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Saya **SITI SOLEHAH BINTI MOHD RUSADI (890421-02-5992)**

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Disahkan oleh:

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Alamat tetap:

G7-11 LORONG 50 TAMAN SRI TANJUNG, SUNGAI LAYAR, 08000 SUNGAI PETANI, KEDAH.

Tarikh: **5 JULAI 2013**

(TANDATANGAN PENYELIA)

NUR NAJMIYAH BINTI JAAFAR
PENSYARAH
FAKULTI KEJURUTERAAN PEMBUATAN
UNIVERSITI MALAYSIA PAHANG
26600 PEKAN
PAHANG DARUL MAKMUR
TEL: +609-424 5886 FAKS: 09-424 5888
HP: +6018-3255826
EMAIL: najmiyah@ump.edu.my

MDM. NUR NAJMIYAH BT JAAFAR

Tarikh: **5 JULAI 2013**

UNIVERSITY MALAYSIA PAHANG

CENTRE FOR GRADUATES STUDIES

We certify that the thesis entitled "DESIGN AND DEVELOPMENT OF SMED QUICK DIE CHANGE TOOLS FOR SMALL PRESS DIE" is written by SITI SOLEHAH BINTI MOHD RUSADI. We have examined the final copy of this thesis and in our opinion; it is fully adequate in terms of scope and quality for the award of degree of BACHELOR IN MANUFACTURING ENGINEERING. We herewith recommend that it be accepted in fulfillment of the requirement for the degree of Bachelor in Manufacturing Engineering.

Signature: _____

Name of supervisor: NUR NAJMIYAH BINTI JAAFAR
PENSYARAH
FAKULTI KEJURUTERAAN PEMBUATAN
UNIVERSITI MALAYSIA PAHANG
26600 PEKAN
PAHANG DARUL MAKMUR
TEL: +609-424 5886 FAKS: 09-424 5888
HP: +6018-3255826
EMAIL: najmiyah@ump.edu.my

Date: 05th July 2013

Signature: _____

Name of assessor: Kartina Johan

Date: 5th July 2013

DESIGN AND DEVELOPMENT OF SMED QUICK DIE CHANGE TOOLS FOR SMALL PRESS DIES

SITI SOLEHAH BINTI MOHD RUSADI

A project report submitted in partial fulfillment of the
requirements for the award of the degree of
Bachelor of Manufacturing Engineering

Faculty of Manufacturing Engineering
UNIVERSITY MALAYSIA PAHANG

JUNE 2013

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of manufacturing engineering.

Signature: _____

Name : _____

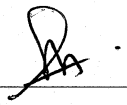
Date: _____

NOR NAJMIYAH BINTI JAAFAR
PENSYARAH
FAKULTI KEJURUTERAAN PEMBUATAN
UNIVERSITI MALAYSIA PAHANG
26600 PEKAN
PAHANG DARUL MAKMUR
TEL: +609-424 5886 FAKS: 09-424 5888
HP: +6018-3255828
EMAIL: najmiyah@ump.edu.my

05th July 2013

STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree is not concurrently submitted for award of the other degree.

Signature: 

Name : SITI SOLEHAH BT MOHD RUSADI

Date: 5 JULY 2013

To my beloved

parents, siblings and friends

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ABSTRACT

The single minute exchange of die is tools of lean production system and most commonly implement in batch production. This review article presents the design and development of single minute exchange of dies (SMED) quick die change tool for small press cut machine. The purpose is to eliminate the wastage of non value added activities involve during internal changeover time. Changeover time is the time elapsed between the last pieces in the run just completed until the first good piece from the process after the changeover. Also, to design and fabricate the intermediate jigs as to support the acceleration of changeover time. By this, it will reflect on the improvement of the production process by increasing the flexibility to meet the changing customer demands. This flexibility need to be achieved in any production plant for scheduling the production process and activity to be suite with the customer demand without ignoring the MUDA wastages. Designing a flexible improvement just to simplify the operator job during the setup time by follows the best ergonomic posture. All the implementation will give a result to the shorten changeover time in a single digit minutes which is the deduction of 75.9% changeover time. Plus, this project also gives a huge impact on man power usage in internal preparation from 2 man power to 1. The project will be conducted as follows to the steps of SMED directed by Sheigo Shingo.

ABSTRAK

Penukaran acuan secara cepat adalah salah satu alat di dalam sistem produksi yang lancar dan selalu digunakan didalam produksi berkumpulan. Artikel ini membentangkan tentang reka bentuk dan pembangunan sistem penukaran acuan secara cepat untuk alatan penukaran pada mesin tekan yang kecil. Tujuannya adalah untuk membuang semua perkara yang tidak mendatangkan untung dan merugikan masa semasa proses penukaran acuan sedang dilakukan. Masa penukaran ialah masa yang hilang bermula dari produk yang terakhir untuk model sehingga pengoperasian semula untuk menghasilkan produk yang terbaik selepas penukaran acuan yang baru. Tambahan lagi, mereka dan fabrikasi peralatan cepat bagi membantu pemecutan masa penukar acuan. Ini juga akan memberi peningkatan taraf pemprosesan apabila tahap fleksibelian meningkat untuk mencapai dan menepati perubahan permintaan pelangan adalah memainkan watak penting didalam permudahan proses penukaran acuan. Proses yang fleksibel perlu dicapai didalam semua operasi pengilanggan didalam sector penjadualan proses produksi dan jugak sebarang aktiviti yang bermanfaat tanpa melupakan pembaziran MUDA. Reka bentuk yang sesuai untuk penghasilan penambahbaikan yang fleksibel dengan memansuhkan serta memudahkan kerja Operator semasa penukaranacuan aktiviti berlangsung dengan mengambil kira aspek pergerakkan struktur badan yang ergonamik. Semua penambahbaikan ini akan member keputusan dengan pengurangan masa penukaran acuan secara cepat iaitu pemotongan masa penukaran sebanyak 75.9%. Di samping itu, iainya juga telah member impak yang besar terhadap pengunaan tenaga kerja dari 2 orang kepada 1 dalam penyediaan dalaman. Projek penambahbaikan proses penukaran ini akan dilaksanakan dengan mengunakan langkah SMED yang telah diperkenalkan oleh Sheigo Shingo.

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LIST OF ABBREVIATIONS

SMED	Single Minute Exchange of Die
LPS	Lean Production System
TPS	Toyota Production System
BPS	Batch Production System
JIT	Just-In-Time
SWCT	Standard Work Combination Table
WI	Work Instruction
SPO	Safety Point Operation
4M	Man, Machine, Method and Materials

CHAPTER 1

INTRODUCTION

1.0 BACKGROUND

The SMED (Single Minute Exchange of Die) is a one of the tools involve in Lean Production System (LPS). LPS is a clear vivid example of process innovation that focuses on the way to increase the manufacturing productivity at the lowest internal production cost. There are a lot of techniques used to support this LPS objective such as small-sized production lots, non-stock production, with strong focus on product and process quality and preventive maintenance. The new management techniques has been developed to take in account the limited production resources is on high demand as the product demand is shrinking and keep changing. Ideally, in order to get the best manufacturing efficiency is by brainy managing the production resources to improve the operational performance by quick respond to the competitive challenges.

The SMED is one of the methods that have been developed by Shingo (1985), in order to reduce and simplifying the setup time during changeover (Moreira). SMED is Japanese process innovation which is it can respond to the changes in customer demand and result in lead time processing parts reduction. Meanwhile, SMED also will eliminate all the waste of long changeover time and large lot sizes. Changeover time is the time elapse between the last good product and the first good for next run product. In a simple word, changeover time is the total time of setup time and start up time where the setup time is the time to

adjust and replace the machine part to run the next model of product. Meanwhile the start up time is the time to run the next model of product at the right production speed and quality.

In past, most of the firm faces with the cost of setup time that requires them such a huge expensive cost. Regarding to the problem faced, the firms decided to minimize the number of setup time in the production and creates a very large production lots. Eventually, this approach ware contributes to the highly stagnation of excessive inventory due to they produced more than customer needs. Contrary, today firms are forced to meet the appropriate terms of price, quality of product and delivery time to the customer with small lots size with differentiation of product. Improving the production processes it is necessary by analyzing all the value added activities involve and eliminate all non value added activities which makes the SMED methodology extraordinarily important.

The time necessary for the firms to implement their setup operations limits is depending to the customer demand and the company loading capacity to satisfy the customer needs. The production plant should be more flexible to face with the changing customer demand just to ensure they are producing the parts just in time with the customer needs. Regarding to the production plant flexibility, the quick changeover is needed to plays its role as to faster or slower the production lead time. The main problem in developing the flexibility of production plant is the wastages that have in setup time that lead to the production downtime. By right, the firm's challenge is to minimize the setup times and converts the idle setup time to the uptime production process, which can be accomplished following the SMED methodology. In order to implement this SMED and ensuring this improvement work as per plan, the setup operations need to be standardized, documented and displays to the workers as to ensure that production workers follow all of the parameters of that process.

1.1 PROBLEM STATEMENT

Traditionally, the setup process is involve the setup the dies or mould, trial the parts, inspect the new model product and adjustment of setup. Zooming to each of stages involve on this setup process, they create a lot of hidden wastages in between the stages of setup process. Firstly, the setup stages involve the changing dies of the previous model to the next model. All the jigs, fixtures and dies need to be set according to the standards parameter in order to ensure the next run product are smoothly produced. The part goes to the trial stages just to test whether the new model of product are meet to the standards quality. If there has any abnormalities due to wrong parameter set up after inspection, the trial parts will to the scrap or rework. The machine and dies need to undergo final adjustment just to repair the abnormalities that occur on the trial parts. Then they will test the part again to ensure the adjustment are correct or else the second trial part will be on hold to face with the rework process or scrap. This setup will be repeating till they get the part with the right quality dimensions and specification. See the figure 1.1 to be more understanding about the flow of traditional set up process.

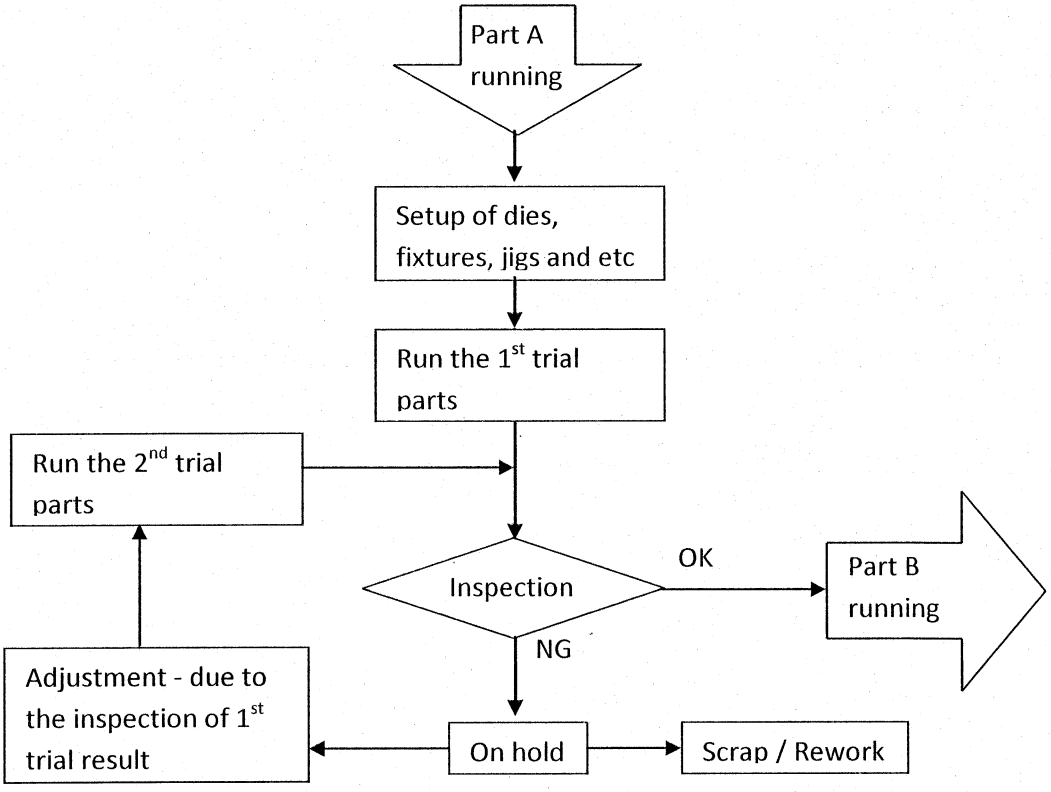


Figure 1.1: Flow of traditional setup process

Furthermore, by considering to the impact of this setup process to the production inventory, man power skills, production planning and control and the most seeing impact is to the cost that firm need to faced off. The setup process are most commonly exposed to the production downtime, to avoid the long production downtime, the management has been set to used large lot sizes to cut the frequent setup and downtime. The infrequent setup will be lead to the other bad impact to the man power skill, inventory and most probably give a huge impact to the cost.

Zooming to each impact, the large lot sizes will contribute to the infrequent set up and the infrequent set up will create a new bad environment to the operators, where they take that as advantages for them to make some other unnecessary activities, doing work will less determinant and less contribution.

Thus, it develops such a difficult set up process with highly risk in term of safety and low skill of man power due to lack of flexibility of different product.

Moreover, the large lot size will develop a high stagnation of inventory and this will lead to high cost of holding and set up cost. This cost will increase the overburden to the firm. Another impact to the production planning and control is the complex scheduling to plan the production and the man power.

1.3 OBJECTIVE

There are two objectives in this project which are:

1. To reduce the changeover time of the process.
2. To design and fabricate the intermediate jigs as to support the die change activity.

1.4 SCOPE OF THE PROJECT

The scope of the project is essential to ensure the research of the project is not running out of the research objective. There is the list of project scope:

1. The time need to complete this project is involve two semester starting from September 2012 until June 2013.
2. This project area is at Stamping machine that has been place in FKP laboratory.
3. This project should be covered only the internal setup activities (Uchi Dandoori). Which mean the value added element involves during the changeover dies.
4. The project will be implemented only for the stamping machine 60 and the dies involve is 'dog bone' die to be as an icon for the others dies standardization.

1.5 PROJECT THEME

The theme of this project is to design and development of SMED quick die change tools for small press dies by eliminating all the wastages of non value added activities involve during the changeover time from double digits minutes to single digits minute.

1.6 PROJECT CONCEPT

This project concept is to simplify the operator job during the changeover time by using the appropriate tools and methods to reduce the internal setup time. Other than that, the project also needs to facilitate the changeover activities by standard man power involvement with a clear and standardize work sequences. There are several step needed just to ensure this project are well done. Firstly, study the changeover process, it extremely needed to ensure and identify the problems involve in the changeover time. Next, classify and separate the external activities from the internal activities and all the wasteful activities. After the classification the type of activities involve, converts all the possible internal activities to external just to shorten the time consumption for setup time and start up time. Final touch in single minutes changeover dies is to streamline the setup process just to reduce the time. This streamlining process will involve all the implementation of any improvement tools, jigs, fixtures, dies standardization and others tools just to simplify the operators job to become simple and less risky.

1.7 PROJECT AIMS

This project aims to reduce about 75.9% of setup time which is reduction from the 13 minutes of changeover time to 3.16 minutes as per the best practice observe in the industry.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will discuss the definition of lean production system on how important the quick die change in developing the house of Toyota Production System (TPS). The role of quick die change also will be an impact on the other lean tools and some of that use the quick changeover as it pillar to support the tool itself such as Just-In-Time (JIT). This topic also going to touch about the batch production system where the lot sizing of production line plays the role to enhancing the production efficiency and quality. On the last section of this topic will be touch on the Single Minute Exchange of Dies (SMED) that will be covered through its definition and the internal and external preparation.

2.2 LEAN PRODUCTION SYSTEM

Lean production system (LPS) is the systematic approach of identifying and eliminating all wastages through the continuous improvement to pursuit the customer satisfaction (Taiichi Ohno). LPS is about to get the things right with lowest cost by eliminating wastages and implementing tens lean strategies which is eliminate waste, minimize inventory, maximize flow, pull production from customer demand, meet customer requirements, do it right the first time, empower workers, design for rapid changeover, partner with suppliers and

continuous improvement (Kruse). Ribeiro define the LPS as a systematic approach that specially focused on the identification and elimination of waste along the value added chain of product. As to make it simple, the term LPS can be defined as a creating more value for customer with lesser resources. In order to achieve this, lean thinking changes the focus of the management from optimizing separate technologies, vertical departments and vertical assets to optimizing the flow of product and services through entire value streams that flow horizontally across technologies, departments and assets to customers (David Upton). Usually, the company will avoid having non-value added activity in production due to the increasing the lead time of producing the part but not adding any worth to the customer perspective. Meanwhile, the company will focused on the way to add and increase the value added activities by eliminating all the wastages during the production time (Ouyang).

The lean concept is based on Toyota Production System (TPS) principle. TPS have the same objective with LPS which is to identify and eliminate the wasteful activities in manufacturing processes through education and involvement of the employee and top management. In the beginning of developing the TPS is just too focused on the improving the Toyota business. Nowadays, the LPS have been used to the whole companies to reducing the wasteful activities in the office business process and streamlining the operations as to pursuit their customer perspective and satisfying their needs. LPS is not only for Manufacture Company, it also can be used in many other industries such as logistic and supply chains, supermarkets, healthcare, banking, and transactional processes, sales and marketing. They choose LPS because the basis is so fundamental to business success and the foundation of a common sense that can be easily to apply and it does not need to be hi-tech to follows the concepts. Lean principles are all centered on process improvement which leads ultimately to improved efficiency which leads to higher profitability. The concept is simple but getting there is usually harder that one can imagine.

