29	1.41	15.94	30.12
July 2007	2.25	12.26	1.36	15.87	30.25
Total Average	2.33	12.34	1.38	16.06	29.91

NO.18, 19	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.25	14.00	1.18	19.43	24.70
2	4.8	13.10	1.12	19.02	25.24
3	4.42	12.40	1.4	18.22	26.34
4	4.4	13.60	1.3	19.30	24.87
5	4.23	13.50	1.26	18.99	25.28
6	4.31	12.80	1.23	18.34	26.17
7	4.12	12.40	1.19	17.71	27.10
8	4.21	13.40	1.2	18.81	25.52
Total Average	4.34	13.15	1.24	18.73	25.65

NO.18, 19	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.43	12.50	1.2	18.13	26.48
2	4.76	14.00	1.3	20.06	23.93
3	4.26	13.50	1.16	18.92	25.37
4	4.68	13.20	1.19	19.07	25.17
5	4.32	12.90	1.26	18.48	25.97
6	4.55	12.10	1.24	17.89	26.83
7	4.71	12.00	1.3	18.01	26.65
8	4.82	13.60	1.2	19.62	24.46
Total Average	4.57	12.98	1.23	18.77	25.61

NO.18, 19	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.32	12.20	1.26	17.78	27.00
2	4.67	12.30	1.3	18.27	26.27
3	4.59	13.50	1.24	19.33	24.83
4	4.36	13.80	1.14	19.30	24.87
5	4.28	14.00	1.19	19.47	24.65
6	4.41	13.90	1.25	19.56	24.54
7	4.83	12.40	1.3	18.53	25.90
8	4.49	12.80	1.2	18.49	25.96
Total Average	4.49	13.11	1.24	18.84	25.50

NO.18, 19	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	4.7	12.90	1.12	18.72	25.64
2	4.36	13.50	1.3	19.16	25.05
3	4.28	13.80	1.27	19.35	24.81
4	4.81	12.10	1.25	18.16	26.43
5	4.95	12.70	1.3	18.95	25.33
6	4.23	12.50	1.19	17.92	26.79
7	4.55	13.20	1.1	18.85	25.46
8	4.31	13.60	1.23	19.14	25.08
Total Average	4.52	13.04	1.22	18.78	25.57

NO.18, 19	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.35	12.10	1.32	16.77	28.62
2	3.21	12.40	1.2	16.81	28.55
3	3.27	11.80	1.29	16.36	29.34
4	3.31	11.20	1.13	15.64	30.69
5	3.25	11.90	1.11	16.26	29.52
6	3.30	12.50	1.24	17.04	28.17
7	3.28	12.10	1.28	16.66	28.81
8	3.19	11.70	1.3	16.19	29.65
Total Average	3.27	11.96	1.23	16.47	29.17

NO.18, 19	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.30	12.50	1.1	16.90	28.40
2	3.14	12.90	1.31	17.35	27.67
3	3.19	11.50	1.24	15.93	30.13
4	3.18	12.10	1.29	16.57	28.97
5	3.32	11.40	1.3	16.02	29.96
6	3.30	11.80	1.13	16.23	29.57
7	3.27	12.30	1.19	16.76	28.64
8	3.25	12.80	1.22	17.27	27.79
Total Average	3.24	12.16	1.22	16.63	28.89

NO.18, 19	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.31	11.50	1.25	16.06	29.89
2	3.16	11.70	1.16	16.02	29.96
3	3.14	12.10	1.13	16.37	29.32
4	3.21	12.00	1.3	16.51	29.07
5	3.29	10.80	1.32	15.41	31.15
6	3.30	11.30	1.14	15.74	30.50
7	3.17	11.80	1.27	16.24	29.56
8	3.25	12.40	1.24	16.89	28.42
Total Average	3.23	11.70	1.23	16.16	29.73

