DESIGN AND DEVELOPMENT AN ERGONOMIC SMED'S EXTERNAL PRERPARATION FOR SMALL PRESS DIE AT FKP LAB

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Name of Supervisor : PUAN NUR NAJMIYAH BINTI JAAFAR

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Date : 19 JUNE 2013

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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 and is not concurrently submitted for award of other degree.

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DEDICATION

To beloved Mother and Father

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ABSTRACT

Single Minute Exchange of Dies (SMED) mainly focuses on recognition of internal and external activities. It is concerned particularly with transferring internal activities into external ones in as many numbers as possible, by also minimizing the internal ones. The major problem when operating a press machine is when the process of changing a die to a new one in order to produce other products. The die changing process is too long to be completed. Much energy is used through the process of changing of die includes human and machine. The objective of this project is to design and fabricate good external preparation equipment (prototype) for small press dies as a reflection to the next semester students who will continue this project in order to produce the actual product. The major step through this project is to study current condition of press machine. After study the current condition, went to PHN Industry Sdn Bhd for a pilot visit to get the related information of the project. Then the design idea is come out through the visit after seeing the condition at stamping department at PHN Industry Sdn Bnd. Two conceptual designs are produced using CAD Software which is Catia V5 and the design that fits the condition at Fakulti Kejuruteraan Pembuatan (FKP) laboratory was selected and validated by the supervisor. The selected design stimulated into rapid prototyping machine and fabricated. A prototype of external preparation equipment for small press dies (Die T-Table) is produced using rapid prototyping machine. This project will bring the idea for the next semester final year student who will continue this project and will assist them in order to produce the actual Die T-Table to be attached at stamping machine in FKP Laboratory.

ABSTRAK

Single Minute Exchange of Die (SMED) menumpukan kepada pengiktirafan aktiviti dalaman dan luaran. Ia adalah berkenaan dengan memindahkan aktiviti-aktiviti dalaman ke aktiviti luaran seberapa banyak yang mungkin, dengan juga mengurangkan aktiviti dalaman. Masalah utama apabila mengendalikan mesin hentakan adalah apabila proses menukar acuan yang lama kepada yang baru untuk menghasilkan produk-produk lain. Proses untuk menukar acuan mengambil masa terlalu lama untuk disiapkan. Banyak tenaga digunakan melalui proses menukar acuan termasuk tenaga manusia dan mesin. Objektif projek ini adalah untuk merekabentuk dan menghasilkan peralatan penyediaan luaran yang baik (prototaip) untuk mesin hentakan kecil sebagai gambaran kepada pelajar-pelajar semester seterusnya yang akan meneruskan projek ini bagi menghasilkan produk yang sebenar. Langkah utama melalui projek ini adalah untuk mengkaji keadaan semasa mesin hentakan. Selepas mengkaji keadaan semasa, pergi ke PHN Industry Sdn Bhd sebagai lawatan perintis untuk mendapatkan maklumat yang berkaitan dengan projek. Kemudian idea reka bentuk terhasil selepas melihat keadaan di kawasan mesin hentakan kecil di PHN Industry Sdn Bhd. Dua reka bentuk konsep dihasilkan menggunakan perisian CAD yang Catia V5 dan reka bentuk yang sesuai dengan keadaan di Fakulti Kejuruteraan Pembuatan (FKP) makmal telah dipilih dan disahkan oleh penyelia. Reka bentuk yang dipilih disalur ke mesin prototaip pantas dan terus dibina. Satu prototaip peralatan penyediaan luar untuk mesin hentakan kecil (Die T-Table) dihasilkan menggunakan mesin prototaip pantas. Projek ini akan mengutarakan idea untuk pelajar yang akan mengambil subjek projek tahun akhir pada semester akan datang yang akan meneruskan projek ini dan akan membantu mereka untuk menghasilkan Die T-Table yang sebenar yang akan dipasang pada mesin hentakan kecil di Makmal FKP.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The industrial manufacturing industry is responsible for the fabrication of products intended for industrial use from raw materials; it is the output of this industry which has made further mass manufacturing possible in most other industries. It is responsible for producing a variety of different machinery, from huge industrial to simple household machines, as well as other industrial-use products such as hardware, paper and packaging materials, glass, and other fixtures. However, in spite of the huge range of products, they all have a common function: to eliminate or reduce the amount of human energy expenditure, or manpower**,** needed to complete the job. No matter what type of machinery is employed, it is crucial in producing many of the goods and services vital to any economy in a timely and cost-efficient manner.