The house of TPS is used to visually describe the lean tools that can be a foundation for improvement and management in the ideal methods. The idea of TPS house is starting with the people inside the house who need shelter to survive. Ideally to build up the house, the most important this to develop the floor that acts as a foundation to the organization it does include the operational stability and total productive maintenance. After getting the tough foundation, built up the walls as a protection that covered Jidoka and Just-In-Time (JIT). Jidoka which is represent the built in quality product and how good the product before it pass to the customer. Everybody in this world willing to buy the product with good quality but less in price compared to have a good quality with the expensive price. JIT is demonstrating how fast the product will be arriving to the customer. The delivery must be at the right time, with right quantity and amount as per requested by the customer. The house is covered by the roof which is representing the customer satisfaction. The motto to satisfy the customer satisfaction is the best quality with the lowest price and shortest lead time. As the first impression while looking through the TPS house is the size, then the eyes are automatically drawn to the roof which means the targets of the TPS house. The figure below showed the TPS house and the lean tools that relates to each other.

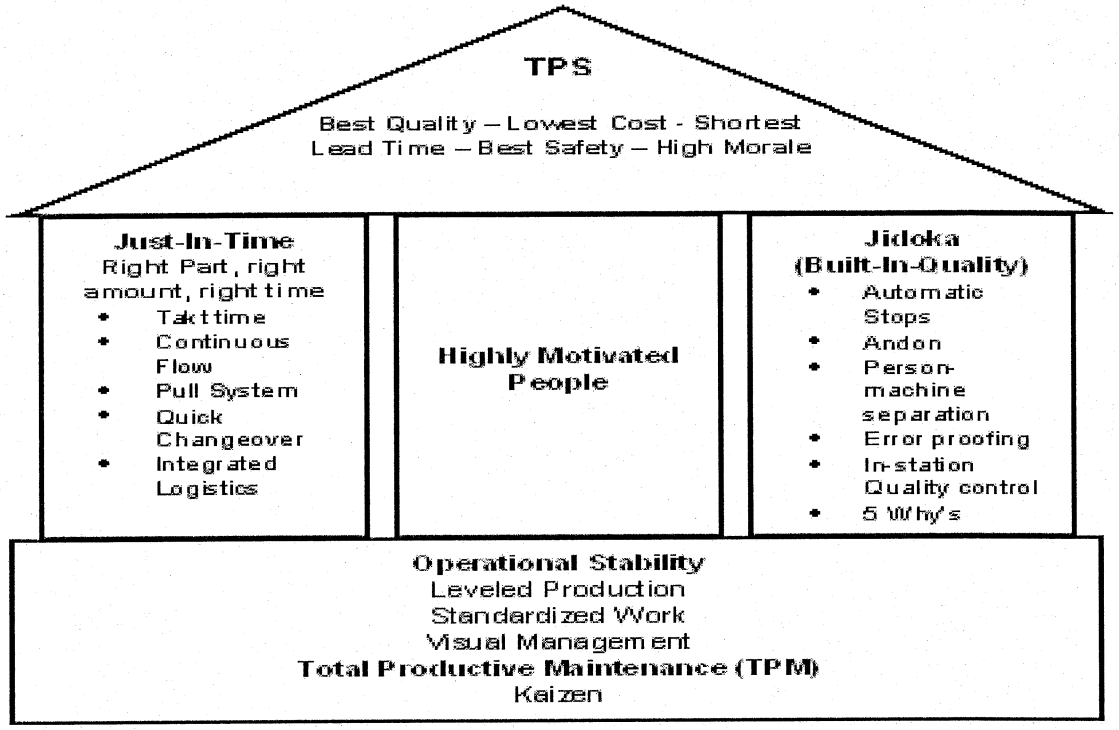


Figure 2.1: The house of TPS

Source: Prof. Paudzi module.

2.2.1 The impact of SMED to LPS

Referring to the house of TPS showed the SMED or quick changeover is representing the JIT which is it used to as a wall to protect the person in the organizations as to be save and secured. The key source of confusion is the flexibility that will be seen in the quick changeover correlation (David). The overall information management system need to be supportive methods and well establish techniques is the key to continuous improvement of manufacturing system (Weindahl). The aims to increase the production efficiency and support the best quality product, reduce the work-in-progress, stock level and unnecessary handling is improving the manufacturing or production flexibility, capability and responsiveness (7 SMED). The good frameworks and techniques that focuses on improving process and practices in quick changeover, Kaizen,

product quality and changeover performance (Hicks). Referring to the Kruse, one out the ten lean strategies is Rapid Changeover (Quick Changeover). Rapid changeover is one of the most important steps in lean transformation where it is a method used in rapid changeover to accelerate the continuous process improvement philosophy and generates dramatic results.

According to Girish, SMED is the key behind the success JIT concept due to the basis of SMED concept of seven wastes. SMED will reduce the time needed to exchange the dies by considering a saving in non-value added process time. Reducing the changeover time will lead to reducing numbers of inventories due to the shorter lead time of producing the parts. Hence, it will help the planner to be easy in scheduling the production process and converting the lot sizing from the large lot size to small lot size. The more frequent product changes and short product changeover is a key requirement to achieve success (Ribeiro). Referring to Prof. Paudzi module, SMED will link to one and another starting from the production, skill, inventory and cost. The production who implemented the SMED will feel the small lot size and the JIT system establish will be succeeded. Plus, the link of JIT and small lot size will create the high skill man power due to the frequently changeover activity and job empowerment. This will result to the production output and inventories. The inventory will be low which at the optimum number of inventory due to the producing parts depending to the customer demand which means there no overproduction waste created. As result, the linkage in between production, labor skill and inventory will reduce the internal cost, reducing in waste and reducing the cost of quality product. Refer to the figure below to verify the link of benefits implementing the SMED.

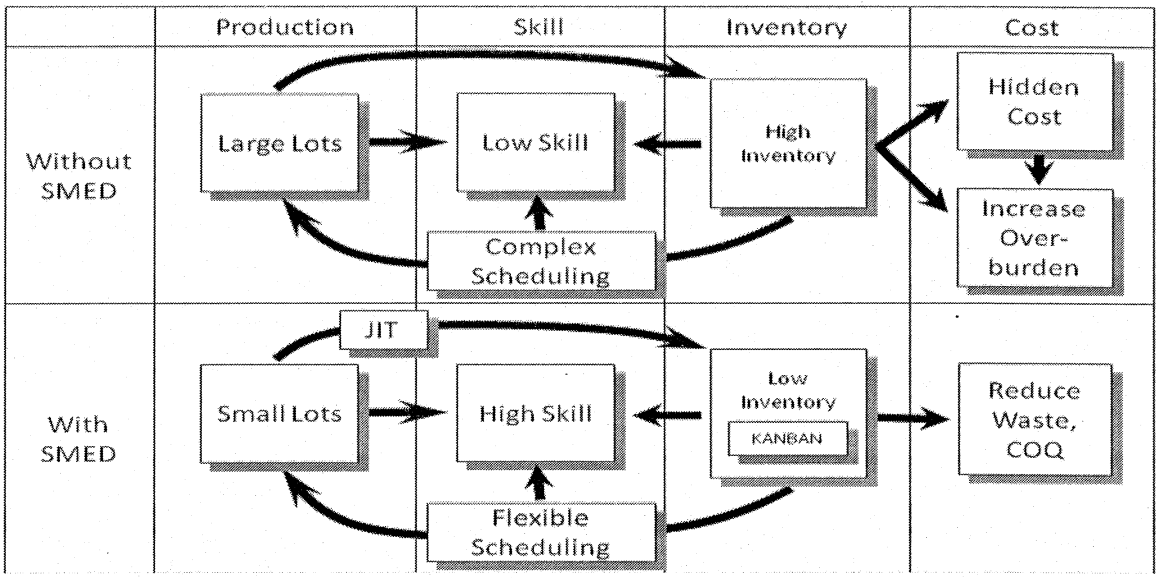


Figure 2.2: Relationship of SMED and LPS benefits

Source: Prof. Paudzi module.

2.3 BATCH PRODUCTION SYSTEM

Batch Production System (BPS) is a method used to produce or process any product in groups that are called batches, as opposed to a continuous production process, or a one-time production. It is suited for medium volume lot of same variety and usually has the repeated orders by the customers (Transtutors).

According to Prof. Paudzi module, there are several characteristic that can be used to identify the BPS which is the BPS is commonly used to meet the customer repeated orders and it is very suitable for moderate product variety so the production equipments used mostly are general purpose but can be meet the higher production volume. BPS needs medium or small production lot size to despite continuous order from the customer, as part variety is also medium and therefore switch over from one part to another is essential. This means, BPS needs quick changeover activities with specially designed jigs and fixtures to reduce the setup time and increase the production rate. Meanwhile, the skill labor

in BPS should be reasonably high for achieving the flexibility in arranging the production schedule that depends on customer demands.

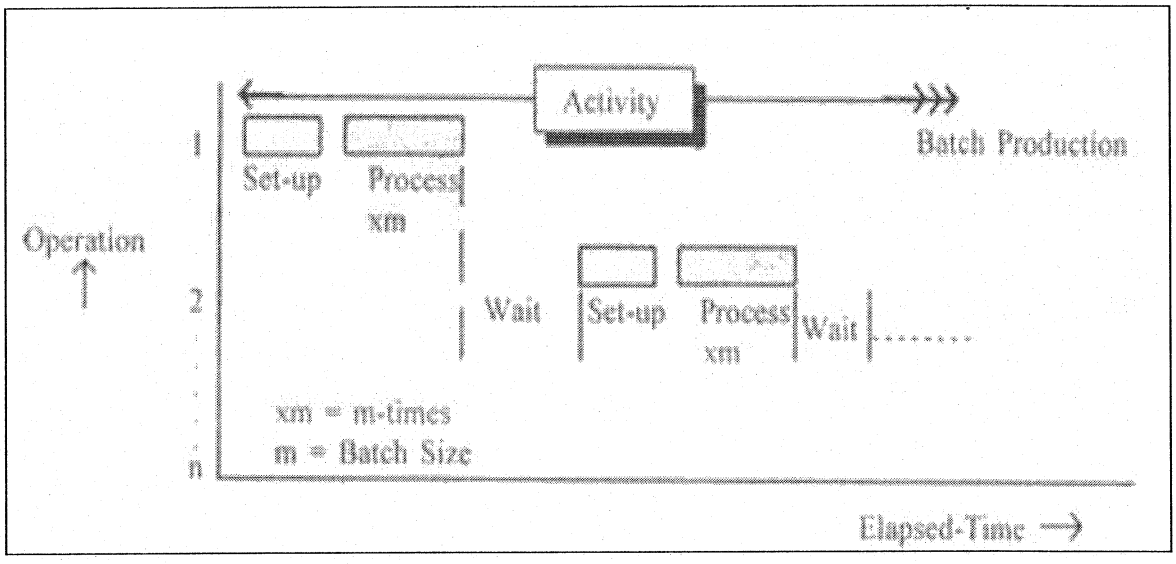


Figure 2.3: The activity of BPS

Source: Transtutor.com

The figures 2.3 demonstrate the activity of BPS that allows a numbers of changeovers in between the process. According to the figure, the longest changeover will lead to the longest time of downtime in production. To avoid this downtime, most of the company will create the large lot size of production to increase the uptime in production. However, this case will lead to the high inventory of finish good and the most important in processing more than the customers need. Actually, the BPS is a system of flexibility, agility and versatility that will produce a high volume and the low cost of product with good design production activities as well as in the supply chain management (Garavelli).

2.3.1 The effect of lot sizing in SMED

The efficiency and responsiveness of TPS methods will be showed by the lot size it used. The small lot size will result to the reduction setup costs. The economic lot size that implemented by the TPS can be calculated with the ratio of actual production time and the changeover time (Girish). As the bigger changeover time take place, the biggest lost in time will be reflect to the production time, thus the lot size will be increase in production and result in non economic lot sizing. By referring to the Economic Order Quality (EOQ), the relation between lot size and the setup time can be conclude as the larger the lot size, the lower production time per unit as referring to the breakup of the setup time into a larger number of units (Moreira).

The readers may refer to the work of Moustapha who investing the appropriate amounts of various resources such as the time, tooling, jigs, and fixtures in the various variety products to reduce the setup time and producing the small batch sizes. The lot sizing will effect relatively to the quality of the product and the inventories as reducing the inventory avoid the defect of product respectively through the time. In order to facilitate the daily production operation, small batch of production is needed for production lines within a short period of time as to follow the JIT requirements (Poon). Converting the lost size become smaller lot and inventories needs to follows with the reduction in setup time or changeover time (Moustapha). This will result to the best quality with lower waste and rework product where the relationship between quality, lot sizing and setup cost reduction will give a huge impact on the total relevant cost as per state on Ouyang's work. As result, the productivity and the process yield will be increases also the awareness of the causes and delays will be increased as per request by the JIT concepts with supply the highest flexibility.

2.4 SINGLE MINUTES EXCHANGE OF DIES

One of the vast building blocks of lean relates to quick changeover setup. The faster the changeover times, the lesser downtime of equipment. Downtime is the definition of the eight deadly waste of a manufacturing environment (fundamental of SMED, Shingo). Single Minutes Exchange of Dies can define as the minimum amount of time for changing the type of production activity from the last piece of previous production to the first piece product produce by the subsequent lot (Shingo and Moreira). Other than that also classify the SMED as the manufacturing system changeover which is measure by the performance of exchanging the dies from one product to the next run on the given manufacturing line and it is depending to how people cope with their work and how they amenable with the hardware for changed over with respect to the time (Micheal). From the author scope, SMED is the systematic approach of reducing the changeover time in the range of 1 to 9 minutes starting from the last piece of product to the first piece of good quality product. In order to achieve the successful SMED system, the correlation between workers who work with the area, methods used and the intermediate jig and tools is required to give a good performance.

SMED principles can be used and applied in almost any operation or process at any industrial unit for any machines. It was developed to improve die and machine tool setups. The goal of SMED is to reduce the setup time to within minutes. Depending on the process, setup within minutes may be very difficult, but in most cases, if the SMED principles are followed, drastic reductions in setup time can be obtained. The process of creating or developing the SMED is follows the DMAIC which is stand for Define, Measure, Analyze, Improve and Control cycle (Jones).

The key to develop a SMED system is depending on four elements which is taken by Goubergen who explore and test the SMED method on 60 changeover project in 10 years at difference industries. The keys are motivation, organization,

technical aspect and methods. The technical aspect is focusing to the jigs and tools that have been choose to speed up the setup time. The organization is needed to support the works on organizing the system to be smooth and support the methods to be used as to tells the operators about the step and job standard. These three elements need to be stabilizing by using the motivation elements as to motivate the operators on doing well during changeover time and determinant. It needs an extra support with training activity. The figure below illustrates the house of quality setup elements.

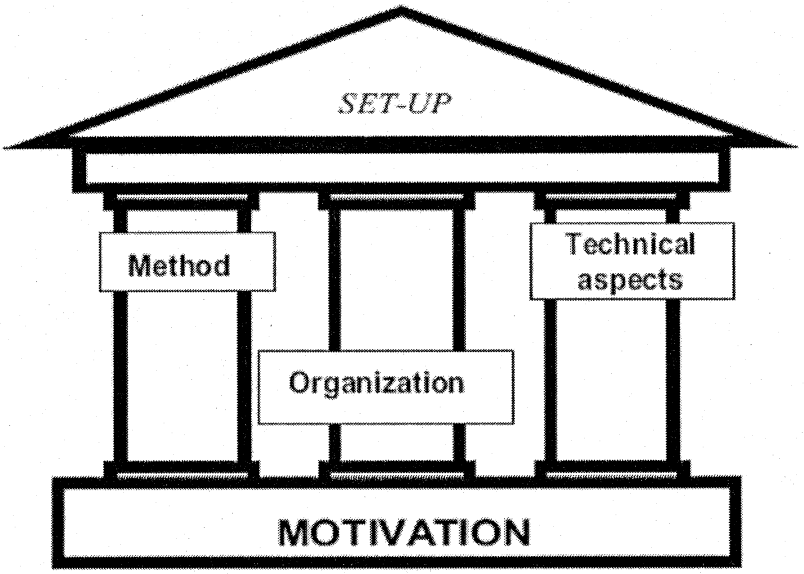


Figure 2.4: House of quality setup elements
Source: Gourbergen

The basis SMED methodology is consist four steps which introduce by the Shingo in a few decades ago. It is cover the four phase that cover all the implemented SMED system which is study the current process, separate the internal and external process, converting the internal and external, and streamlining all the setup process (Shingo, Rebiero, Moreira and Prof. Paudzi module). This method is extremely same to the Kruse that define the methods in

the other words but simply explain the means with Shingo concepts. Kruse said there are four stages to implement the rapid changeover which is scanning, planning, and workshop and sustain. There are two words that describe each other. At the first step, the scanning brings the massage to study the current process with looking and zooming towards the possibility of improvement and wastages. Then the planning stage describe after the study process, the any non value added activities and the wastages will be separated and plan to eliminated by any means. The process aims to deduce the changeover time by creating the vision for workshop process and define the boundaries involve in between internal and external process. The workshop stage covers the technical stage which is cover to analyze the data in planning stage and to implement the improvement. The last stage is sustain which is to complete all the remaining workshop stage and to trained the people on how to work with the new SMED system and evaluate the system to be success. In most of the SMED project, there are rarely result in less than 50% reduction in setup time however it will give the result as much as 80% to 90% (Jones).

According to Goubergen, the Shingo methods to implement the SMED is the simple and easy to follow with moderate investment but give the impressive result where it will cut the reduction time up to 90%. Most of the company will save a billion dollars after implementing the SMED.