NO.18, 19	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.12	10.90	1.3	15.32	31.33
2	3.30	12.80	1.23	17.33	27.70
3	3.32	12.40	1.191	16.91	28.38
4	3.12	11.60	1.21	15.93	30.13
5	3.16	11.90	1.28	16.34	29.38
6	3.19	11.30	1.3	15.79	30.40
7	3.21	10.90	1.1	15.21	31.56
8	3.27	11.80	1.17	16.24	29.56
Total Average	3.21	11.70	1.22	16.13	29.80

NO.18, 19	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.15	11.30	1.18	15.63	30.71
2	3.21	12.30	1.3	16.81	28.55
3	3.30	11.20	1.25	15.75	30.48
4	3.13	11.80	1.11	16.04	29.93
5	3.16	10.80	1.29	15.25	31.48
6	3.19	11.40	1.14	15.73	30.51
7	3.20	11.90	1.27	16.37	29.32
8	3.18	12.70	1.3	17.18	27.94
Total Average	3.19	11.68	1.23	16.10	29.86

NO.18, 19	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.21	11.50	1.18	15.89	30.21
2	3.12	10.70	1.16	14.98	32.04
3	3.32	11.20	1.3	15.82	30.34
4	3.23	12.20	1.2	16.63	28.86
5	3.15	11.20	1.23	15.58	30.81
6	3.19	12.80	1.15	17.14	28.00
7	3.11	12.40	1.25	16.76	28.64
8	3.18	11.30	1.3	15.78	30.42
Total Average	3.19	11.66	1.22	16.07	29.92

NO.18, 19	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	4.34	13.15	1.24	18.73	25.65
November 2006	4.57	12.98	1.23	18.77	25.61
December 2006	4.49	13.11	1.24	18.84	25.50
Total Average	4.47	13.08	1.23	18.78	25.59

NO.18, 19	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	4.52	13.04	1.22	18.78	25.57
February 2007	3.27	11.96	1.23	16.47	29.17
March 2007	3.24	12.16	1.22	16.63	28.89
Total Average	3.68	12.39	1.23	17.29	27.88

NO.18, 19	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	3.23	11.70	1.23	16.16	29.73
May 2007	3.21	11.70	1.22	16.13	29.80
June 2007	3.19	11.68	1.23	16.10	29.86
July 2007	3.19	11.66	1.22	16.07	29.92
Total Average	3.20	11.68	1.23	16.11	29.83

NO.20, 21	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.5	3.00	3.5	9.00	53.33
2	3	3.00	3.4	9.40	51.06
3	2.8	3.00	3.5	9.30	51.61
4	2.9	3.00	3.8	9.70	49.48
5	3	3.00	3.4	9.40	51.06
6	3.5	3.00	3.6	10.10	47.52
7	2.7	3.00	3.4	9.10	52.75
8	2.8	3.00	3.3	9.10	52.75
Total Average	2.90	3.00	3.49	9.39	51.20

NO.20, 21	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.7	3.00	3.2	8.90	53.93
2	2.9	3.00	3.3	9.20	52.17
3	3	3.00	3.7	9.70	49.48
4	3.5	3.00	3.9	10.40	46.15
5	2.5	3.00	3.5	9.00	53.33
6	2.7	3.00	3.4	9.10	52.75
7	2.7	3.00	3.3	9.00	53.33
8	2.9	3.00	3.7	9.60	50.00
Total Average	2.86	3.00	3.50	9.36	51.39

NO.20, 21	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.9	3.00	3.6	9.50	50.53
2	3	3.00	3.3	9.30	51.61
3	2.8	3.00	3.8	9.60	50.00
4	2.7	3.00	3.4	9.10	52.75
5	2.5	3.00	3.5	9.00	53.33
6	2.8	3.00	3.3	9.10	52.75
7	2.8	3.00	3.6	9.40	51.06
8	2.9	3.00	3.5	9.40	51.06
Total Average	2.80	3.00	3.50	9.30	51.64