In the past a lot of effort has been put to reducing the cycle time and speeding up the output rate whilst totally ignoring the change overtime from one product to another. This has lead to the Economic batch quantity Concept and has resulted in small batches appearing to be Uneconomical to run. Reducing Setup times can give the equivalent of huge increase in process speed. This is all achieved without detriment to the quality of the Product. The idea of a setup time reduction Plan is move towards SMED (Single Minute Exchange Die) or OTED (One Touch Exchange of Dies).

1.2 PROBLEM STATEMENT

Lean Production System is about constantly finding the most convenient solutions possible. It concerns everything from reducing or eliminating unnecessary waste to giving customers exactly what they want. The concept was introduced in Japan by Toyota. That is also where it was refined and tested. Today, decades later, the thoughts and ideas have spread all over the world to thousands of companies.

The major problem when operating a press machine is when the process of changing a die to a new one in order to produce other products. Now, the die changing process is taking too long to be completed. Much energy is used through the process of changing of die includes human and machine. Forklift is used to remove existing die on the machine and then lift the other die to put back into the press machine. Manpower then used to make sure the mold is in the right position. The workers had to use a lot of energy to move the mold to make sure it is in the required position. Here, too much time and energy has been wasted to complete the conversion process mold.

As such, a necessary tool to save time and labor during the conversion process of the dies. The main purpose of this project is to reduce the changeover time at a small press machine located at Manufacturing Engineering Laboratory by reducing or eliminating activities that do not provide benefits. So in this stage of project, a prototype of external preparation activities at small press machine will be produced before it goes to the next stage which is to produce the actual equipment.

1.3 PROJECT OBJECTIVE

The objective of this project is to design and fabricate good external preparation equipment for small press dies. Stamping machines that available in the FKP laboratory serve as inspiration to create a suitable table design so that the resulting design will be appropriate and to the machine and its environment in terms of size and dimensions. The size of the resulting prototype will be scaled down to a scale of 1:5. The design of Die T-Table will be drawn using CAD Software which is Catia V5 and the prototype will be produced using the Rapid Prototyping machine. Rapid prototyping is a group of techniques used to quickly fabricate a scale model of a physical part or assembly using three-dimensional computer aided design (CAD) data. Construction of the part or assembly is usually done using 3D printing technology. The first techniques for rapid prototyping became available in the late 1980s and were used to produce models and prototype parts. Today, they are used for a wide range of applications and are used to manufacture production-quality parts in relatively small numbers if desired without the typical unfavorable short-run economics.

1.4 PROJECT SCOPE

i. The small press machine 60 tonnes that are located at Manufacturing Engineering Laboratory.
ii. The project will be focused only on external preparation activities during the changing process of the dies.
iii. The main target of this project is designing and producing a prototype of external preparation equipment for small press dies.

1.5 OUTPUT EXPECTED FROM THE RESULT

i. Able to design the Die T-Table using CAD Software.
ii. Able to fabricate the prototype of Die T-Table

1.6 Definition of Term

Changeover: In manufacturing, changeover is the process of converting a line or machine from running one product to another. Changeover times can last from a few minutes to as much as several weeks in the case of automobile manufacturers retooling for new models. The terms set-up and changeover are sometimes used interchangeably however this usage is incorrect. Set-up is only one component of changeover.