2.4.1 Internal and external preparation

Continuing the SMED methodology approach, setup time or changeover time will be divided into categories or some say types, internal preparation and external preparation (Michael Reik). The internal preparation can be defined as the activity that can be executed while the process is stopped (Rebeiro). This on-line activity only can be performed while the machine down and the production is stop to run the next model (Goubergen). Meanwhile the external preparation is the activity happened while the machine and equipment is still running the

process (Girish and Rebeiro). This external activity can be performed before or after the changeover time take place (Goubergen). Both internal and external activity helps each other in order to speed up the changeover time and enhancing the production efficiency (McIntosh). The internal activity is the counting time for production downtime if it takes too long in setup and startup time (Wrye). Meanwhile the external activity is used to support the internal by preparing the equipments need and supplying at the right time with the right tools and jigs (Prof. Paudzi module).

If the activities of external and internal preparation are not separated, the time taken to changeover just based on jigs or tools of quick release dies just only give the result 5% reduction in changeover time (Jones and Shiego Shingo). Ideally, the first step on reducing the changeover time is by critically thinking on how to eliminate the adjustment and trial run which it takes almost 45% of changeover time. This will relates on how to set the positioning of the parts and makes the parameter setting faster than before. This will cover 20% of reduction of time. The important thing in dividing these two preparation activities is to accelerate 25% of changeover time by setting the external parts and currier before or after the changeover time started (Prof. Paudzi module). However, according to his module, using the quick release die jig will reduce the setup time up to 10%.

From the author perspective, using the intermediate jigs are necessary as to accelerate the changeover time, the methods of implementation and installation the intermediate jigs is depends on us. According to article written by Malcom Jones who learned the SMED system through Shiego Shingo, the SMED system is not necessary to used high technology jigs to rise up the setup time. The most important part the methods and the arrangement of works. Therefore, the reduction setup time for using the quick release dies equipments is depends on the combination of methods, and the jigs itself whether the jigs can be simplifity the operators job or not. This will result in range of reduction setup time in 5% to 10% or more. Refer to the table 2.1 below for zooming to the percentage of

reduction setup time and organizing to focus on which part to give the high priority.

Operation	Reduction setup time (%)	Preparation
Preparation for necessary items (before and after) Example: checking dies, jigs, cleaning, new raw material & etc.	25%	External
Exchanging part 1: removing blades, jigs and mounting	10%	Internal
Positioning part 1: centering, setting parameter & dimensioning	20%	Internal
Trial run and final adjustment	45%	NVA

Table 2.1: Operation, reduction setup time and type of preparation

Source: Prof. Paudzi module

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this topic it mainly discusses about the methods and the development of this project. This chapter covered about the SMED methodology and the techniques used as well as the design of changeover concept. The best way to describe the methodology and the boundaries of this project is by using the flow chart and the project milestone (refer to the Appendix A for project milestone).

3.2 PROJECT FLOW DIAGRAMS

This flow diagram is based on Shingo basic step on implementing the SMED. It consist a four basic stage to cover which is study the current process, separate the internal activities and the external activities, converting internal to external activities and streamlining the setup process. Each stage will be closely explained based on Shingo's techniques. Refer to the figure 3.1 for introducing on how the project going to conducted.

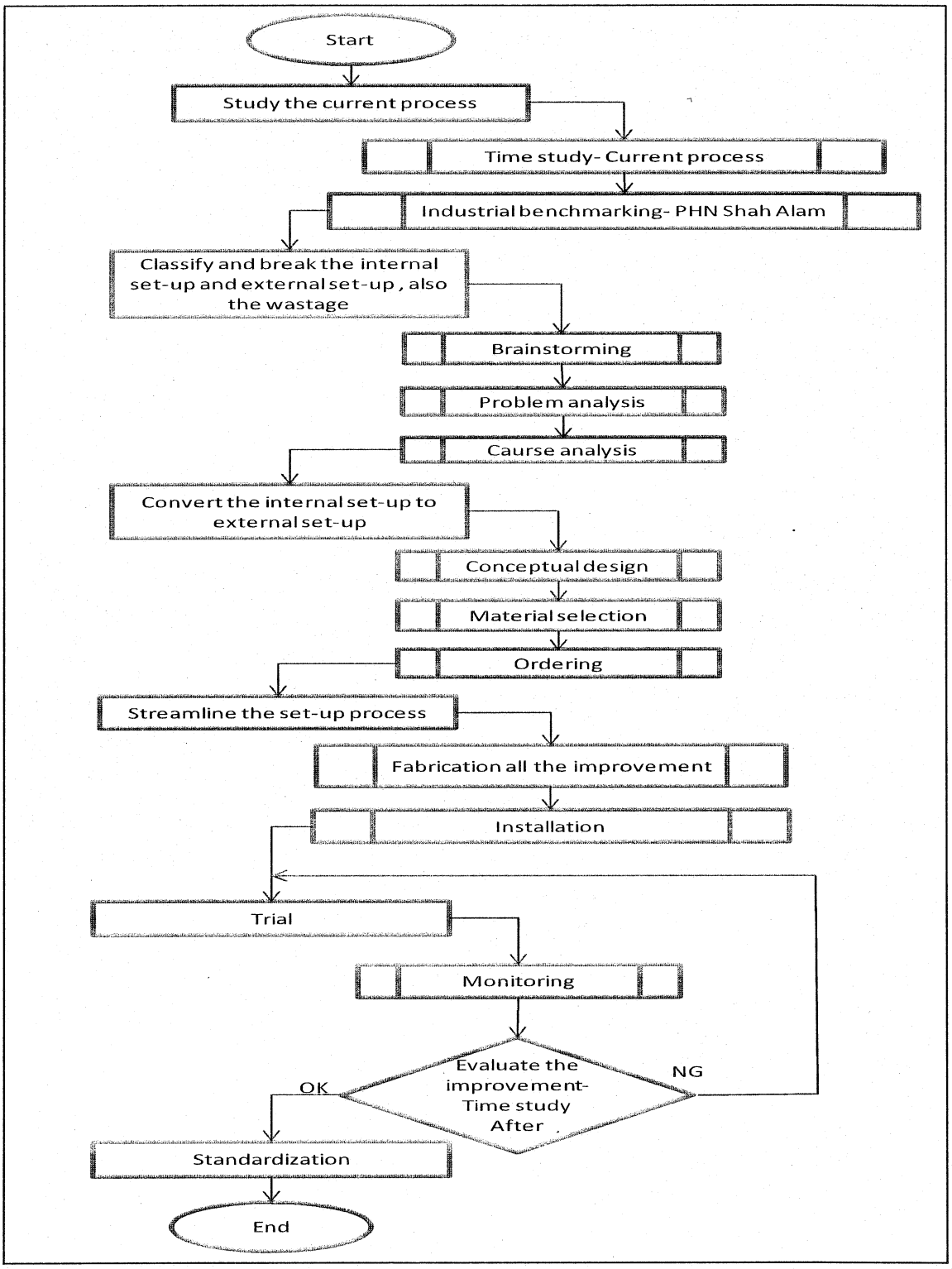


Figure 3.1: Project flow diagrams

3.3 STAGES OF SMED

3.3.1 Stage 1: Study the current process

3.3.1.1 Time study

The study for the current changeover process is carried out through the time study of each changeover activities. The time study is a business efficiency that combining the time and motion study of a specific work. It is a tried and tested method of work measurement for setting basic times and hence standard times for carrying out specified work. Time study is used to study the motion of the operator's job to deal mainly with the labor cost (Pigage and Tucker). If there have any unnecessary motion and time, it will cost to the company to pay more for labor cost but result in less output in productivity. Therefore, study the current process by using time study as tools is a good approach to scan the wastage in changeover process.

As the best practice in industry, the time study is carried out by taking the video of the process at least 5 cycle which means, 5 times of changeover activity. Getting the 5 time of the changeover process is to get the most reliable time of current setup and start up time. Referring through the Appendix B1, B2 and B3 illustrates the time study of current process of changeover dies for operator 1 and operator 2. In Appendix B1, it show the Yamazumi chart for current process that show the motion and time for man power involve during the process. In Appendix B2, it shows the Standard Work Combination Table (SWCT) for operator 1 meanwhile Appendix B3, show the SWCT for operator 2. This SWCT will show the handling time which is the job that done by the human, the machine time which is the job that done by the machine, waiting time which how much time that operator wait for the other process and the walking time which is the time taken for operator to walk from one point to another point. Simply say, this SWCT will visualize to us which part and at what time the non value added happen and how much time consume for it to happen.

3.3.1.2 Industrial benchmarking

Starting the project of changeover only by getting the theory of the important quick changeover dies is not enough. The good approach to looking through is by visually experience the quick changeover activity on the methods did the industrial used, the value added motion and activities, the tools and jigs that they used and how they standardize the SMED system. PHN Sdn.Bhd has been choosing as the idol of this quick changeover project. Ideally the PHN can do the changeover activity in 179sec including with the start up time. Thus, this project are aim to get the changeover time in just the same level of PHN or less than 179sec. By using SWCT as a tool to analyze the SMED activity in PHN, the Appendix C wills tells us the clear value added activity that they implemented.

3.3.2 Stage 2: Separating the internal and external preparation.

3.3.2.1 Brainstorming

In the stage two to implement the SMED system, the clear operation involve during the changeover process is needed. This is because, it used to separating both internal and external process so that the changeover process will cut the cost of time consumption. The first step of brainstorming is focused on separating the activities to its type. Internal preparation is the elements covered while the production stopped, and the rest is external preparation (Malcolm Jones). Check sheet is used as a tool to list down all the activity involve of each operators, the time used to do the operation, the type of preparation whether internal or external and the non value added activity. Refer to the Appendix D to see the SMED check sheet.

3.3.2.2 Problem and course analysis

The problem analysis has been carried out by using SMED operation check list. This check list contains the team required for setup and operation, the tools needed, the parts needed, the Standard Operating Procedure (SOP) to follow, the duration time for external preparation and internal preparation, the problem and action section, the suggested improvement, and remarks. The purpose of using this kind of check sheet is to greatly define the time requirement of each preparation, the problem face with providing the suggested action taken for the improvement. Furthermore, according to Shingo, distinguishing the setup preparation between internal and external is the key to success in implementing SMED. The proper preparation and transportation while machine is still running will reduce the time for internal setup. Refer to the Appendix E to see the SMED operation check list.

After analyzing the problem, the course of analysis need to be taken to find out the possible root course based on 4M which is Man, Machine, Material and Methods. The Man or Manpower section is to find the causes that can be attributed to the people working on the process while the Machine section is to find out the causes due to the machines or the equipment in the process. The potential causes due to materials used such as the waste of material or the cost of materials will be find out in the Material section. As the changeover is the process so it need the methods on how to operate the process of changeover between two dies. In the Methods section, it really need to find out what is it about how we conduct the operation that can cause the effects that we trying to solve. All these four section M will be brainstorm the cause and effecting factors by using Ishikawa diagram or the common name is Course and Effects diagram. The Ishikawa diagram is an effective tool to visualize the cause and effect and thus analyze data and give the way towards a solution to a problem. The figure 3.2 below is the course and effect diagram that used to analyze this problem.

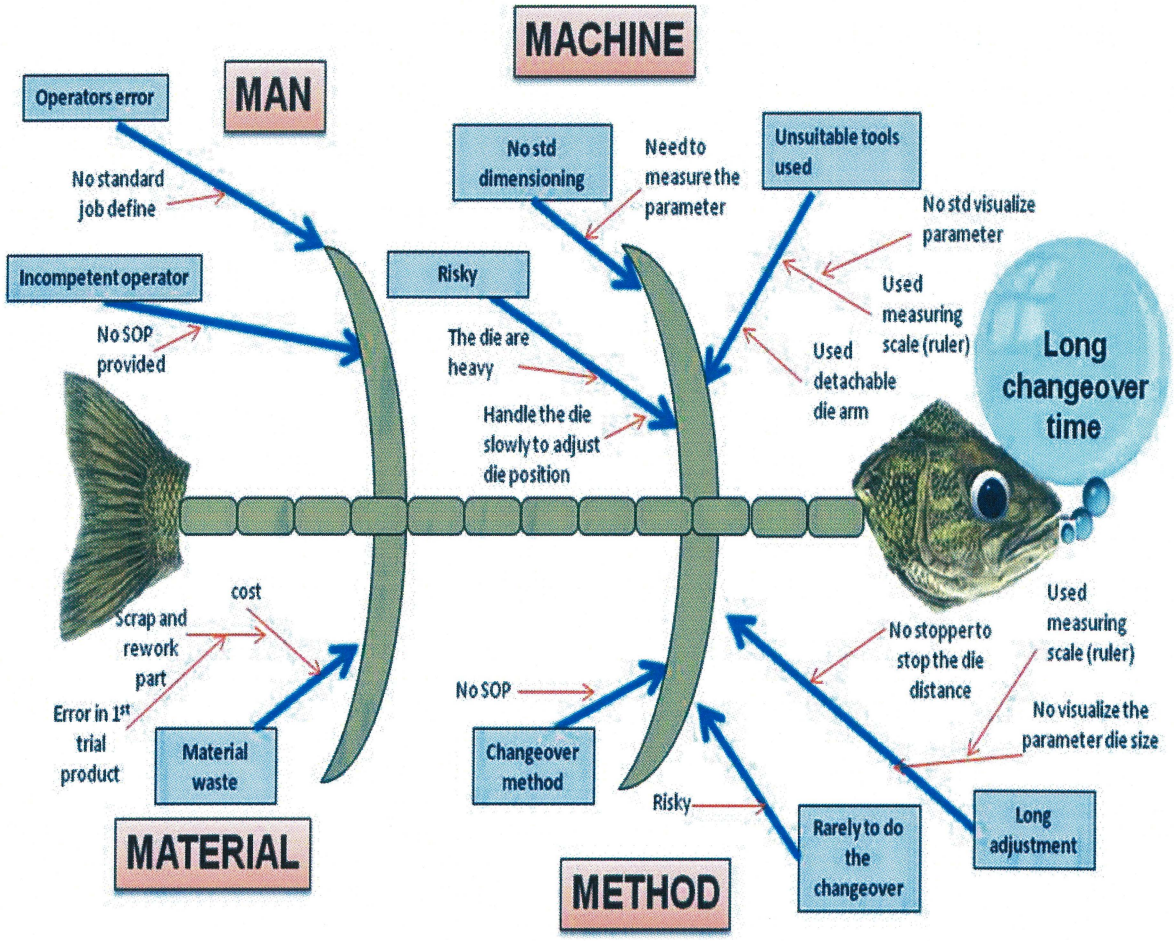


Figure 3.2: Course and effects diagram

Regarding to the cause and effects diagram at above, the analysis and observation have been done to come out with the current result analysis. The factors are classified according to the section. For Man, the possible cause is there have no standard job and there has no SOP provided as to guide the incompetent operators for doing the changeover activity. This is because, the operator are not clear with the step of changeover process and lead to the inconsistency in time result to the setup time.

Another factor is machine; there are more possible courses that lead to the machine and methods. The process is quite risky due to infrequently running the changeover activity. The safety issues while handling the dies moving is slightly neglected. The operator need to handle the die slowly and securely to ensure the die are not falling down and hit their foot also their fingers not to slip towards the die base. Using the appropriate tool and jigs is probably important, based on the observation, the operators are using the ruler to measure the shut height and the distance between the die and machine for ensuring the die have been place centre to the machine and clamper. However, using ruler during the changeover activity is obviously not practical. The impact of using the inappropriate tools will lead to the courses such as adjustment of the die position to the clamper.

The last but not least is the material factor; material factor is obviously effects to the cost. After the setup time is done, the startup time need to take place to run the next part and the first part will undergo to the trial section in order to ensure that the changeover are perfectly done and producing the output according to the quality specification. However, if the first part faces to the quality problems such as the dimension of the part are out of the quality spec, that parts will be on hold for another action by the quality inspector decision whether the part become scrap or can do a rework. Either rework or scrap both will create another cost of production. As a result, the changeover problems are very risky and it needs a treatment to solve it.

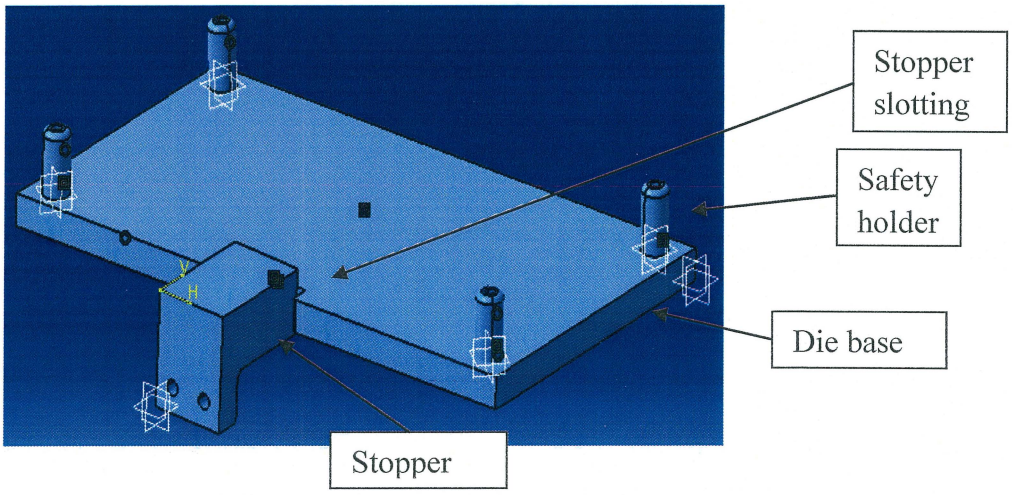
3.3.3 Stage 3: Convert the internal setup to external setup

Converting the internal setup to external setup need to be done by follows three steps in action which is preparing the condition operation setup, standardizing the essential functions and designing the intermediate tool and jigs. The first part is preparing the condition operation setup which is delegating all the external preparation to the team as it is out of project scope. This project only covers the internal preparation. All the activities involving the external preparation is clearly define with the estimation time about when to start the

external preparation also being stated. The cooperation between internal and external preparation project are really needed just to ensure the SMED system are success. Second and the third step will be covered in conceptual design sub-topic.