NO.20, 21	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.6	3.00	3.5	9.10	52.75
2	2.5	3.00	3.2	8.70	55.17
3	2.4	3.00	3.8	9.20	52.17
4	2.70	3.00	3.3	9.00	53.33
5	2.8	3.00	3.5	9.30	51.61
6	2.6	3.00	3.4	9.00	53.33
7	2.7	3.00	3.8	9.50	50.53
8	2.5	3.00	3.6	9.10	52.75
Total Average	2.60	3.00	3.51	9.11	52.71

NO.20, 21	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.50	3.00	3.5	9.00	53.33
2	2.30	3.00	3.4	8.70	55.17
3	2.60	3.00	3.8	9.40	51.06
4	2.40	3.00	3.9	9.30	51.61
5	2.50	3.00	3.4	8.90	53.93
6	2.40	3.00	3.3	8.70	55.17
7	2.30	3.00	3.2	8.50	56.47
8	2.30	3.00	3.4	8.70	55.17
Total Average	2.41	3.00	3.49	8.90	53.99

NO.20, 21	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.30	3.00	3.4	8.70	55.17
2	2.50	3.00	3.9	9.40	51.06
3	2.30	3.00	3.5	8.80	54.55
4	2.40	3.00	3.2	8.60	55.81
5	2.60	3.00	3.6	9.20	52.17
6	2.20	3.00	3.5	8.70	55.17
7	2.10	3.00	3.7	8.80	54.55
8	2.50	3.00	3.3	8.80	54.55
Total Average	2.36	3.00	3.51	8.88	54.13

NO.20, 21	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.10	3.00	3.7	8.80	54.55
2	2.50	3.00	3.5	9.00	53.33
3	2.30	3.00	3.8	9.10	52.75
4	2.40	3.00	3	8.40	57.14
5	2.20	3.00	3.4	8.60	55.81
6	2.40	3.00	3.6	9.00	53.33
7	2.30	3.00	3.5	8.80	54.55
8	2.30	3.00	3.4	8.70	55.17
Total Average	2.31	3.00	3.49	8.80	54.58

NO.20, 21	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.50	3.00	3.2	8.70	55.17
2	2.30	3.00	3.5	8.80	54.55
3	2.40	3.00	3.6	9.00	53.33
4	2.20	3.00	3.4	8.60	55.81
5	2.20	3.00	3.8	9.00	53.33
6	2.00	3.00	3.7	8.70	55.17
7	2.40	3.00	3.5	8.90	53.93
8	2.10	3.00	3.4	8.50	56.47
Total Average	2.26	3.00	3.51	8.78	54.72

NO.20, 21	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.40	3.00	3.5	8.90	53.93
2	2.30	3.00	3.7	9.00	53.33
3	2.10	3.00	3.3	8.40	57.14
4	2.00	3.00	3.2	8.20	58.54
5	2.20	3.00	3.8	9.00	53.33
6	2.10	3.00	3.9	9.00	53.33
7	2.30	3.00	3.4	8.70	55.17
8	2.40	3.00	3.3	8.70	55.17
Total Average	2.23	3.00	3.51	8.74	54.99

NO.20, 21	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2	3.00	3.4	8.40	57.14
2	2.3	3.00	3.5	8.80	54.55
3	2.3	3.00	3.7	9.00	53.33
4	2.3	3.00	3.3	8.60	55.81
5	2.3	3.00	3.2	8.50	56.47
6	2	3.00	3.5	8.50	56.47
7	2.1	3.00	3.8	8.90	53.93
8	2.2	3.00	3.6	8.80	54.55
Total Average	2.19	3.00	3.50	8.69	55.28

NO.20, 21	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	2.90	3.00	3.49	9.39	51.20
November 2006	2.86	3.00	3.50	9.36	51.39
December 2006	2.80	3.00	3.50	9.30	51.64
Total Average	2.85	3.00	3.50	9.35	51.41