Internal setup: Operations that only can be performed when the machine is stopped. For example, mounting or removing dies.

External setup: Operations that can be conducted while the machine is operating. For example, transportation of tools and parts to where they are needed.

Setup time: Period required preparing a device, machine, process, or system for it to be ready to function or accept a job. It is a subset of cycle time.

Single Minute Exchange of Die (SMED): One of the many lean production methods for reducing waste in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product

Quick Changeover: On the base of Single Minutes Exchange of Dies (SMED) helps operator to reduce setup time, improve the effective machine running time, and surely increase the quality.

Downtime: Period during which an equipment or machine is not functional or cannot work. It may be due to technical failure, machine adjustment, maintenance, or non-availability of inputs such as materials, labor, power. Average downtime is usually built into the price of goods produced, to recover its cost from the sales revenue. It is also called waiting time.

CHAPTER 2

LITERATURE REVIEW

2.1 THE HISTORY OF LEAN

After World War II Japanese manufactures were faced with dilemma of vast shortage of material, financial and human resources. The problems that Japanese manufactures were faced with differed from those of their westerns counterparts. These conditions resulted in the birth of the "lean" manufacturing concept. Toyota Motor Company, led by its president Toyota recognized that American automakers of that era were out-producing their Japanese counterparts, in the mid- 1940's. American companies were outperforming their Japanese counterparts by a factor of ten. In order to make a move toward improvement early Japanese leaders such as Toyoda Kiichiro, Shigeo Shingo and Taiichi Ohno devised a new disciplined, process oriented system, which is known today as a "Toyota Production System" or "Lean Manufacturing".

Taiichi Ohno, who was given the task of developing a system that would enhance productivity at Toyota is generally considered to be the primary force behind this system. Ohno drew upon some ideas from the west and particularly from Henry Ford's books "Today and Tomorrow". Ford's moving the assembly line of continuously flowing material formed the basis for the Toyota Production System. After some experimentation, the Toyota Production System was developed and refined between 1945 and 1970, and it is still growing today all over the world. The basic underlying idea of this system is to minimize the consumption of resources that add no value to the product. In order to compete in today's fiercely competitive market, US manufactures have come to realize that the traditional mass production concept has to be adapted to the new ideas of lean manufacturing.

2.2 WHAT IS LEAN?

Lean manufacturing, lean enterprise, or lean production, often simply, "Lean", is a production practice that considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target for elimination. Working from the perspective of the customer who consumes a product or service, "value" is defined as any action or process that a customer would be willing to pay for.

Essentially, lean is centered on preserving value with less work. Lean manufacturing is a management philosophy derived mostly from the Toyota Production System (TPS) (hence the term Toyotism is also prevalent) and identified as "Lean" only in the 1990s (*Womack e.t al, 1990*). TPS is renowned for its focus on reduction of the original Toyota seven wastes to improve overall customer value, but there are varying perspectives on how this is best achieved. The steady growth of Toyota, from a small company to the world's largest automaker has focused attention on how it has achieved this success (*Bailey e.t al, 2007*).

The lean manufacturing (LM) or Toyota Production System (TPS) was pioneered by a Japanese automotive company, Toyota, during 1950's. Due to its global superiority in cost, quality, flexibility and quick respond. LM was transferred across countries and industries (*Schonberger, 2007*).LM has become a widely acceptable and adoptable best manufacturing practice across countries and industries (*Holweg, 2007*). The primary goals of LM were to reduce the cost of product and improve productivity by eliminating wastes or non-value added activities (*Womack e.t al, 1990*).

The success of LM implementation depends on several factors and approaches. Prior study has identified four critical success factors: leadership and management, financial, skills and expertise,and supportive organizational culture of the organization (*Achanga e.t al, 2006*). Other researchers also suggested that applying the full set of lean principles and tools also contribute to the successful LM transformation (*Herron e.t al, 2007*). However, in reality not many companies in the world are successful to implement this system (*Balle, 2005*). Furthermore, previous researchers insist that there is no “cookbook” to explain step by step of the LM process and how exactly to apply the tools and techniques (*Allen, 2000*). Many manufacturing companies have implemented LM in many different ways and names in order to suit with their environment and needs. Therefore, it is important to conduct the research in order to identify the approaches and processes in LM implementation.