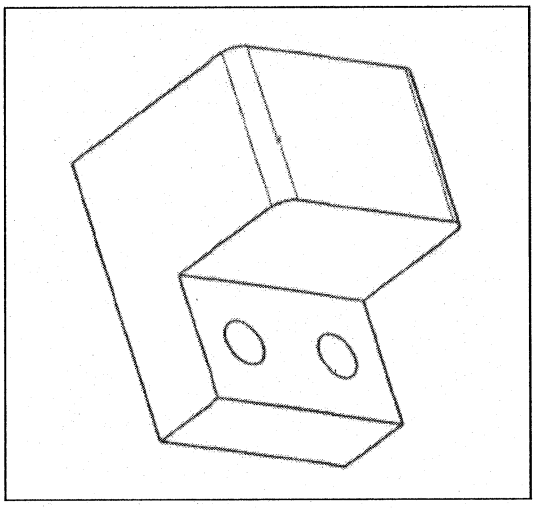
3.3.3.1 Conceptual design

This sub-topic will be covered the standardizing the essential function and the designing intermediate jigs. The purposed of standardizing the functional point is way to eliminate the adjustment and other non value added activity. There are two standardizing process that need to be covered which is the die standard and the visualization of the shut height of the dies. First, die standard are necessary need to standardize due to each of the die have their own parameter that might be differ to each other. So, as the aim of the changeover activity is to eliminate the adjustment so each of the dies need to be standardizing for its base. The figure below show the die base standardization with adding the safety holder as to ensure the safety issue among the operators to handle the dies and slotting for stopper place to eliminate adjustment of between the dies, machine centralization and the clamper.



Die modification with safety holder and stopper

Secondly, design the stopper as to stop the die in place that centre to the machine and clamper. The purpose of installing the stopper as jigs is to eliminate the adjustment of the die place and it is used to faster and easier alignment. The figure below showed the stopper design to be match with the stopper slotting in the die standardization.

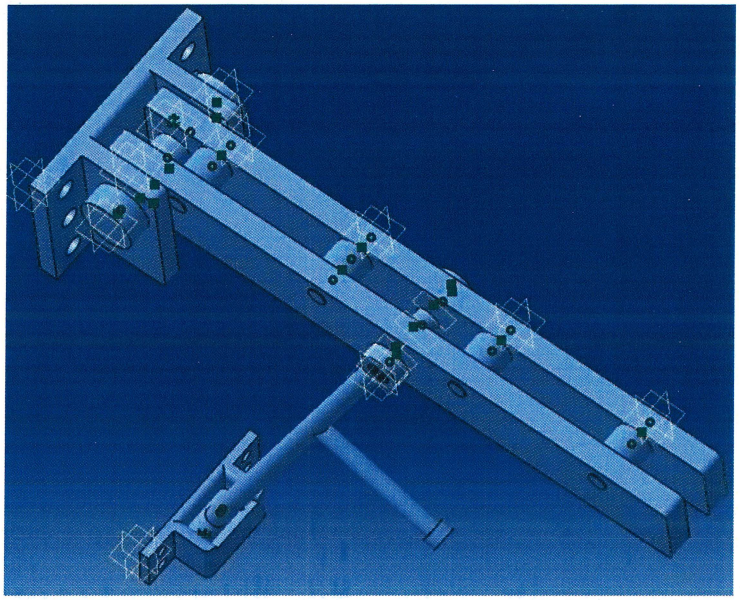


Stopper

The designs of the tools come out according to the SMED operation checklist while it visualizes all the problems face during the setup activities. The designs come out only cover the internal preparation due to the scope of the project. According to the checklist, there are three improvements that need to be design as to support the internal preparation which is adjustable die arms, adjustable controller and stopper.

Thirdly, the adjustable die arm is needed to modify as it can be adjusted 90 deg up and down. While the stop producing the parts, the die arm just simply move up by the operators to allow the changeover of the dies. As the old die has been taken out from the machine and the new dies slide to move in, the die arms will be easily move downwards 90 deg. This improvement will eliminate the time needed for placing and removing the detachable die arm that used before this.

Referring to the time study in figure 3, there have large consuming time for placing and removing the die arms. Plus, this is kind of non value added activity that needs to be eliminated. The figure below showed the design of the adjustable die arm.



Adjustable die arm

3.3.3.2 Material selection and quotation

The material is selected due to the characteristic of the material itself. Based on the usage of the jig and tools to be design, the material that been chosen should be toughness enough to support the die arms which it can be support the dies with maximum load 500kg. Considering all the specification, the best and most commonly used in designing jigs and tools is mild steel. This is because, mild steels is available to the markets and easy to work with it. Plus, it can be used in any area of application. The cost of mild steels is quite low compared to the others.

After deciding the suitable materials and the dimension on what shape according to the design, the material has been undergoes to the other process which is making quotation with the supplier. The table 3.1 below shows the Bills of Materials (BOM) of the project.

No.	Items	Materials	Part size (mm)	Quantity
1.	Solid shaft	Mild steel	D16x1500	1
2.	Solid shaft	Mild steel	D25x60	4
3.	Solid shaft	Mild steel	D14x30	4
4.	Solid shaft	Mild steel	D20x50	2
5.	Hollow shaft	Mild steel	D27x1000	2
6.	Hollow shaft	Mild steel	D34x400	1
7.	Steels plate (t = 8mm)	Mild steel	8 x500x500	1
8.	Steels Plate (t=6mm)	Mild steel	6x2500x150	1
9.	Bearing		6201	10
10.	Bush		OD 12 X ID 10	18
11.	Bolts and nuts with washer		M12	4
12.	Bolts and nuts with washer		M10	12
13.	Bolts and nuts with washer		M8	6

Table 3.1: Bills of Material (BOM)

3.3.4 Stage 4: Streamlining the setup process

In this stage the objective is to accomplish the setup and startup operation with the faster, easier and safer way. This new SMED system needs to be maintained by streamlining all the opportunities for improvement with the targets

to eliminate the adjustment and any other activities that would not add any value to the operation. Thus, before to get started with the second opportunities of the improvement, the installation and fabrication of the conceptual design as mention before is needed. Without the fabrication and installation step, how could the changeover will be improved without any improvements happened.

After installation of the improvement and standardization that mentioned before, the trial process for the new changeover activity needs to be done. In this trial stage, focuses on the changeover process need to be smooth and lean that will result into the time study. The time study is used as a tool to study the time consumption for the changeover process. If there has any waste indentified within the process, the waste need to deduct and the proper improvement need to focuses on. The trial stage is function as a try and tested stage to come out with the best changeover methods that will result to the aims of this project. The evaluation of the improvement is based on the time study after the improvement.

3.4 STANDARDIZATION

Standardization is the most important issues in every new system establish to ensure that system will be maintain as per plan. The standardization issue is just come out with the SOP. It can be come out with the others way such as color coding, number coding and visual board. This SMED system is planning to come out with the Standard Operation Procedure (SOP) of the changeover operation in Work Instruction (WI) format and Safety Point Operation (SPO).

The WI is a common visual control tool that always been showed in every machine as to operates the machine in a safer manner. Providing the WI with the time, picture and explaining the operation is the best way to make the incompetent operator easy to understand. The operator is the important person to make the SMED system success because they are the one who works with the system that we develop. The important this is to let them understood how important they are to success the SMED system. The good information should be

CHAPTER 4

RESULT AND ANALYSIS

4.1 INTRODUCTION

In this chapter, the readers will experience readings on fabrication process, how the data need to be collected and the result of the study. This chapter will cover the fabrication stage of die modification and the adjustable die arms. After all it will be end up with how the data collected and the result discussion.

4.2 THE FABRICATION STAGE

Before starting the fabrication stage, a proper action plan should be come out as to ensure the time of boundary of this project are not exceeded. As referring to Dr.Seues, "a good thinker should play along with time development, the longer time (free time) you have the looser you are" this statement also can be implemented in any kind of project because in project achievement, the role of time and the aims of the project is the most important than anything. The action plan for fabrication stage is shown below:

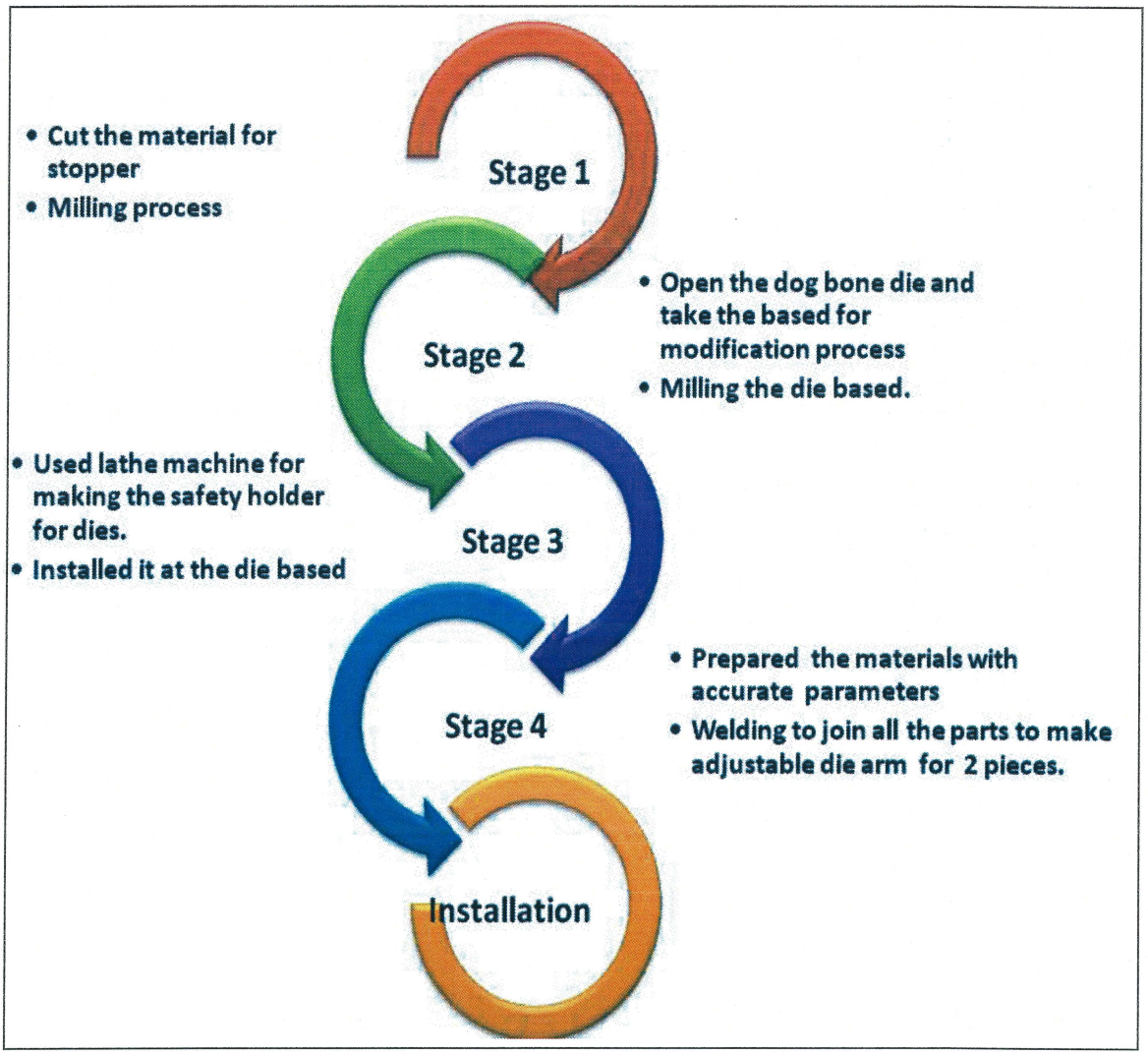


Figure 4.1: Fabrication action plan

4.2.1 Stopper

The fabrication process starts with machining the stopper to stop the dies and as to be function as to eliminate the adjustments for centering the dies and the stamp machine. To fabricate the stopper is quitted simple process due to simple part designed. First of all, after the ordered material arrived the next step is to cut it into required size. After get the approximated size, the work piece is ready to machining by using milling machine Markino KE55. The process of milling starts with squaring the work piece as to make in 90° at every edge. After get the approximated squared part, the work piece undergoes the pocketing process by

using 20mm end mill tools. This process is to create the pocket side to the work piece. The last part is to a though hole by using drilling process with 12mm drill tools.

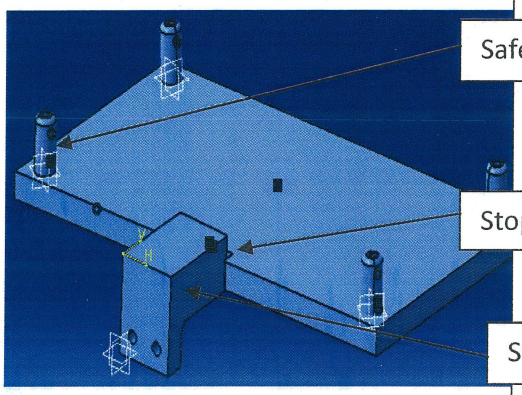
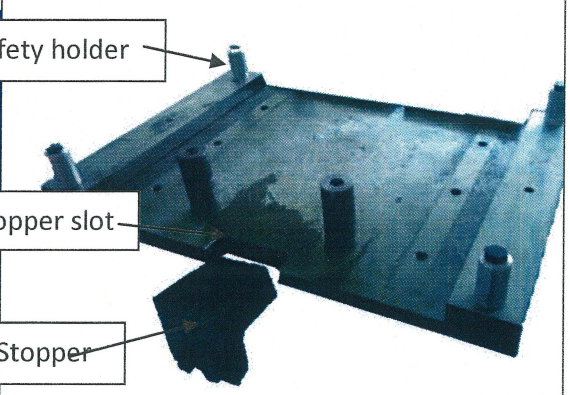
4.2.2 Die modification

After looking for the first Gemba activity to find out what are the consensus need to be improved as to support the time reduction for changeover, the author found that the dies used need to be standardized. The standardization of the die for this project only covers for the dog bone dies to make it as an icon for the others die develop in the future. The existing die need to be modified as to creating the slot for stopper and to add on the safety holder as to avoid the fingers slips to the bottom of the die while its moving.

At first, the die needs to be opened as to take out the die base. After that, the die base has been set up at the milling machine Markino Ke55 as to undergo machining process. The process start with marking the part to be machine by small inches hole drill as to create the limit for the pocketing process. The limit has been set up and the pocketing process is done by using 16mm end mill tools.

4.2.3 Safety holder

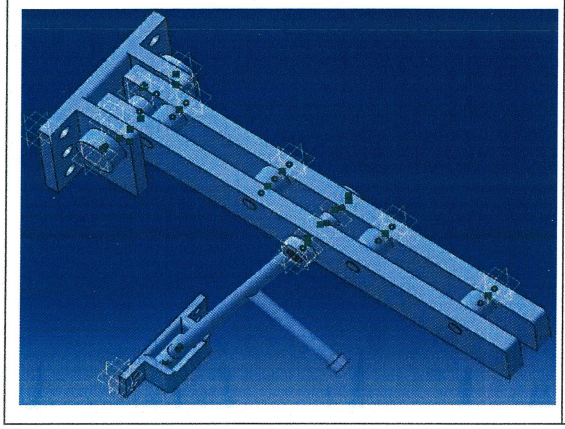
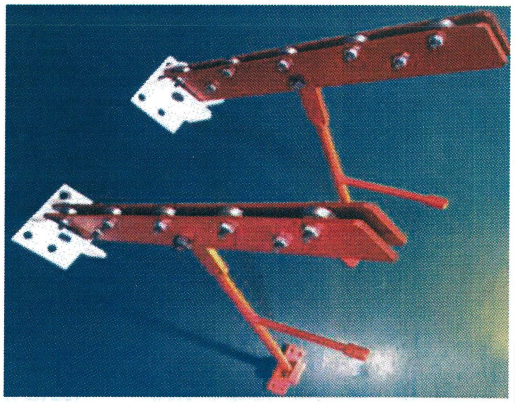
Second part is to add on the safety holder to the dies. As usual, cut the material into 4 pieces then bought it to lathe machine ROMI as to create external radius and creating through hole via drilling process by using same machine. The machining process of safety holder is repeated for the next three work pieces. Next, finish all the machining process, the safety holder need to be installed at the dies base as shown in the figure below. Please refer to the Appendix F1 for this die base modification drawing.

In planning (in design stage)	In actual (after fabrication)
	

4.2.4 Adjustable die arm

Generally the arms must be exits in pairs, right and left. It same goes to the die arms where it completely needs to develop in pairs as to give the fully support to move the dies in and out. Plus, the load transmitted along the arms also need to divided into two thus, each arms may admitted less load compared to the single die arm. In this project, the die arms are designed to be easy to adjust and no need to detach from the machine event after the die change is completed.

The fabrication of adjustable die arms is having the same process like the other part which is cut the materials used into the approximate size and at the correct quantity used. Then the parts are divided into two sections which is the parts that need to be weld and the milling. For the milling process it take a several days to complete due to large amount and hard material used. The process requires slow feed rate with high spindle speed. After finish all the milling section, the welding section will be started to combine all the parts. Next, the part welded creates semi assemble parts of die arms. These semis assemble part need to be painted with red color as to show that adjustable die arms is hazardous and need to handle securely. Finally, these semis assemble parts need to assembled at the second stage by using bolts and nuts as shown in figure below. Please refer to Appendix F2 for adjustable die arms drawing for more information.