NO.20, 21	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	2.60	3.00	3.51	9.11	52.71
February 2007	2.41	3.00	3.49	8.90	53.99
March 2007	2.36	3.00	3.51	8.88	54.13
Total Average	2.46	3.00	3.50	8.96	53.61

NO.20, 21	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.31	3.00	3.49	8.80	54.58
May 2007	2.26	3.00	3.51	8.78	54.72
June 2007	2.23	3.00	3.51	8.74	54.99
July 2007	2.19	3.00	3.50	8.69	55.28
Total Average	2.25	3.00	3.50	8.75	54.89

NO.22, 23	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.3	2.20	2.9	8.40	57.14
2	3.2	2.20	3	8.40	57.14
3	3.4	2.20	2.85	8.45	56.80
4	3	2.20	2.9	8.10	59.26
5	3.2	2.20	2.85	8.25	58.18
6	3.5	2.20	2.9	8.60	55.81
7	3.1	2.20	2.85	8.15	58.90
8	3.2	2.20	3	8.40	57.14
Total Average	3.24	2.20	2.91	8.34	57.55

NO.22, 23	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3	2.20	2.75	7.95	60.38
2	3.5	2.20	2.8	8.50	56.47
3	3.3	2.20	2.95	8.45	56.80
4	3.2	2.20	3	8.40	57.14
5	3.5	2.20	2.75	8.45	56.80
6	3.4	2.20	2.85	8.45	56.80
7	3.1	2.20	2.9	8.20	58.54
8	3.1	2.20	2.9	8.20	58.54
Total Average	3.26	2.20	2.86	8.33	57.68

NO.22, 23	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.2	2.20	3	8.40	57.14
2	3.2	2.20	2.95	8.35	57.49
3	3.4	2.20	2.8	8.40	57.14
4	3.1	2.20	2.75	8.05	59.63
5	3.2	2.20	2.9	8.30	57.83
6	3.5	2.20	2.95	8.65	55.49
7	3.3	2.20	3	8.50	56.47
8	3.1	2.20	2.85	8.15	58.90
Total Average	3.25	2.20	2.90	8.35	57.51

NO.22, 23	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	3.1	2.20	2.95	8.25	58.18
2	3	2.20	2.8	8.00	60.00
3	2.9	2.20	2.9	8.00	60.00
4	3.20	2.20	2.9	8.30	57.83
5	3.2	2.20	3	8.40	57.14
6	3.1	2.20	2.75	8.05	59.63
7	3.5	2.20	2.9	8.60	55.81
8	3.2	2.20	2.8	8.20	58.54
Total Average	3.15	2.20	2.88	8.23	58.39

NO.22, 23	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.80	2.20	3	8.00	60.00
2	2.50	2.20	2.8	7.50	64.00
3	2.60	2.20	2.85	7.65	62.75
4	2.30	2.20	2.95	7.45	64.43
5	2.90	2.20	2.9	8.00	60.00
6	3.20	2.20	2.85	8.25	58.18
7	3.00	2.20	2.75	7.95	60.38
8	2.70	2.20	2.9	7.80	61.54
Total Average	2.75	2.20	2.88	7.83	61.41

NO.22, 23	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.60	2.20	2.9	7.70	62.34
2	2.40	2.20	2.8	7.40	64.86
3	2.20	2.20	2.9	7.30	65.75
4	2.50	2.20	3	7.70	62.34
5	2.60	2.20	3	7.80	61.54
6	2.80	2.20	2.75	7.75	61.94
7	2.90	2.20	2.85	7.95	60.38
8	2.60	2.20	2.95	7.75	61.94
Total Average	2.58	2.20	2.89	7.67	62.64