Lean focuses on abolishing or reducing waste (“muda” the Japanese word for waste) and on maximizing or fully utilizing activities that add value from the customer’s perspective. From the customer’s perspective, value is equivalent to anything that the customer is willing to pay for in a product or the services that follows. So the elimination of waste is the basic principle of lean manufacturing.

2.3 CHANGOVER

In manufacturing, changeover is the process of converting a line or machine from running one product to another. Changeover times can last from a few minutes to as much as several weeks in the case of automobile manufacturers retooling for new models. The terms set-up and changeover are sometimes used interchangeably however this usage is incorrect. Set-up is only one component of changeover. Example: A soft drink bottler may run 16oz glass bottles one day perform a changeover on the line and then run 20oz plastic bottles the next day.

The key to success in many manufacturing businesses is a move toward a leaner, more flexible, more responsive manufacturing environment. The ability of a company to change over rapidly from one product to another is essential if this move is to be achieved. There is a significant amount of information in the literature on specific ideas that have been used to reduce changeover times, but in the vast majority of cases this rich source of data is ignored by companies undertaking changeover reduction programmed. Change over time that is illustrated in Figure 2 is defined as a method of analyzing and reducing the time needed to change a process from producing one good part to producing the next good part.

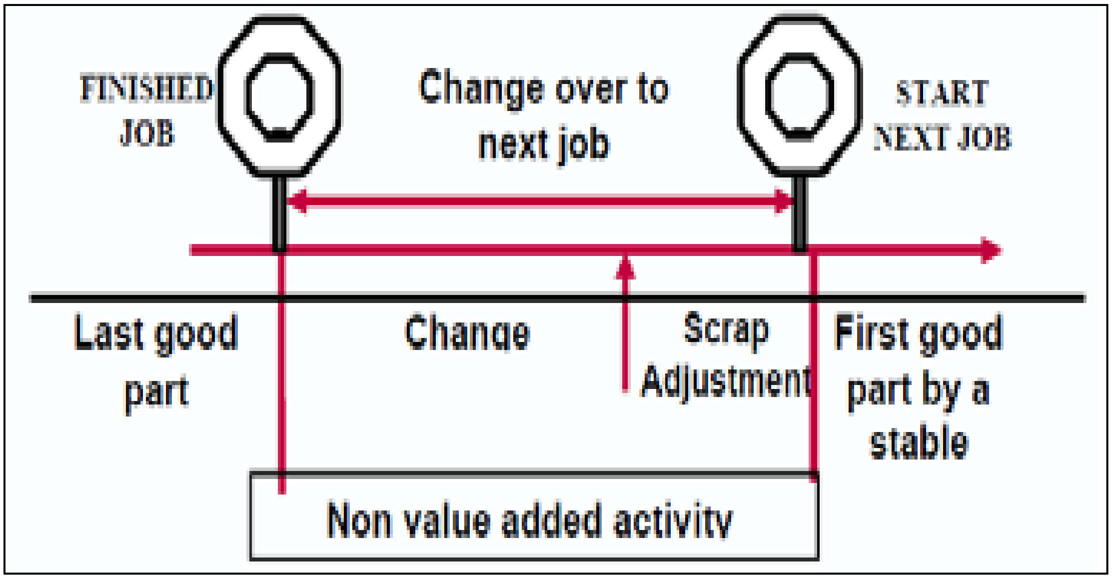


Figure 2.1: Representation of change over time

Source: Paudzi Abdullah module 2013

2.4 REDUCING CHANGEOVER

The need to reduce changeover times, or set-up reduction (SUR), was first realized by Shingo'. This arose from Toyota's development of their Just-In-Time based production system. Shingo's contribution was the development of SMED (Single Minute Exchange of Dies), which gained improvements mainly by adopting improved working methods, and which was based on the concept of moving internal to external work.