In planning (in the design stage)	In actual (after the fabrication)
	

After all the fabrication parts are completely done, the next stage is to install all these jigs to the stamps machine at FKP lap OCP 60 as to take the data.

4.3 DATA COLLECTION

The data of this changeover die is collected by using time study of the process. The process of taking the time study is same like before when the author start to analyze the current changeover activity before improvising the intermediate jigs to accelerate the changeover time.

First of all, each step of the process that handles by human, walking and machine process need to be noted down. Then, the video of the changeover process has been take out for five (5) time shoot just to calculate the average time of it. This average time should not be in very large range. After that, the video need to be analyze by creating the Standard Work Combination Table (SWCT) where we combine all the elements of human work handling, walking and machine work. However, by considering the elements of work in this process is human work handling due to the human need to control how fast they pushed the press button to move the stamp head up and down. Plus, the walking time need to

be neglected due to the walking area is small and it still in the range of ideal walking time. According to Pigage and Tucker, walking time can be neglected is the time taken to walk from section A to section B is just 1 to 4 seconds in the small workstations while the

The video of changeover activity are available inside the CD attached. This is the best video of the time of the consistent changeover activity.

4.4 DATA ANALYSIS

After implementation of all the step involve in SMED techniques directed by Shiego Shingo, the result of the time study that have been carried out in SWCT (see Appendix G) aspect showed that the die change activity have been made in 3 minute 16 seconds. By referring to the SWCT that resulted after the SMED project, almost 75.9% of changeover time has been deducted due to adopting the parallel operation between two operators. In uchi dandoori there are only one operator used to operate the jig and fixtures while changeover activity meanwhile the other one has been balanced the workload by preparing the external preparation (soto dandoori) via converting the internal preparation to external preparation. This converting is very crucially needed as to promote the shorter time for changeover activity (Malcom Jones). Plus, the man power job has been simplified via implementing the auto clamp, intermediate jigs and the standard job define. Referring to the SWCT, each operation has been carried in short time as to compare it to before the development of SMED system at this OCP 60 stamping machine. Moreover, there have no existing the waiting time in the process.

According to yamazumi before the improvement in Appendix B1, the usage of 2 man power for uchi dandoori is needed just to operate the changeover dies activity due to the heaviness dies to control in motion. There have a lot of excess time exits due to the usage of inappropriate tools used and lack of information on handling the die change activity that reflect to no SOP provided or

visualized. In here, the first and second techniques in SMED implementation directed by Shingo are very important one to done. A well prepared study and research through the operation involve inside the die change process is needed for separating the internal and external preparation then convert them into two difference preparation and time. This will cut down more time involvement due to the early preparation for jigs, fixtures and tools have been made while the production keep on run. Back to the scope of the project, this project only covers the uchi dandoori only. Thus, the removal 1 man power inside the uchi dandoori needs to be calculated as a good achievement in changeover activity.

This result on SWCT shows that the project aims to be same levels as the best practice in industry has been achieved. It just exceeds 16 seconds from the industrial benchmark at PHN for changeover standard due to certain point that need attention to be improvised. This exceeding 16 seconds for changeover time might be caused at the usage an extra time while handling the controller. Plus, the man power should be supervised and trained for the new systems develop as to ensure the smoothness die change process.

By considering this man power role for training purposed, the developer has come out with the Work Instruction (WI) (Appendix H1) that complete with time management and the picture of each operation. The WI shows the complete process with visualized work flow with respect to time involvement and touched to the safety and quality aspect. The safety for handling any hazardous part need to be visualized as to ensure there are no accidents occurs as per prediction in future. Therefore, the developer takes the good opportunity by providing the Safety Point Operation (SPO) as to spot the hazards situation just to take the precaution before the accidents happen. Please refer to Appendix H2 for get through with SPO.

Back to the SMED a technique that the author implemented, the first two techniques is to separate and convert the internal to external preparation have been done in chapter 3. The author used the SMED check sheet and SMED

operator check sheet to study the current process and find out the main core problems that make the process hard to control with time. The next step is to focus on standardization, based on the SMED check sheet the author found that the dies need to be standard as to ensure all the adjustment to centre the dies to the stamps machine is eliminated. In order to achieve this kind of elimination, the next techniques has been used to eliminate all the adjustment by installing the stopper to be function as a guide for dies centering to the stamps head, slot auto clampers and the parallel distance of the dies. The next step is using th intermediate jigs as to accelerate the internal preparation for the exchange of th dies. The design has been touched in chapter 3 and the fabrication process is already explained in crystal clear mean at above.

After follows all the techniques in implantation the SMED at small press machine, the result give us that all the techniques is proven in order to develop the SMED system in a plant. According to Malcom Jones in his article. 'The Power of SMED' state that the implantation of SMED need a several step before it have been achieved to the most advance in die exchange. The first stage of implementation majority will get the 50% to 60% of time reduction only, and the next one may be increased to 80% to 90% of time reduction. This time reduction achievement is based on the methods that we analyze and the problems that we spot on at the beginning of the current study process. Comparing to the Jones, this project have been achieve 75.6% of time reduction from 13 minutes to 3 minute 16 seconds which is show that this is the best achievement of SMED system develop at the first stage implementation.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter will discuss through the conclusion of the project achievement by depending to the result generated and the project aims. Plus, the section of recommendation that reflected to the future work kaizen as the best suggestion that need to be added to gain more time reduction during changeover activity. In the future work kaizen, it will be touched basically based on recommendation that proposed by the author.

5.2 OBJECTIVE OF PERFORMANCE

Usually the development of SMED system need undergo many stages as to achieve the target of reduction setup time up 90% or until the changeover time takes single minutes in action. There are more than enough if the reduction changeover time can be reduced about 50% to 60% at the early birth of development. Then the kaizen process will takes place by doing step by step improvement by focusing at the certain point that critically calling for attention to fixed. At first, to reduce the changeover time need to be set the target or aims that need to be parallel to the compatibility of the production uptime as per best practices in industry. A well research need to be taken out as to ensure all the

improvement proposal are closely right on target and relay with the planed jigs design. By preferring the perfect SMED development study, industrial benchmarking need to be successfully done as to generate the brilliant project aims with good function of jigs design as implemented in SMED in the real manufacturing world.

The implementation of SMED in the real world must focus on the way to reduce the production downtime that will reflect to the inventory level. Inventory level is kind of evil that necessary to hold for the company in order to ensure the production process in keep on ride as per plan just to meet the customer demand just in time to the customer needs. However, an evil is still an evil, the number of stagnation for inventory must be in the most economically lost size with the ideal safety stock to be hold. If not, the number of evil in inventory will burst up and definitely will create an external cost to the company.

Therefore, the conceptual design of intermediate jigs are generates through the problem analysis for the current stages die change activity. The usage of problem solving tools is needed for the analysis such as ishikawa diagram, observation analysis and time study analysis. These analyses have been carried out just to come out the correct jigs design and planning systems as to achieve the aims. The design and fabrication of intermediate jigs has been cleared by giving the function as per planed during the current stage analyses.

As to ensure this SMED system is consistently followed by the users, the system standardization is the final resort for this SMED development project. The standardization has been made in three ways there are WI, SPO and SWCT as per training purpose and the sustainability of the system develop to be followed. It also can be used as references in future kaizen activity.

5.3 PROBLEM ENCOUNTERED AND WAY TO OVERCOME

During this study, there are a few problems that occur along completion of this project. At the beginning of the project, they would be a difficult to plan the industrial benchmarking at PHN Shah Alam due to the availability of both sides. However, that is not a big deal to fear off. The project should move on the ropes eventually there are some delays occurs due to slightly delays on industrial project benchmark. To overcome this matter, the project milestone needs to reschedule by doing the study at the current stage of die change at FKP Lab.

Next, the materials selection should be focus deep on the material characteristic and its specification. The wrong materials choose will drag the impact on part to be function as per plan. Here, the proper research through the material physical and mechanical properties should be done as to generate the best result in part performance. Then, the action plan should be come out for the fabrication process and materials ordering so that the materials will be arrived just in time to the needs. The project faced to the delayed problems for materials ordering and leads to troubleshooting action as to make the fabrication process still move on. The action taken is to rearrange the fabrication strategy by focusing to the part that available the materials and need for milling process.

At the end, the project faced the difficulty to install all the fabricated jigs to the small press machine by drilling a hole and make threads to attach the jigs to the machine. This is because, the machine wall undergoes surface harden process to add on the toughness and hardened properties. The specific tools drill for hardened materials should be used in this case as to avoid tool wear after making one hole at 30mm deep. Plus, the drilling process need an extraordinary time consumption which it takes almost 2.5 hour to drills about 30mm deep for one hole. To overcome this problem, the number of hole usage has been reduced as to reduces the time for installation so that the project will be end on the time without over delayed. The reduction of hole usage is depending to the compatibility for the jigs to be function and support the load transmitted.

5.4 CONCLUSION

Based on Shingo analogy, the SMED system is the process of changeover within single digit minutes lead the project to set the target on doing the reduction in changeover time from 13minutes as per practice in current to 3.16 minutes in planned. As to support this acceleration changeover time is by design and fabricated the intermediate jigs that will give a good fit to the machine and its usage. After all, the objective and aims of this project have been achieved by generating the reduction about 75.9% of changeover time which is from 13 minutes to 3.16 minutes. Meanwhile, the fabricated jigs are performed as per planned. In addition, this project also able to deduct 1 man power usage for internal preparation as to compare in previous changeover activity where the usage of man power for internal preparation is two. The deduction of man power is affordable and no overburden issue arrived in here due to the operation standard is agreed to eliminated the non value added by using 2 man power for a simple operation of new changeover system.

Please refer to the table 5.1 below as to simply conclude project in term of 4M which is Man, Material, Machine and Method.

	Before	After
Man	- Use 2 man powers to operate the changeover activity. The usage of 2 man power are unnecessary due to it creates a lot of waste on waiting and non added any value to enhance the changeover time based on current stage study.	- Use 1 man power only for internal preparation. There are no waiting issues exist in study the changeover process.

Method	- No SOP provided as a training issues and the changeover process are risky due to handling a heavy.	- The WI is provided after the study and the developer are focus on safety issues on handling the heavy things through SPO (Safety Point Operation) as to spot on the hazed and precaution action. The method has been simplify by adopted the intermediate jigs to the machine and it resulted to the 75.9% reduction of changeover time which is from 13 minutes to 3.16 minutes.
Machine	- The machine does not install any jigs permanently as to support the die change activity. The detachable jigs like die arms are heavy to handle and consume a lot of time to handle.	- The intermediate jigs has been install to the machine as to support the die change time reduction such as adjustable die arms and the die modification standard. There are lot of time can be cut off by this installation.
Materials	- The materials are wasted through wrong set up and adjustment.	- The materials are not wasted due to following the standard set up due to no adjustment has been made during die change activity.

Table 5.1: Project conclusion based on 4M

5.5 RECOMMENDATION

In future, the author would recommend to who interested making a kaizen for this SMED system is to make an improvement for handling the controller. The controller should be adjusted to move in and out as opening the door. The adjustable controller is needs to install as to allow the adjustable die arm move up and down. When the production stopped, the adjustable controller will be move a side as we open the door when we want to out from our home. After the adjustable controller move a side, the die arm will have its way to move up 90 deg to slide the old die out and new die in. Next, the die arm will move downward 90 deg back to its position, the adjustable controller can be move to its place back as we closed our door after back home. In here the author would attached along with the conceptual design of the adjustable controller.

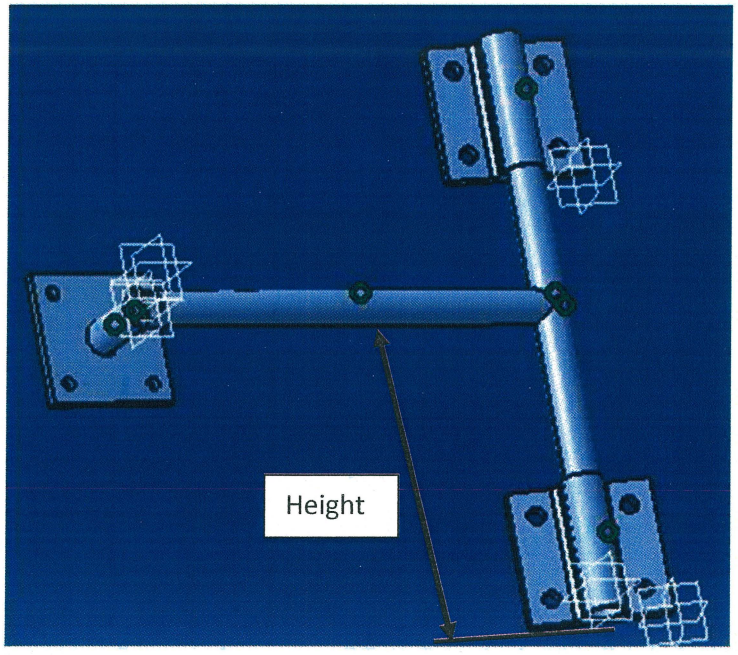


Figure 5.1: Conceptual design for adjustable controller

Referring for figure 5.1, the height should be compatible to the controller height measure as to promote the ergonomic motion for the user to handle the

machine. As a reference for more details in recommended design please see the drawing provided in Appendix I.

As per best practice in manufacturing world that have been observed in PHN Shah Alam, the best method to install all the intermediate jigs is by using welding process. This is because, welding is the fast and reasonable method to attached the jigs to the machine instead of drilling a hole and thread making. A better researched regarding on installation using welding to the machine need to come out as to find the way to not disturbing the machine circuit while welding. However, welding a possible method that has high possibility to be used for installed the jigs. Plus, by using welding may cut a lot of time consumption for installation stage.

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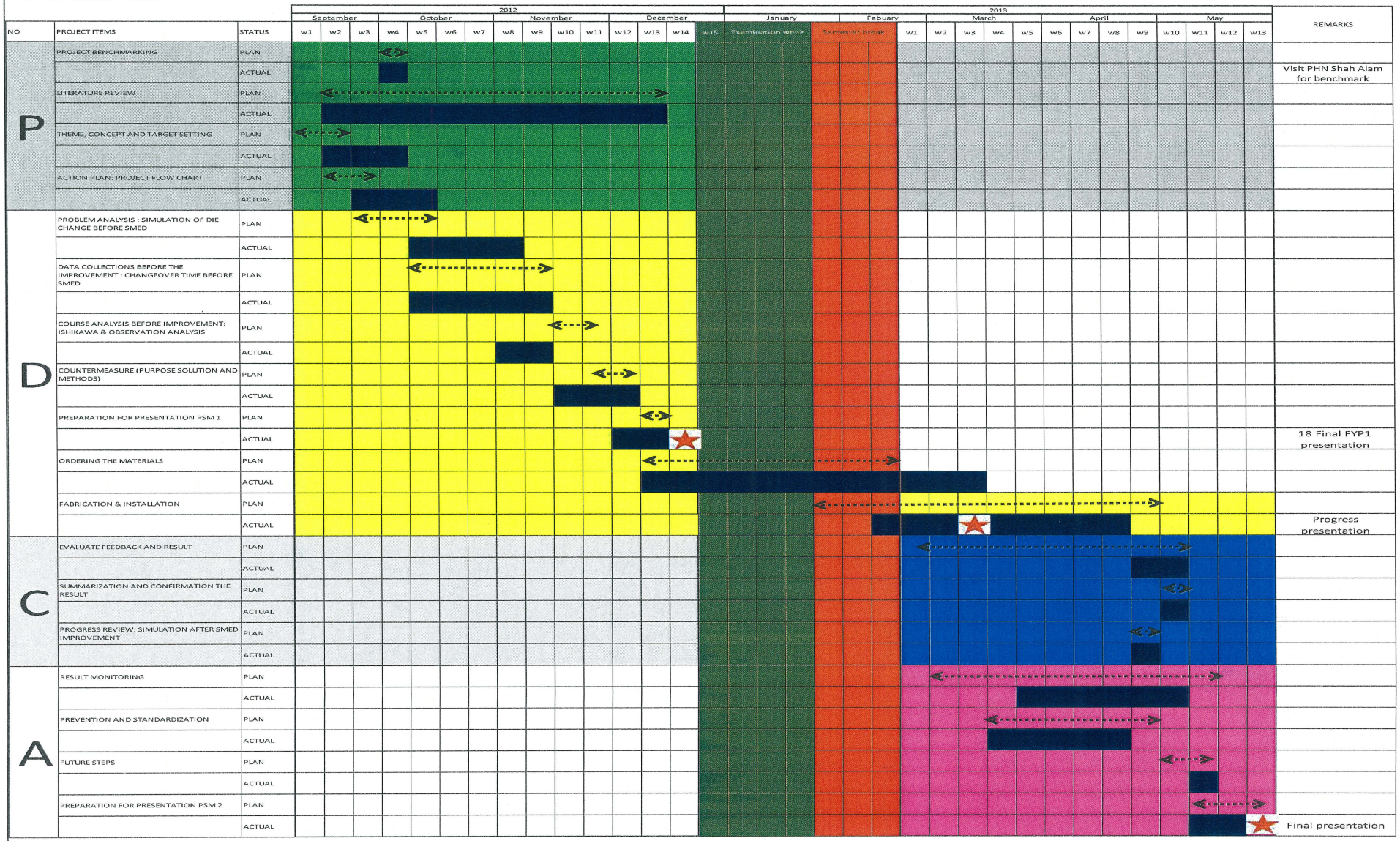
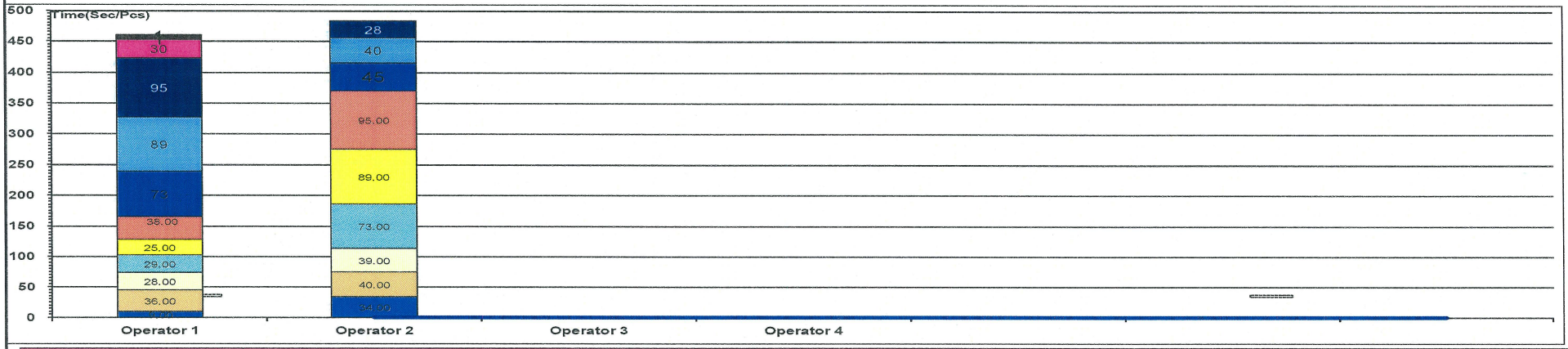
PROJECT MILESTONE