NO.22, 23	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.40	2.20	2.95	7.55	63.58
2	2.60	2.20	2.8	7.60	63.16
3	2.30	2.20	2.75	7.25	66.21
4	2.50	2.20	2.95	7.65	62.75
5	2.70	2.20	2.95	7.85	61.15
6	2.40	2.20	3	7.60	63.16
7	2.30	2.20	2.8	7.30	65.75
8	2.20	2.20	2.85	7.25	66.21
Total Average	2.43	2.20	2.88	7.51	63.99

NO.22, 23	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.50	2.20	2.75	7.45	64.43
2	2.30	2.20	2.9	7.40	64.86
3	2.40	2.20	2.9	7.50	64.00
4	2.30	2.20	3	7.50	64.00
5	2.20	2.20	2.85	7.25	66.21
6	2.40	2.20	2.85	7.45	64.43
7	2.20	2.20	2.75	7.15	67.13
8	2.60	2.20	2.95	7.75	61.94
Total Average	2.36	2.20	2.87	7.43	64.62

NO.22, 23	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.30	2.20	2.95	7.45	64.43
2	2.50	2.20	3	7.70	62.34
3	2.10	2.20	3	7.30	65.75
4	2.20	2.20	2.75	7.15	67.13
5	2.20	2.20	2.95	7.35	65.31
6	2.10	2.20	2.8	7.10	67.61
7	2.30	2.20	2.8	7.30	65.75
8	2.40	2.20	2.95	7.55	63.58
Total Average	2.26	2.20	2.90	7.36	65.24

NO.22, 23	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.4	2.20	2.75	7.35	65.31
2	2.3	2.20	2.9	7.40	64.86
3	2.1	2.20	2.8	7.10	67.61
4	2.3	2.20	2.75	7.25	66.21
5	2.3	2.20	3	7.50	64.00
6	2.2	2.20	2.9	7.30	65.75
7	2.3	2.20	2.9	7.40	64.86
8	2.1	2.20	2.85	7.15	67.13
Total Average	2.25	2.20	2.86	7.31	65.72

NO.22, 23	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	3.24	2.20	2.91	8.34	57.55
November 2006	3.26	2.20	2.86	8.33	57.68
December 2006	3.25	2.20	2.90	8.35	57.51
Total Average	3.25	2.20	2.89	8.34	57.58

NO.22, 23	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	3.15	2.20	2.88	8.23	58.39
February 2007	2.75	2.20	2.88	7.83	61.41
March 2007	2.58	2.20	2.89	7.67	62.64
Total Average	2.83	2.20	2.88	7.91	60.81

NO.22, 23	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.43	2.20	2.88	7.51	63.99
May 2007	2.36	2.20	2.87	7.43	64.62
June 2007	2.26	2.20	2.90	7.36	65.24
July 2007	2.25	2.20	2.86	7.31	65.72
Total Average	2.33	2.20	2.88	7.40	64.89

NO.24	October 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0	8.00	2.2	10.20	47.06
2	0	9.00	2.5	11.50	41.74
3	0	8.00	2.3	10.30	46.60
4	0	7.50	2.3	9.80	48.98
5	0	8.00	2	10.00	48.00
6	0	8.00	2.3	10.30	46.60
7	0	8.50	2.2	10.70	44.86
8	0	9.00	2.4	11.40	42.11
Total Average	0.00	8.25	2.28	10.53	45.74

NO.24	November 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0	7.50	2.5	10.00	48.00
2	0	8.00	2.5	10.50	45.71
3	0	9.00	2.2	11.20	42.86
4	0	7.50	2.4	9.90	48.48
5	0	8.50	2.3	10.80	44.44
6	0	9.00	2.4	11.40	42.11
7	0	9.00	2.5	11.50	41.74
8	0	8.50	2.2	10.70	44.86
Total Average	0.00	8.38	2.38	10.75	44.78

NO.24	December 2006				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0	8.50	2.5	11.00	43.64
2	0	8.50	2.3	10.80	44.44
3	0	8.00	2.4	10.40	46.15
4	0	9.00	2.5	11.50	41.74
5	0	7.50	2.3	9.80	48.98
6	0	8.00	2.5	10.50	45.71
7	0	8.00	2.3	10.30	46.60
8	0	9.00	2.4	11.40	42.11
Total Average	0.00	8.31	2.40	10.71	44.92