Other practitioners followed, notably Hay and Mather from the United States, who again concentrated on the improved method aspects of SUR.

In more recent years, companies have become increasingly focused on market and customer responsiveness. The problem has been to achieve this while at the same time reducing stocks throughout the whole process of manufacture. This has led, particularly in the automotive industry, to the adoption of a series of techniques that are collectively termed lean manufacture. Again, it has been recognized that the ability to rapidly and accurately changeover machines and equipment from manufacturing one product to another is a key requirements.

The SMED approach is defined as the period between the last good product from previous production order leaving the machine and the first good product coming out from the following production order (*Gest e.t al, 1995*). Most initiatives for set-up reduction time have been associated with Shigeo Shingo's "Single Minute Exchange of Die" (SMED) methodology (*Shingo, 1985*). SMED was proposed as a workshop improvement tool focusing on low cost proposals with a kaizen improvement basis, involving shop floor teams (*McIntosh e.t al, 2001*). Later on, the evolution of Toyota Production System contributed to the spreading of the methodology around the world (*Liker e.t al, 2006*). Shingo claimed that SMED is a "scientific approach" to set-up time reduction that can be applied in any factory to any machine. With regards this statement, many studies are focusing in its applicability to other types of factories and machines (*McIntosh e.t al, 2000*).

Shingo (*Shingo, 1985*) bases his method on categorizing all setup activities into internal and external ones. With internal activities being the ones that can be performed only when the machine is shut down, and external being those that can be conducted during the normal operation of machine, when it is still running. These internal and external set-up activities involve different operations, such as preparation, after-process adjustment, checking of materials, mounting and removing tools, settings and calibrations, measurements, trial runs, adjustments, etc. SMED methodology is formed by four single stages (*Shingo, 1985*); a preliminary stage where the internal and external set-up conditions are not distinguished; the first stage were separating internal and external set-up takes place; the second stage where internal activities are converted to external ones; and finally the third stage focusing on streamlining all aspects of the set-up operation.

The application of Shingo's methodology usually results into two main benefits: increasing manufacturing capacity and improving the equipment flexibility (*Coimbra, 2009*). That allows working with smaller batch sizes, creating a flow of materials by eliminating waiting.

2.5 SINGLE-MINUTE EXCHANGE OF DIE (SMED)

Single Minute Exchange of Die (SMED) is one of the many lean production methods for reducing waste in a manufacturing process. It forms one of the key factors behind the success of the Just – in – Time (JIT) concept. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product. It is based on the concept of the Seven Wastes. Reducing time in changing over from one die to another is considered a saving in non-value adding process time. As reducing the change over time also results reduced inventories due to shorter runs, it is also considered a saving in the inventory. It is also often referred to as Quick Changeover (QCO). Closely associated is a yet more challenging concept of One-Touch Exchange of Die, (OTED), which says changeovers can and should take less than 100 seconds.

Working in any kind of manufacturing environment one of the unfortunate characteristics is waste. Waste can extend from unused raw material to damaged products, and it can carry quite of a financial loss for the company if not treated in an efficient manner. In order to reduce waste, there are several numbers of methods and strategies that companies can use depending on the desired results. One of the most popular methods is Single Minute Exchange of Die or SMED. SMED was developed by Shigeo Shingo in 1950s Japan in response to the emerging needs of increasingly smaller production lot sizes required to meet the required flexibility for customer demand. The SMED technique is used as an element of Total Productivity Maintenance (TPM) and “continuous improvement process”. It is one of the methods of a reducing wastage in a manufacturing Process. The phrase "single minute" does not mean that all changeovers and startups should take only one minute, but that they should take less than 10 minutes (in other words, "single-digit minute").