APPENDIX A

Machine	Stamping machine FKP	YAMAZUMI CHART (BEFORE)	Vol/Month		Issued Date	27/11/2012
Part No/Model.	Changeover		Vol/Day		Takt time	



Operator 1			Operator 2			Operator 3			Operator 4								
No.	Detail	Sec.	No.	Detail	Sec.	No.	Detail	Sec.	No.	Detail	Sec.	No.	Detail	Sec.	No.	Detail	Sec.
1	closed die	9	1	unclamped the top die	34												
2	change machine setting	36	2	unclamped the bottom die	40												
3	unclamped the top die	28	3	place the die arm	39												
4	unclamped the bottom die	29	4	move out the old die	73												
5	move up the head mechine	25	5	place the old die and take the new die	89												
6	place the die arm	38	6	waiting for new die transferred	95												
7	move out the old die	73	7	move in new die	45												
8	place the old die and take new die	89	8	adjust centre of die	40												
9	adjust the lifter height	95	9	move the lifter a side	28												
10	move in new die	45	10	remove the die arm	30												
11	adjust the centre of die place	40	11	waiting for shut height measurement	63												
12	remove the die arm	25	12	shut height adjustment	35												
13	measure the shut height	63	13	adjust the position of die for clamping	87												
14	down the machine head	20	14	clamping top die	38												
15	adjust the die position for clamping	89	15	clamping bottom die	30												
16	clamping the bottom die	38	16	1st trial product	12												
17	clamping the top die	30	17														
TOTAL		772	TOTAL		778	TOTAL		0	TOTAL		0	TOTAL		0	TOTAL		0	TOTAL		

APPENDIX B1

machine	stamping machine/ OPT 1
process	changeover FKP

Standardized Work Combination Table

Handling	Waiting	Rev	Date	Issued	Checked	Approved
Walking	Machine	0	27/11/2012	SOLEHAH		

C.T=778 sec

No	Operation	Time HT	MT	WT
1	closed die	9		
2	change machine setting	36		
3	unclamped the top die	28		
4	unclamped the bottom die	29		
5	move up the head mechine	25		
6	place the die arm	38		
7	move out the old die	73		
8	place the old die and take new die	89		
9	adjust the lifter height	95		
10	move in new die	45		
11	adjust the centre of die place	40		
12	remove the die arm	25		
13	measure the shut height	63		
14	down the machine head	20		
15	adjust the die position for clamping	89		
16	clamping the bottom die	38		
17	clamping the top die	30		
18				
19				
20				
21				
22				
23				
24				
28				
Total		772	0	0

APPENDIX B2

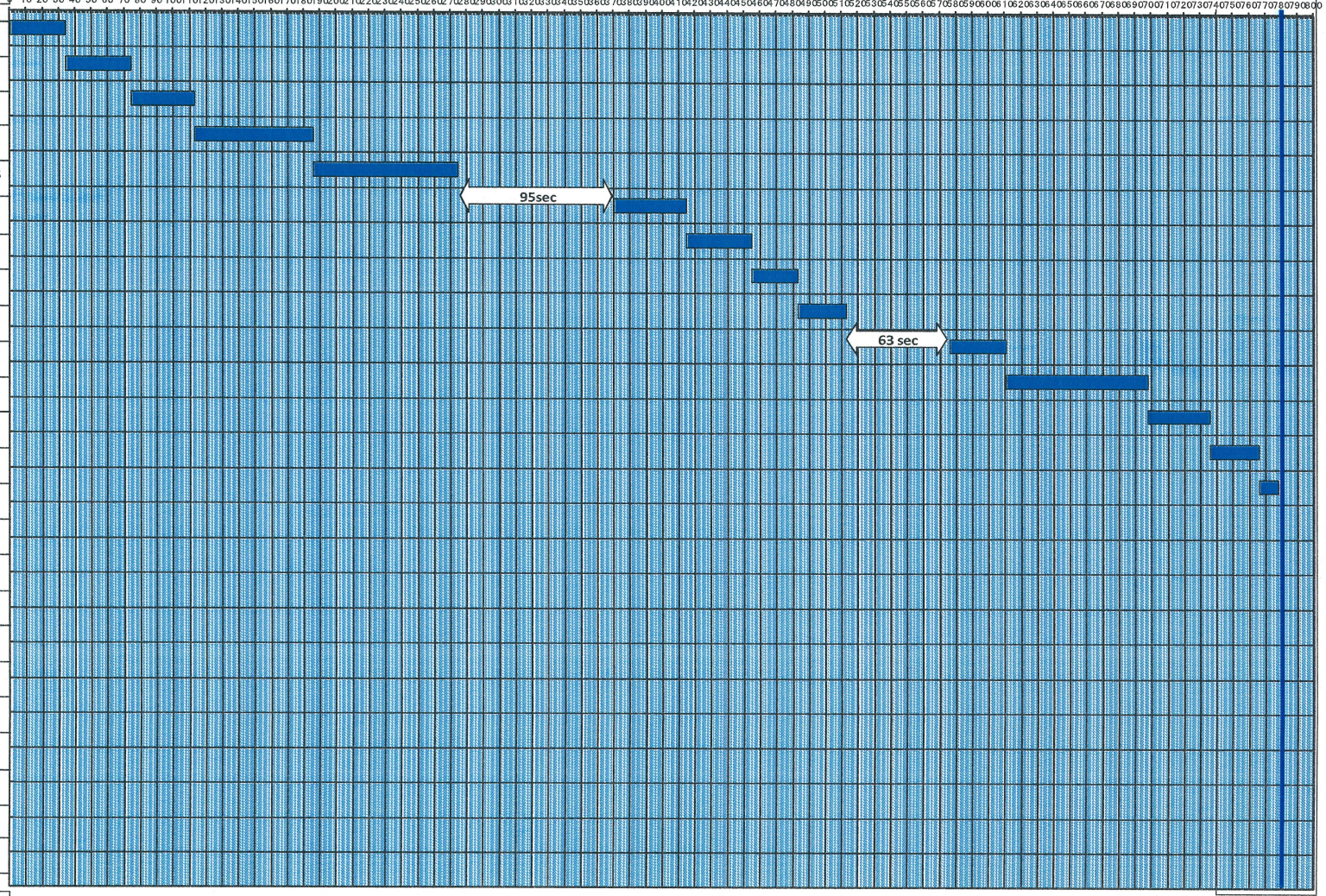
machine	stamping machine / OPT 2
process	changeover FKP

Standardized Work Combination Table

Handling	Waiting	Rev	Date	Issued	Checked	Approved
Walking	Machine	0	27/11/2012	SOLEHAH		

C.T=778 sec

No	Operation	Time HT	MT	WT
1	unclamped the top die	34		
2	unclamped the bottom die	40		
3	place the die arm	39		
4	move out the old die	73		
5	place the old die and take the new die	89		95
6	move in new die	45		
7	adjust centre of die	40		
8	move the lifter a side	28		
9	remove the die arm	30		63
10	shut height adjustment	35		
11	adjust the position of die for clamping	87		
12	clamping top die	38		
13	clamping bottom die	30		
14	1st trial product	12		
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
28				
Total		620	0	158



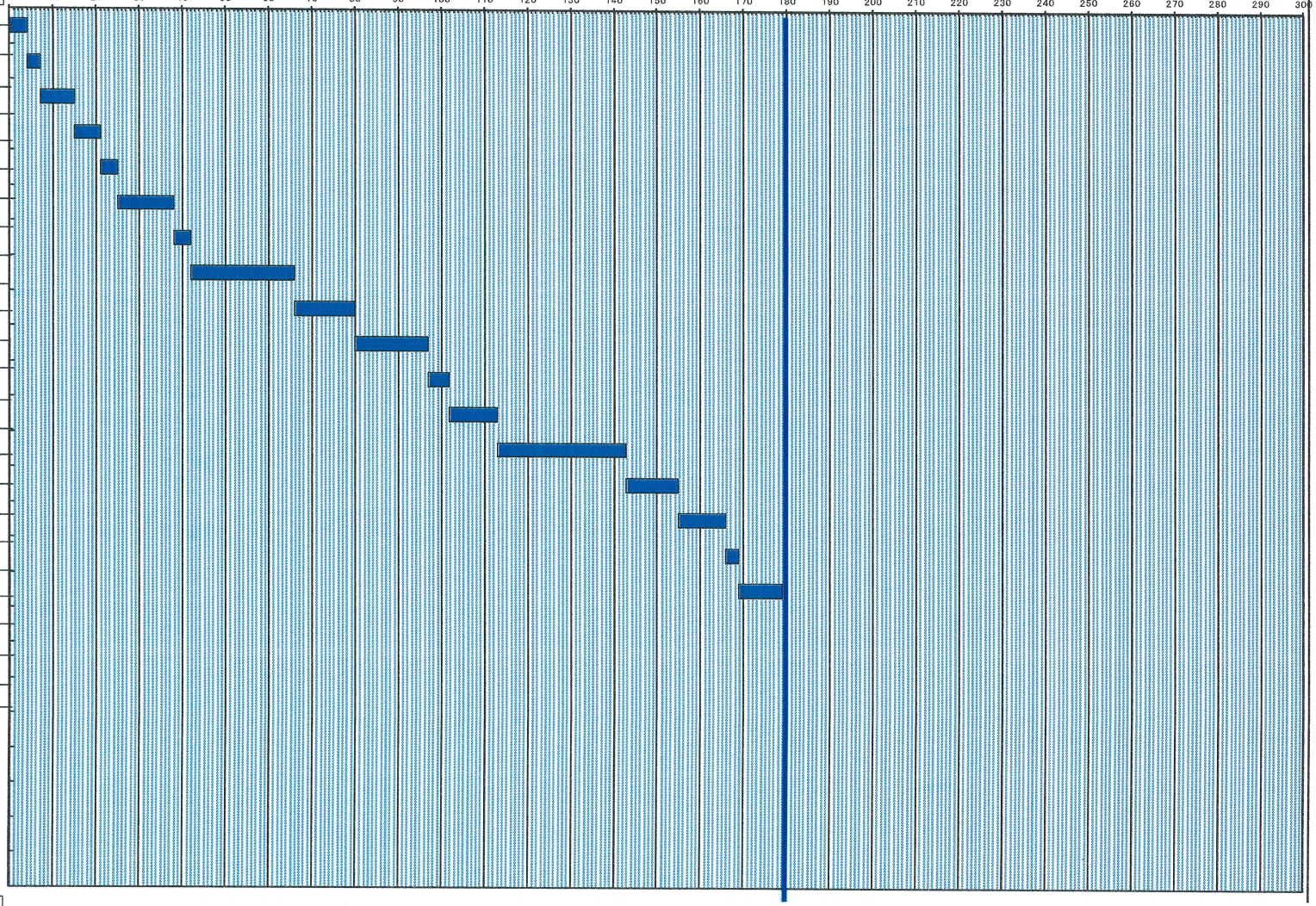
APPENDIX B3

machine	stamping machine /OPT 1
process	changeover PHN

Standardized Work Combination Table

Handling	Waiting	Rev	Date	Issued	Checked	Approved
Walking	Machine	0	27/11/2012	SOLEHAH		

No	Operation	Time HT	MT	WT
1	closed die	4		
2	change machine setting to changeover mode	3		
3	unclamped top die	8		
4	unclamped bottom die	6		
5	move up head machine	4		
6	move up die arm	13		
7	move out old die	4		
8	rotate die currier	24		
9	move in new die	14		
10	remove die currier a side	17		
11	slide down die arm	5		
12	slot in controller at a place	11		
13	set the shut height	30		
14	clamped the top die	12		
15	clamped the bottom die	11		
16	test the clamper	3		
17	1st product testing	10		
18				
19				
20				
21				
22				
23				
24				
28				
Total		179	0	0



APPENDIX C

APPENDIX D

SMED Check Sheet

List of activities involve in the changeover die for small press

Operator	No.	Activity	1st cycle	2nd cycle	3rd cycle	4th cycle	5th cycle	Average (sec)	Internal	External	Remarks
Opt 1	1	closed die	9	8	11	8	9	9	√		
	2	change machine setting	37	35	36	34	38	36	√		
	3	unclamped the top die	30	26	28	27	29	28	√		
	4	unclamped the bottom die	29	30	28	27	32	29	√		
	5	move up the head mechine	25	25	25	24	26	25	√		
	6	place the die arm	37	39	38	38	38	38		√	
	7	move out the old die	71	75	72	74	73	73	√		
	8	place the old die and take new die	89	90	91	92	83	89		√	
	9	adjust the lifter height	95	95	94	96	95	95		√	
	10	move in new die	45	45	47	44	43	45	√		
	11	adjust the centre of die place	40	39	41	40	40	40	√		NVA
	12	remove the die arm	27	23	24	26	25	25		√	NVA
	13	measure the shut height	63	54	69	65	64	63		√	NVA
	14	down the machine head	18	22	19	21	20	20	√		
	15	adjust the die position for clamping	89	90	87	92	87	89	√		NVA
	16	clamping the bottom die	36	40	39	37	38	38	√		
	17	clamping the top die	36	34	32	22	26	30	√		
	Total							772			
Opt 2	1	unclamped the top die	33	35	35	33	34	34	√		
	2	unclamped the bottom die	40	35	45	37	43	40	√		
	3	place the die arm	40	39	41	39	36	39		√	
	4	move out the old die	71	75	72	74	73	73	√		
	5	place the old die and take the new die	89	90	91	92	83	89		√	
	6	waiting for new die transferred	95	95	94	96	95	95			NVA
	7	move in new die	45	45	47	44	43	45	√		
	8	adjust centre of die	40	35	45	37	43	40	√		NVA
	9	move the lifter a side	30	26	28	27	29	28		√	NVA
	10	remove the die arm	36	34	32	22	26	30		√	NVA
	11	waiting for shut height measurement	63	54	69	65	64	63			NVA
	12	shut height adjustment	33	35	35	33	34	35	√		
	13	adjust the position of die for clamping	89	82	89	88	87	87	√		NVA
	14	clamping top die	37	39	38	38	38	38	√		
	15	clamping bottom die	36	34	32	22	26	30	√		
	16	1st trial product	18	10	12	8	12	12	√		
	Total							778			

* NVA is Non-value added activity

APPENDIX E

SMED Operation Checklist

Equipment: Stamping machine OCP 60
Operation: Changeo'
Date: 26 Nov 2012

Revision no. :
SMED PIC: Mdm. Najmiyah Jaaf

A) Team required for setup and operation			
1	Engku Nuzuwal (OPT 1)		
2	Siti Solehah (OPT 2)		

B) Tools needed			
1	Die arm		
2	lifter		
3	Adjustable trolley		
4	Measuring scale (Ruller)		

C) Parts needed			
1	dog bone die (old die)		
2	die 2 (new die)		

D) Standard Operating Procedure (SOP) to follow			
	SOP / SMED - changeover		SOP / SMED - preparation
	Not provided		Not provided

E) Prepartaion duration (External setup)			
	Start time : 10.10 A.M		Finish time: 10.30 A.M
	Checked by:		Verified by:

F) Changover Duration (Internal setup)			
	Start time : 10.30 A.M		Finish time: 10.43 A.M
	Checked by:		Verified by:

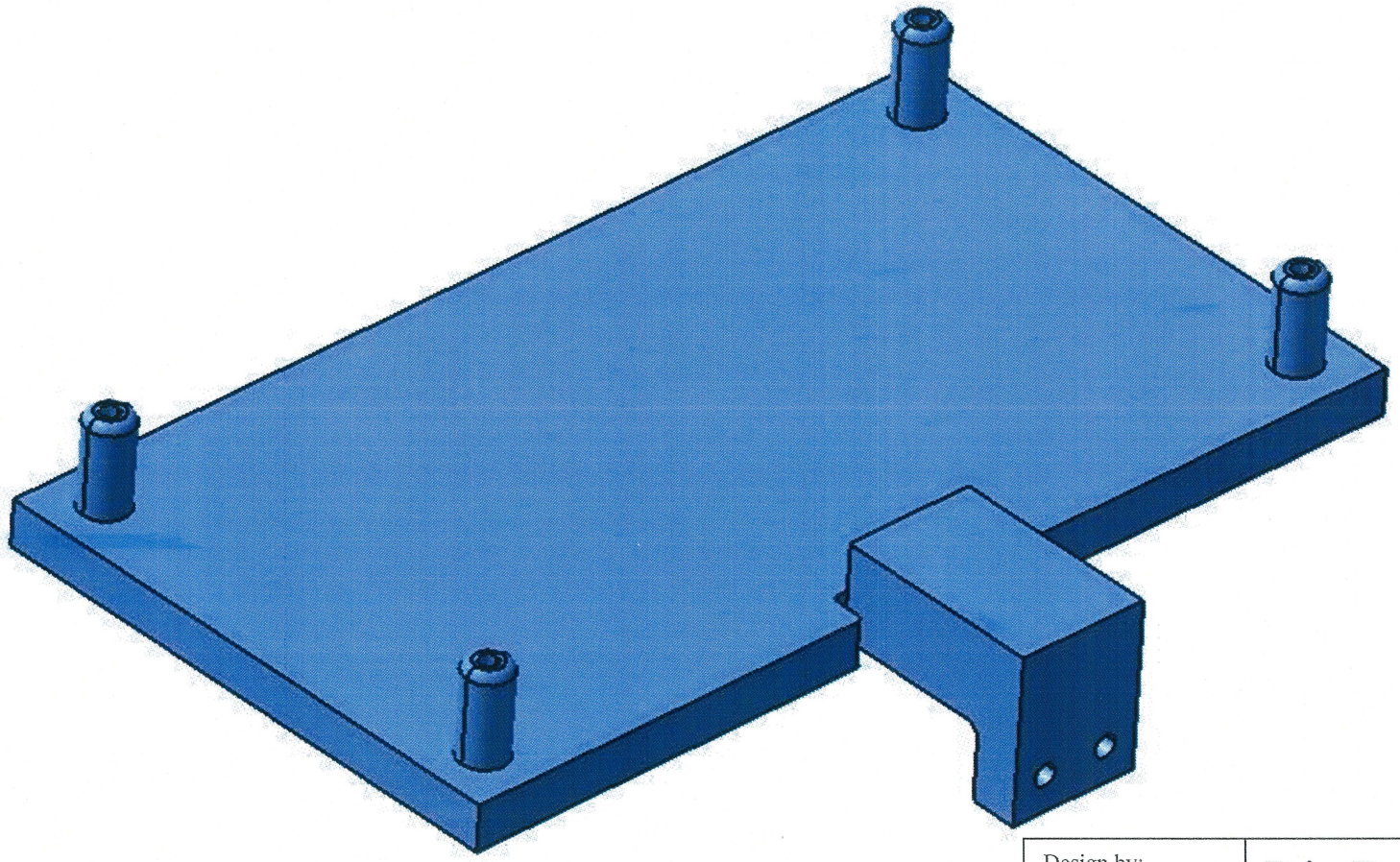
G) Problem and action taken		
Problem		Action taken
Need to measure the shut height with measuring scale		Visualize the shut height of every die
The die arm are quite heavy to carry		Modify the die arm to be an adjustable die arm
The die centering place need to measure with the measuring scale		Intall the stopper
The are no SOP provided for the process		Standardize the changeover process and visualize the SOP

H) Improvement proposal

- install the stopper on the machine bad to eliminate the centering place of the die.
- Modify the die arm as adjustable tools that can move 90 deg upword and downwords. This will eliminate the risk of heavy object falling down while carrying to the machine or vice versa.
- Modify the machine controller as to allow the movement of die arm while it going upward(setup time) and downwards (production time).
- Modify the die based with installing the safety holder to reduce the risk of sliped fingers or and while moving the dies in or out the machine.

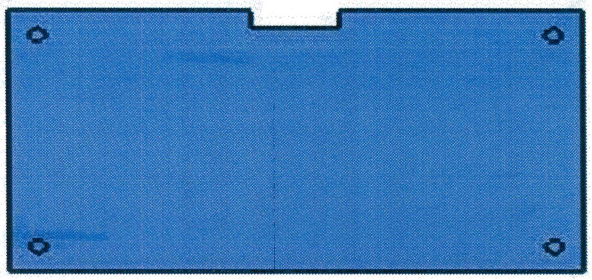
I) Remarks

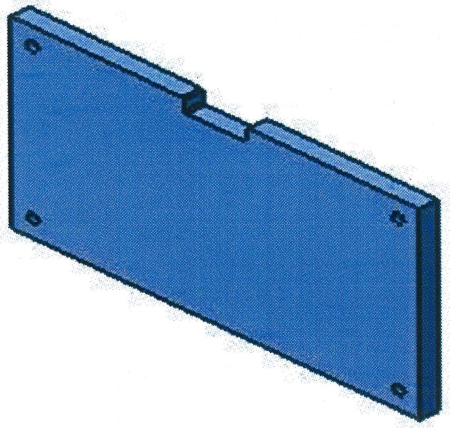
The activity of this changeover has been done for 5 cycle at the same date. Each cycle result in changeover time in range 13 minute. For the preparation activity result in range of 20 minutes. This prepartion time takes 20 minutes due to the distance of the adjustable table, lifter and the die house to transfer the equipment near to the machine.



Design by: SITI SOLEHAH	Die Base Modification		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 1/5

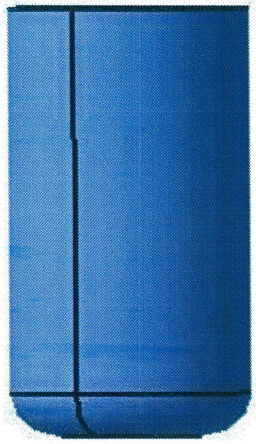
APPENDIX F1-1

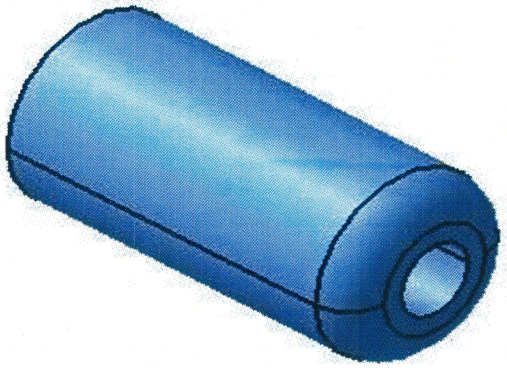


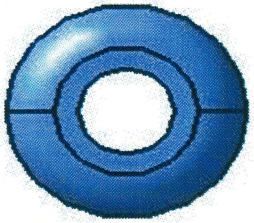


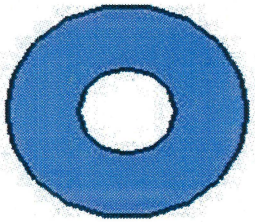
Design by: SITI SOLEHAH	Die Base		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 2/5

APPENDIX F1-2



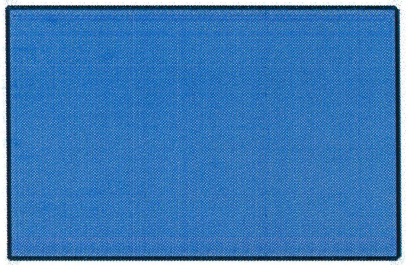


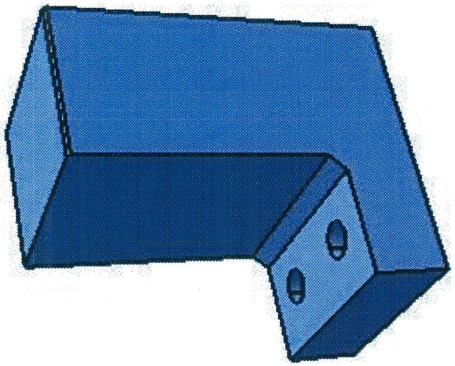


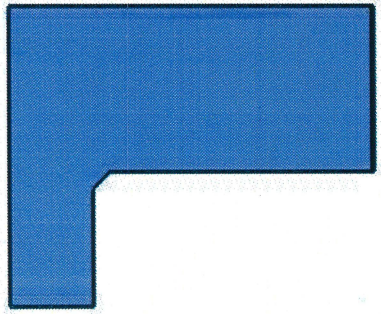


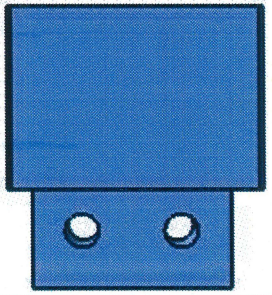
Design by: SITI SOLEHAH	Safety Holder		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 3/5

APPENDIX F1-3



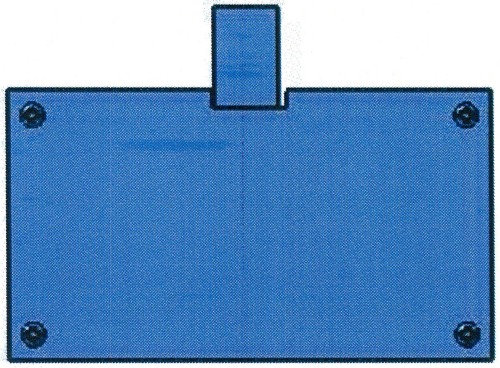


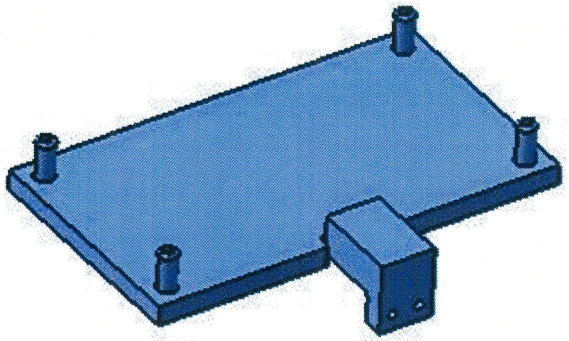


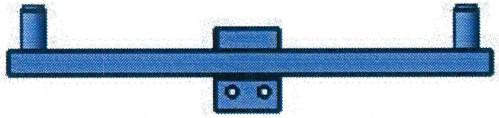


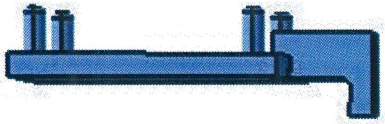
Design by: SITI SOLEHAH	Stopper		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 4/5

APPENDIX F1-4







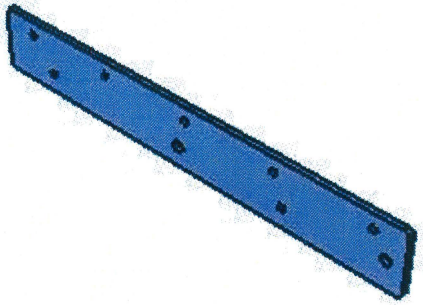


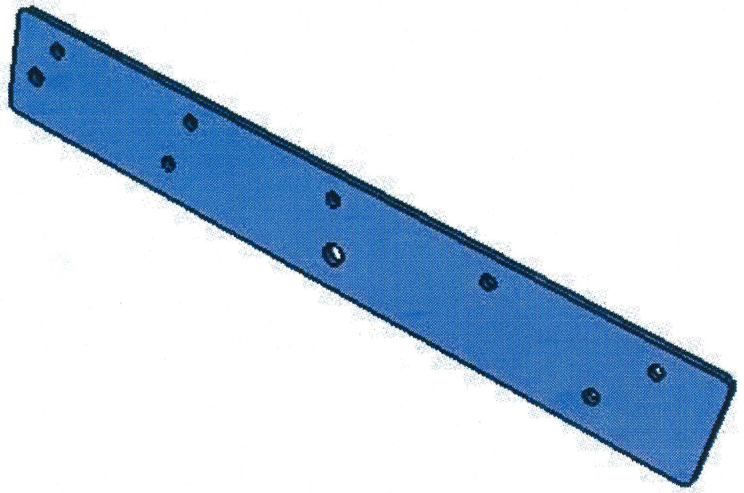
Design by: SITI SOLEHAH	Assembly design		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 5/5

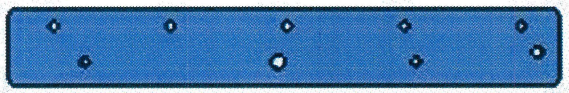
APPENDIX F1-5

Design by: SITI SOLEHAH	Adjustable Die Arms		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 1/6

APPENDIX F2-1

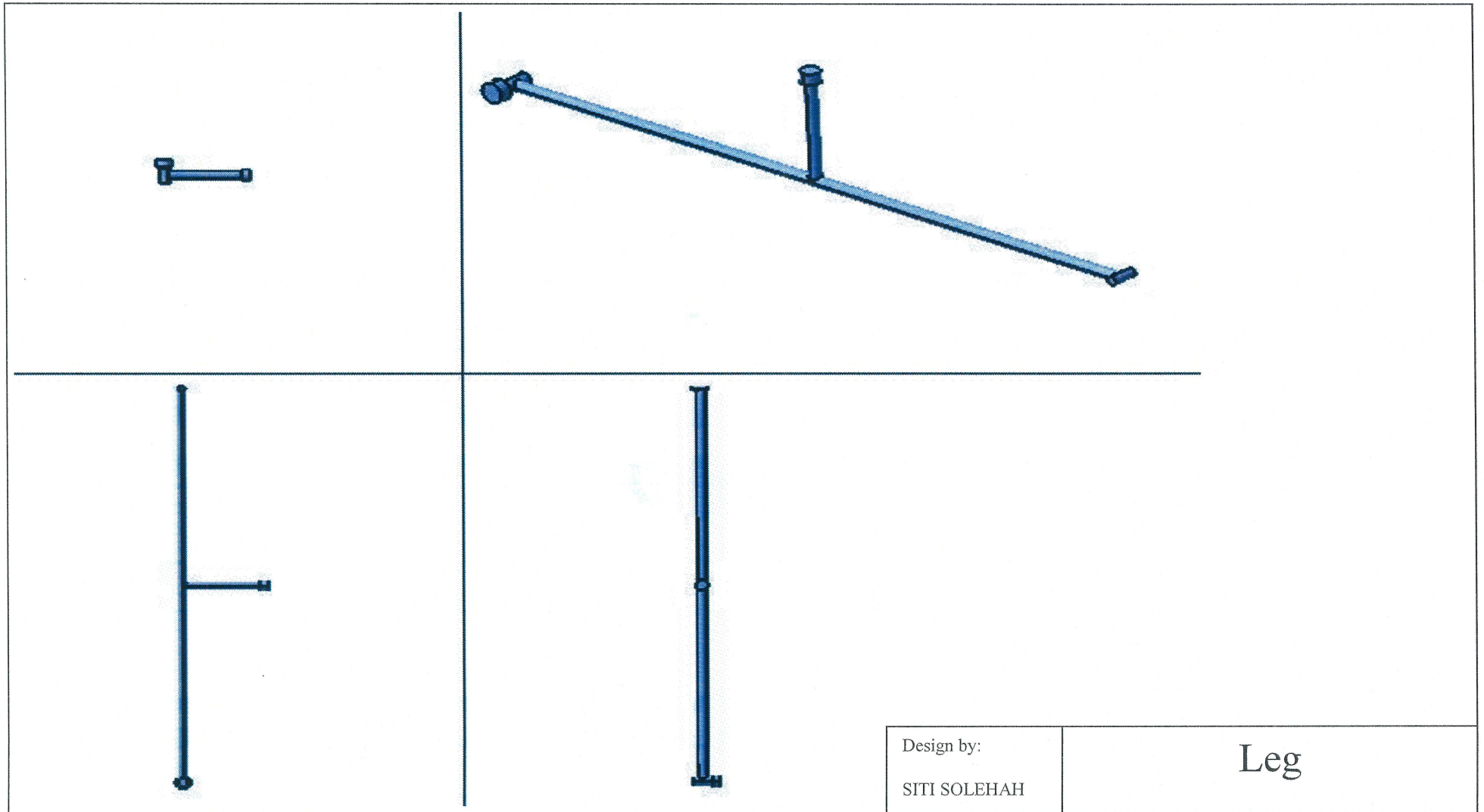






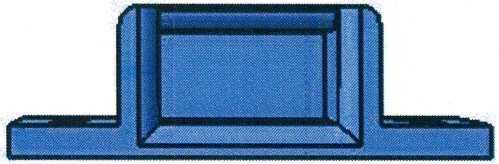
Design by: SITI SOLEHAH	Side Plate		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 2/6

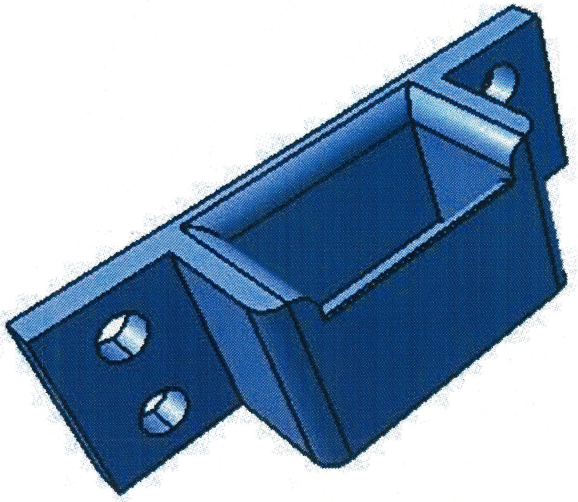
APPENDIX F2-2

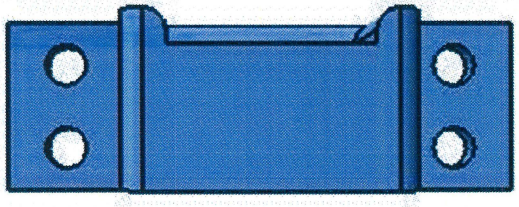


Design by: SITI SOLEHAH	Leg		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 3/6