NO.24	January 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	0	9.00	2.5	11.50	41.74
2	0	8.00	2.4	10.40	46.15
3	0	8.00	2.3	10.30	46.60
4	0.00	7.50	2.5	10.00	48.00
5	0	9.00	2.3	11.30	42.48
6	0	8.50	2.5	11.00	43.64
7	0	7.50	2.3	9.80	48.98
8	0	8.50	2.2	10.70	44.86
Total Average	0.00	8.25	2.38	10.63	45.31

NO.24	February 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.00	4.00	2.1	8.10	59.26
2	2.10	4.50	2.2	8.80	54.55
3	2.20	5.00	2.5	9.70	49.48
4	2.20	5.00	2.3	9.50	50.53
5	2.00	4.50	2.2	8.70	55.17
6	2.10	4.50	2.1	8.70	55.17
7	2.10	5.00	2.2	9.30	51.61
8	2.00	4.50	2.3	8.80	54.55
Total Average	2.09	4.63	2.24	8.95	53.79

NO.24	March 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.10	4.50	2.2	8.80	54.55
2	2.20	4.50	2.3	9.00	53.33
3	2.00	5.00	2.4	9.40	51.06
4	2.10	4.00	2.5	8.60	55.81
5	2.10	4.50	2	8.60	55.81
6	2.20	5.00	2.4	9.60	50.00
7	2.00	4.50	2.3	8.80	54.55
8	2.10	4.00	2.2	8.30	57.83
Total Average	2.10	4.50	2.29	8.89	54.12

NO.24	April 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.20	4.00	2	8.20	58.54
2	2.20	5.00	2	9.20	52.17
3	2.00	4.00	2.5	8.50	56.47
4	2.00	5.00	2.3	9.30	51.61
5	2.10	4.50	2.5	9.10	52.75
6	2.20	4.50	2.3	9.00	53.33
7	2.00	5.00	2.2	9.20	52.17
8	2.10	5.00	2.4	9.50	50.53
Total Average	2.10	4.63	2.28	9.00	53.45

NO.24	May 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.10	4.50	2.5	9.10	52.75
2	2.20	4.00	2.4	8.60	55.81
3	2.10	4.00	2.5	8.60	55.81
4	2.20	5.00	2.1	9.30	51.61
5	2.00	4.50	2	8.50	56.47
6	2.00	5.00	2.2	9.20	52.17
7	2.00	4.00	2.2	8.20	58.54
8	2.10	4.50	2.3	8.90	53.93
Total Average	2.09	4.44	2.28	8.80	54.64

NO.24	June 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.00	4.00	2.4	8.40	57.14
2	2.10	4.50	2.3	8.90	53.93
3	2.20	5.00	2.5	9.70	49.48
4	2.10	5.00	2.1	9.20	52.17
5	2.00	4.50	2	8.50	56.47
6	2.00	4.50	2.1	8.60	55.81
7	2.10	4.00	2.2	8.30	57.83
8	2.20	4.00	2.4	8.60	55.81
Total Average	2.09	4.44	2.25	8.78	54.83

NO.24	July 2007				
Loop	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
1	2.1	4.00	2.5	8.60	55.81
2	2	4.50	2.3	8.80	54.55
3	2.2	4.50	2.3	9.00	53.33
4	2.2	4.00	2.5	8.70	55.17
5	2.1	5.00	2.4	9.50	50.53
6	2	4.00	2.1	8.10	59.26
7	2.1	4.50	2.1	8.70	55.17
8	2	4.50	2	8.50	56.47
Total Average	2.09	4.38	2.28	8.74	55.04