At Toyota, Shingo developed the concept of Single Minute Exchange of Dies (SMED) to reduce setup times (*Shingo, 1985*); for instance, setup time in large punch press could be reduced from hours to less than ten minutes. This has a big effect on reducing lot sizes. Another way to reduce the inventory is by trying to minimize machine down time (*Shingo, 1985*). This can be done by preventive maintenance. It is clear that when inventory is reduced, other sources of waste are reduced too. For example, space that was used to keep inventory can be utilized for the other things such as to increase facility capacity. Also, reduction in setup times as a means to reduce inventory simultaneously saves times, thus reduces time as a source of waste.

Ohno at Toyota developed SMED in 1950. Ohno’s idea was to develop a system that could exchanges dies in a more speedy way. By the late 1950s’s Ohno was able to reduce the time that was required to change dies from a day to three minutes (*Womack et al, 1990*). The basic idea of SMED is to reduce the setup time on a machine. There are two types of setup: internal and external. Internal setup activities are those that can be carried out only while the machine is stopped while the external setup activities are those can be done while the machine is running. The idea is to move as many activities as possible from internal to external.

Single-Minute Exchange of Die (SMED) refers to the theory and techniques used for the reduction of equipment setup times. SMED has as its objective to accomplish setup times in less than ten minutes, i.e. a number of minutes expressed by a single digit. Although not all setups can be literally reduced to this time, between one and nine minutes, this is the goal of the SMED methodology (*Shingo, 1985*).

SMED, also known as Quick Changeover of Tools, was developed by Shingo (1985), who characterized it as a scientific approach for the reduction of setup times, and which can be applied in any industrial unit and for any machine. SMED is defined as the minimum amount of time necessary to change the type of production activity taking into consideration the moment in which the last piece of a previous lot was produced vis-à-vis the first piece produced by the subsequent lot (*Shingo, 1985*). His pioneering work led to documented reductions in changeover times averaging 94% (e.g. from 90 minutes to less than 5 minutes) across a wide range of companies. Changeover times that improve by a factor of 20 may be hard to imagine, but consider the simple example of changing a tire:

- For many people, changing a single tire can easily take 15 minutes.
- For a NASCAR pit crew, changing four tires takes less than 15 seconds.

Many techniques used by NASCAR pit crews (performing as many steps as possible before the pit stop begins; using a coordinated team to perform multiple steps in parallel; creating a standardized and highly optimized process) are also used in SMED. In fact the journey from a 15 minute tire changeover to a 15 second tire changeover can be considered a SMED journey. In SMED, changeovers are made up of steps that are termed “elements”. There are two types of elements:

- Internal Elements (elements that must be completed while the equipment is stopped)
- External Elements (elements that can be completed while the equipment is running)