APPENDIX F2-3

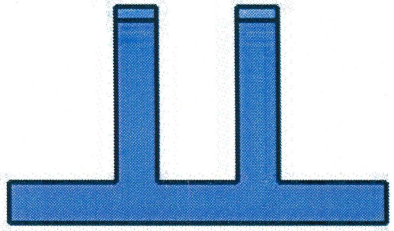


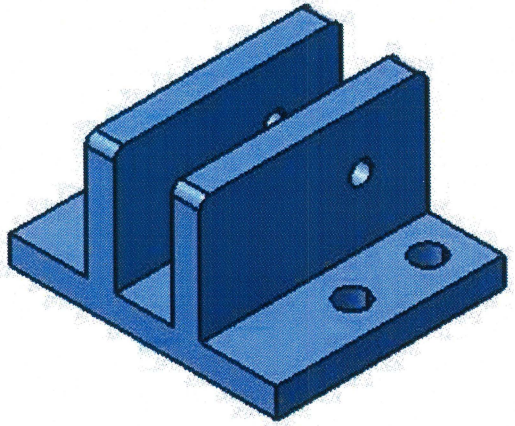


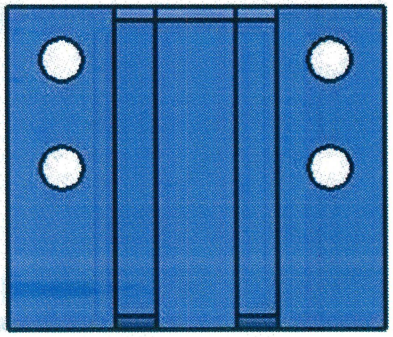


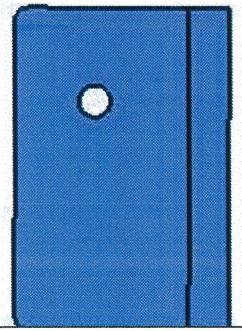
Design by: SITI SOLEHAH	Stand		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 4/6

APPENDIX F2-4



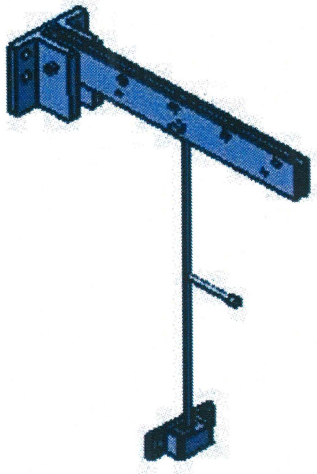


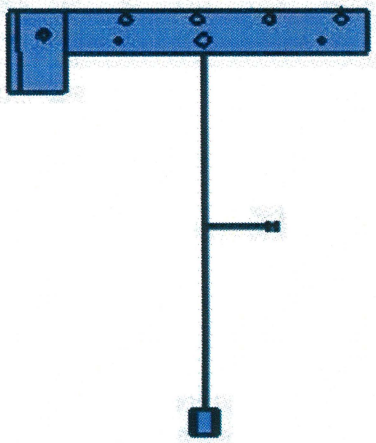


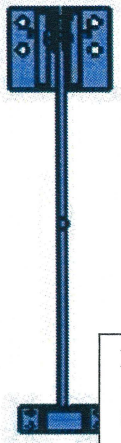


Design by: SITI SOLEHAH	Fixed Head		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 5/6

APPENDIX F2-5







Design by: SITI SOLEHAH	Assembly Design		
Approved by: NUR NAJMIYAH	Date: 26/11/2012	Scale: 1:5	Page: 6/6

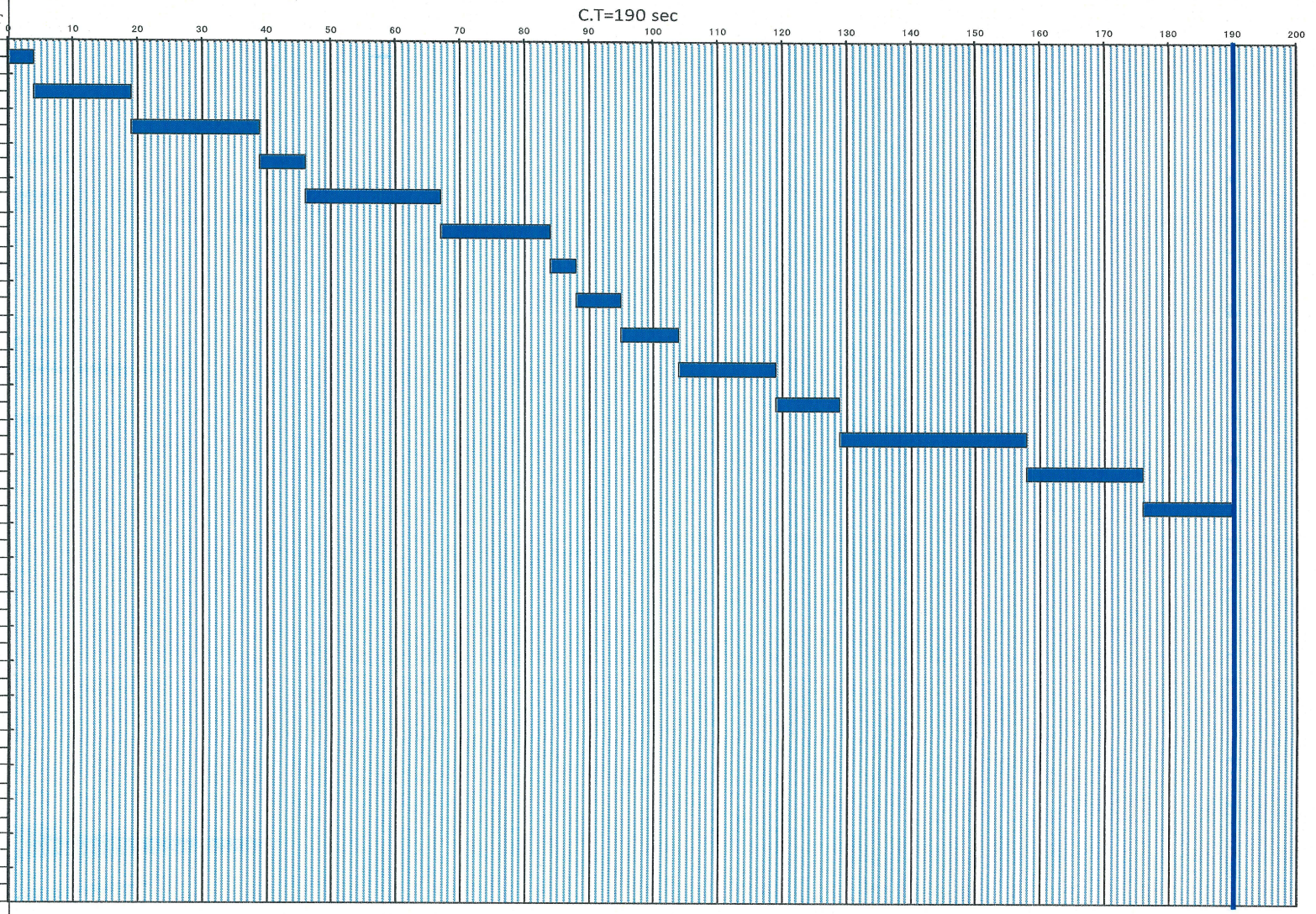
APPENDIX F2-6

Line	Press shop
process	Changeover

Standardized Work Combination Table

Handling	Waiting	Rev	Date	Issued	Checked	Approved
Walking	Machine	0	12/5/2013	S.Solehah		

No	Operation	Time HT	MT	WT
1	Turn on the die change menu	4		
2	Unclamp all the clampers	15		
3	Move up the stamp head	20		
4	Remove a side the controller	7		
5	Slide up the die arms	21		
6	Lift up the lifter	17		
7	Move out the old die	4		
8	Move in the new dies	7		
9	Move in the bottom clamps	9		
10	Slide down the die arms	15		
11	Place back the controller	10		
12	Move down the stamps head	29		
13	Clamps the topside	18		
14	Trial section (open die)	14		
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
28				
Total		190	0	0

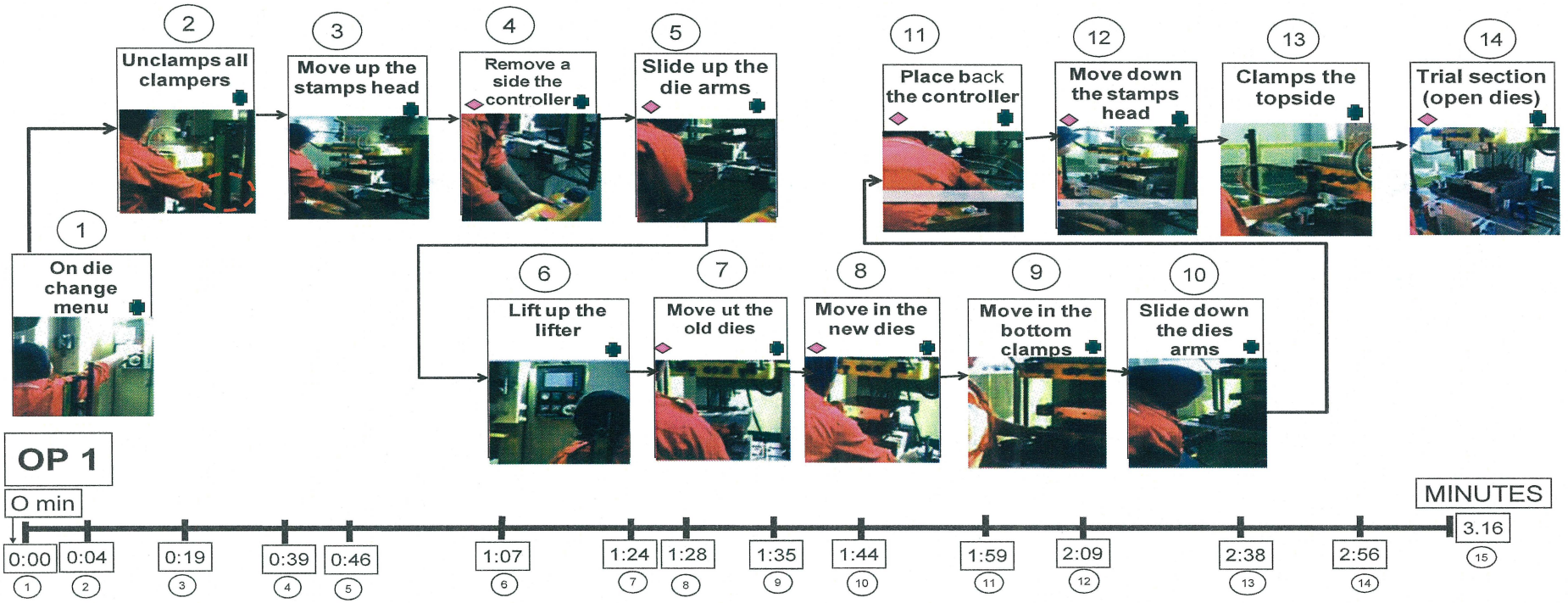


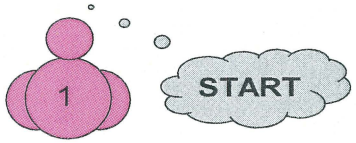
APPENDIX G

WORK INSTRUCTION

Rev. No.	Rev. Date	Revision Content	Prepared by	Approved by
0	28.5.2013	changeover dies at stamping	Siti Solehah	Najmiah Jaafar
1				
2				
3				
4				
5				
6				

PROCESS	DIES CHANGE (UCHI DANDORI)	MODEL	ALL MODEL FOR STAMPING	PART NAME	N/A	PART NUMBER	N/A





MAN POWER	QUALITY	SAFETY	CYCLE TIME	DIVISION NO
1	◆	✚	3.16 min	1/1

APPENDIX H1

SAFETY POINT OPERATION

REV NO		REVISION CONTENT	PREPARED BY		
0		Safety procedure	SITI SOLEHAH		
				REV. NO	0
				EFFECTIVE DATE	28.5.2013
				APPROVED BY	PREPARED BY

S.P.O	SECTION	Stamping	PROCESS	Die change	MACHINE	Stamping	NO. OF OPT	1	

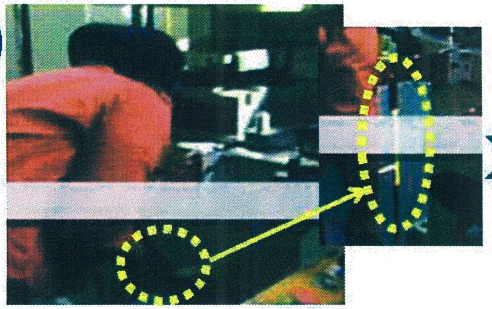
PPE (SAFETY EQUIPMENT)

Safety Shoes

1

Operation	Unclamps the topside
Safety	Place the auto clamper at it hook to avoide the stamps head hit the clamper while moving the head upwards.
Quality	N/A

2

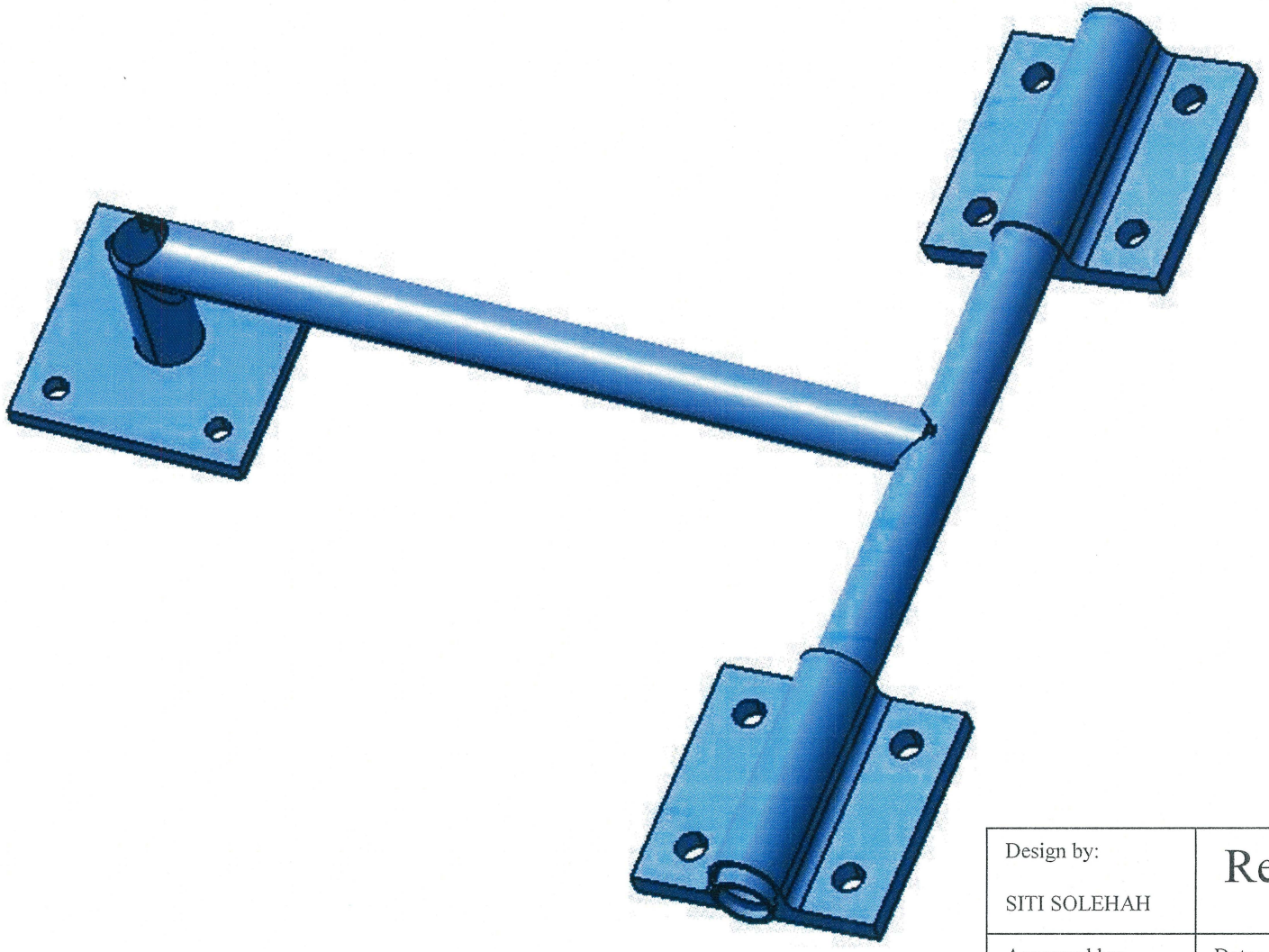


Operation	Slide up and down the adjustable die arms
Safety	Please hold the die arms at the right place to avoid the finger clog between the stands and the roller.
Quality	N/A

3

Operation	Move in and out the dies
Safety	Please hold at the safety holder as to move the die in or out just to avoid the finger slip towards the bottom dies while it moving.
Quality	N/A

APPENDIX H2



Design by: SITI SOLEHAH	Recommended Design		
Approved by: NUR NAJMIYAH	Date: 28/5/2013	Scale: 1:5	Page: 1/1

APPENDIX I