NO.24	Phase1				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
October 2006	0.00	8.25	2.28	10.53	45.74
November 2006	0.00	8.38	2.38	10.75	44.78
December 2006	0.00	8.31	2.40	10.71	44.92
Total Average	0.00	8.31	2.35	10.66	45.15

NO.24	Phase2				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
January 2007	0.00	8.25	2.38	10.63	45.31
February 2007	2.09	4.63	2.24	8.95	53.79
March 2007	2.10	4.50	2.29	8.89	54.12
Total Average	1.40	5.79	2.30	9.49	51.07

NO.24	Phase3				
Month	Setup time	Operation time	Transportation time	Total Time/Conga	Amount/8Hour
April 2007	2.10	4.63	2.28	9.00	53.45
May 2007	2.09	4.44	2.28	8.80	54.64
June 2007	2.09	4.44	2.25	8.78	54.83
July 2007	2.09	4.38	2.28	8.74	55.04
Total Average	2.09	4.47	2.27	8.83	54.49

APPENDIX B

STANDARD WORK INSTRUCTIONS

Conga Drum Work Instructions

Splitting	
Machine No.: 1	**Materials:** 36” Diameter Cutter
No. of workers 2	
Work Instruction 1. First worker feed work piece from the front 2. Second worker receive work piece and put on the pallet	
Remark: Machine setup should consider on thickness of work piece	

Plane	
Machine No.: 2, 3	**Materials:** Cutter
No. of workers 2	
Work Instruction 1. First worker feed work piece to machine 2 and receive work piece from machine 3, put on the pallet 2. Second worker receive work piece from machine 2 and put in machine 3	
Remark: Random inspection for thickness and finished surface	

Cutting End	
Machine No.: 4	**Materials:** Cutter
No. of workers 1	
Work Instruction 1. Put 2 pieces of wood on the machine 2. Push the work piece through the cutter 3. Put the finished work piece on the pallet	
Remark: Try to cut the defects on the surface	

Choosing Wood	
Tools: pallet	**Materials:**
No. of workers 1	
Work Instruction 1. Clarify defects and separated wood colour before gluing by eye inspection	
Remark: Defects wood is crack, bud	

Gluing	
Tools: Gluing machine	**Materials:** Glue (Use glue preparing manual)
No. of workers 2	
Work Instruction 1. First worker feed work piece through gluing machine 2. Second worker receive work piece and attach two pieces of wood together	
Remark: Using nice surface to the bottom piece	

Heating	
Machine No.: 5	**Materials:**
No. of workers 2	
Work Instruction 1. Put the gluing wood into the machine which head and end of wood is in line 2. Start the hydraulic press 3. Push stop hydraulic button for 20 minutes 4. Release the hydraulic press 5. Take work piece out of the machine and put on the pallet	
Remark: Only set the temperature at 120°C	

Angle Cutting	
Machine No.: 6, 7	**Materials:** Cutter
No. of workers 1/Machine	
Work Instruction 1. Put the work piece into machine which fit to the jig 2. Put start button 3. Put slide button to slide cutter via work piece 4. Put stop button to release clamp 5. Inspect work piece and put on the pallet	
Remark: Angle and size should random check	

Gluing and Forming Raw Shell	
Machine No.: 8	**Materials:** Glue
No. of workers 3	
Work Instruction 1. First worker choose and put group of work pieces (8-9 pieces) 2. Gluing by brush on the work piece 3. Second worker put work pieces into steel hoop 4. Third worker put other hoops and put on the clamp machine 5. Push start button to press all hoop 6. Push stop button to release work piece	
Remark: Leave finished work piece at least 6 hours	

Turning	
Machine No.: 9	**Materials:** Cutter and Sand Paper
No. of workers 1	
Work Instruction 1. Put the drum on the machine and make it tight 2. Push start button 1 to start rolling work piece 3. Push start button 2 to start turning by cutter 1 4. Push start button 3 to start turning by cutter 2 5. Push start button 4 to start turning by cutter 3 6. Start sanding by hand, sand paper number 150, 180, 220 7. Push stop button 8. Inspect size before take the drum from machine	
Remark: Inspect carefully every drum	