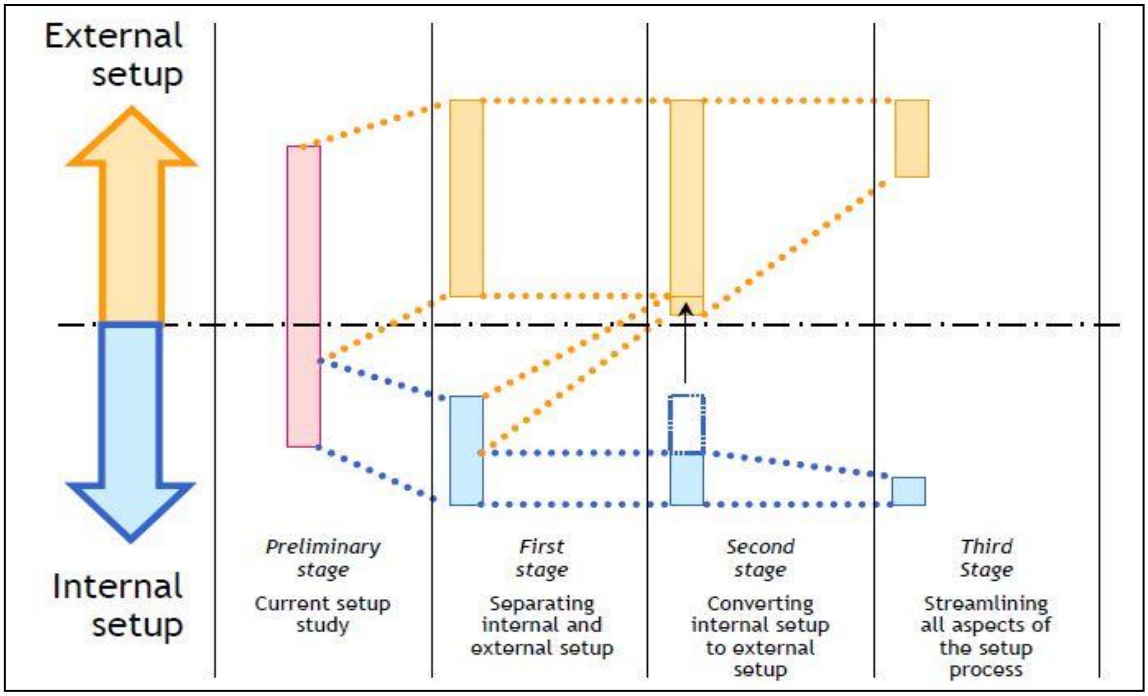


Figure 2.2: SMED methodology and its impact in the setup process

Source: Paudzi Abdullah module 2013

2.6 STAGES OF SMED

2.6.1 Current Setup Study

This first stage consists of studying the current setup process because simply put "what is unknown cannot be improved". It is necessary to know the process, the variability and the cause(s) that produce this variability.