Head and Bottom Cut	
Machine No.: 10	**Materials:** Cutter
No. of workers 1	
Work Instruction 1. Put the drum on the machine 2. Push start button 3. Push stop button 4. Take work piece out of the machine	
Remark: Inspect carefully piece by piece	

Chamfer	
Machine No.: 11, 12	**Materials:** Router Cutter
No. of workers 1	
Work Instruction 1. Put the drum on router machine 2. Push start button 3. Push the work piece through cutter 4. Push stop button 5. Inspect defect after finished	
Remark: Inspect carefully piece by piece	

Thorn Filler	
Machine No.: 18, 19	**Materials:** Filler
No. of workers 1/machine	
Work Instruction 1. Put the drum on the machine and lock 2.Push start button and put filler on the drum 3.Put the filler two times more 4.Push stop button 5.Inspect and leave for 6 hours	
Remark: Inspect carefully piece by piece	

Sanding	
Machine No.: 13-17	**Materials:** Sandpaper
No. of workers 1/machine	
Work Instruction 1. Put the drum on the machine 2. Push start button 3. Sand with sandpaper number 150, 180, 220 in sequence 4. Push stop button 5. Inspect the surface	
Remark: Surface should don’t have any mark	

Painting	
Machine No.: 20, 21	**Materials:** Paint (Use colour manual)
No. of workers 2/machine	
Work Instruction 1. Put the drum on machine 2. Push start button 3. Push automatic painting start button 4. Push stop button 5. Carried to the safety room and inspect 6. Turn the drum to protect defect from colour ooze	
Remark: Finished drum should bright and clear on surface	

Drilling	
Machine No.: 22, 23	**Materials:** Screw
No. of workers 1/machine	
Work Instruction 1. Put the drum on machine and lock 2. Setup to the first position 3. Push start button for first drill 4. Move the drum to second position 5. Push start button for second drill 6. Push stop button 7. Inspect all holes	
Remark:	

Setup Drumhead	
Machine No.: 24	**Materials:** Rims and Drumhead
No. of workers 2	
Work Instruction 1.Put drumhead on the shell and insert lugs 2.Put the drum on the machine 3.Push start button 4.Fit all the lugs 5.Push stop button 6.Inspect the lugs and head	
Remark: Inspect carefully piece by piece	

Insert Bottom Rim	
Tools: Screwdriver and Rubber Hammer	**Materials:** Bottom Rim
No. of workers 1	
Work Instruction 1. Put the rim on the drum 2. Drill hole through the rim 3. Insert nail into the hole 4. Hammer softly 5. Inspect the nails	
Remark:	

Screen and Cleaning	
Tools: Screen and Rag	**Materials:** Wax, Sandpaper, Ink
No. of workers 2	
Work Instruction 1. Put the drum into row 2. Sanding drumhead by sandpaper 3. Put the screen on the drumhead 4. Put ink to the screen 5. Wax the drumhead	
Remark: After screening logo should see clearly	

Packing	
Tools:	**Materials:** Paper tape, Box
No. of workers 1-3	
Work Instruction 1.Preparing box 2.Wrap the drum by plastic bag 3.Put the drum and accessories into box 4. Tape the box	
Remark: All boxes should have barcode	

BIOGRAPHY

Mr. Ekapach Sithitriwat was born in Bangkok, 1981. He graduated from The University of Nottingham in 2004 with a B.Eng in Menufacturing Engineering and Management. After graduated, he started his carrier with PK Music as a internal consultant. He continues his study in Engineering Management and Manufacturing jointly offered by Chulalongkorn University and Warwick at the Regional Centre for Manufacturing System Engineering. He, presently, works for Siemens Limited Thailand as a project coordinator in office and facilities management.