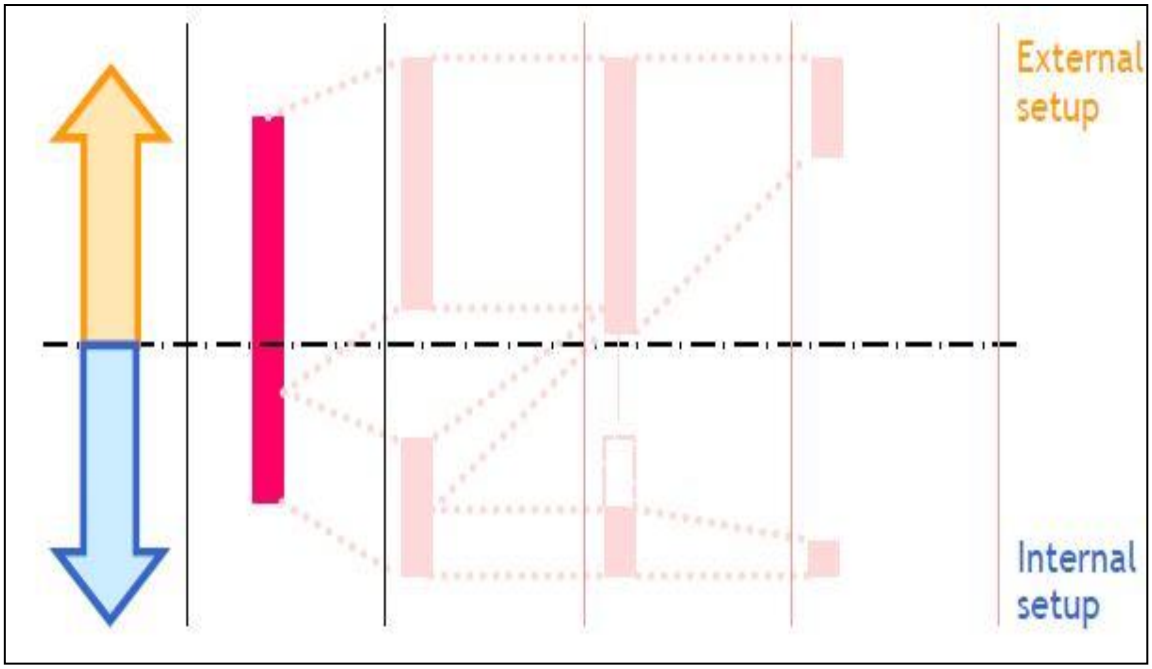


Figure 2.3: SMED preliminary stage

Source: Paudzi Abdullah module 2013

2.6.2 Separating Internal and External Setup

The first stage consists of separating the operations that should be carried out when the machine is still processing the previous lot (external setup) and those where it is necessary to carry out setup with the machine stopped (internal setup). The goal for this stage is to separate/classify setup operations according to the given definition of external and internal setup. This classification takes into account the same operations and duration included in the current method, that is to say, without improving any particular operation. Also, in this stage it is necessary to assure that the operations that are defined as external setup can all be carried out with the machine running.

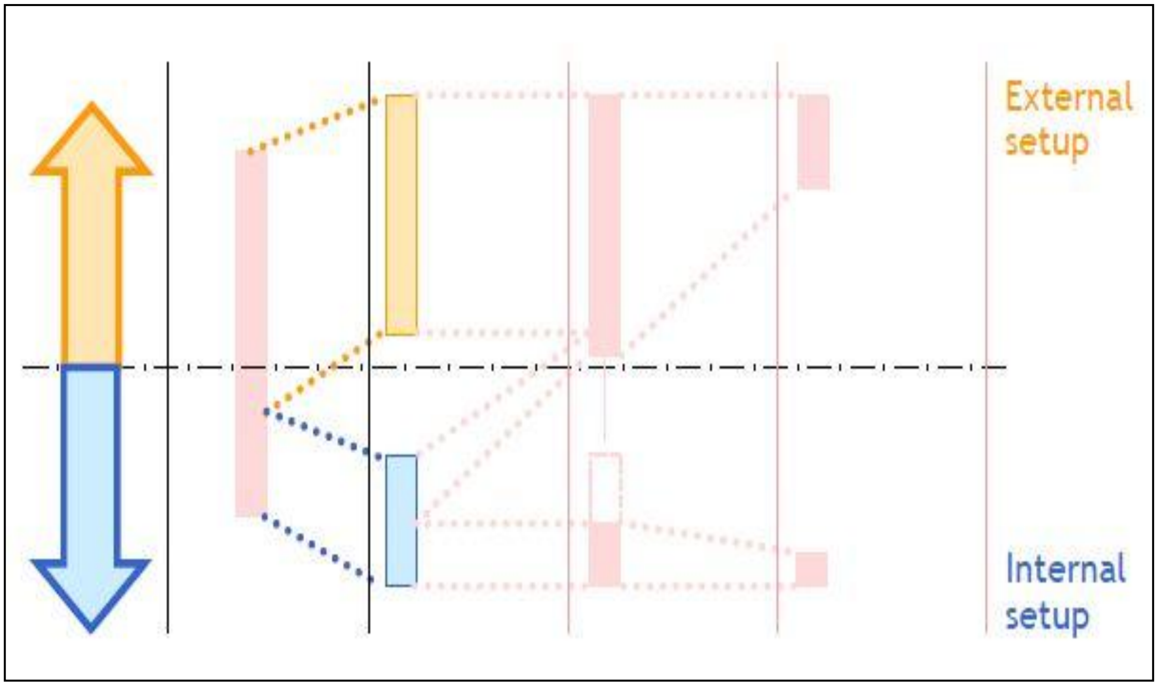


Figure 2.4: SMED first stage

Source: Paudzi Abdullah module 2013

2.6.3 Converting Internal Setup to External Setup

The setup process time reduction from the first stage can be very significant but is not where SMED ends. To reduce setup time as far as possible (or economical), it is necessary to study the possibility of converting some internal setup operations into external setup, so that they could be carried out while the machine is running.

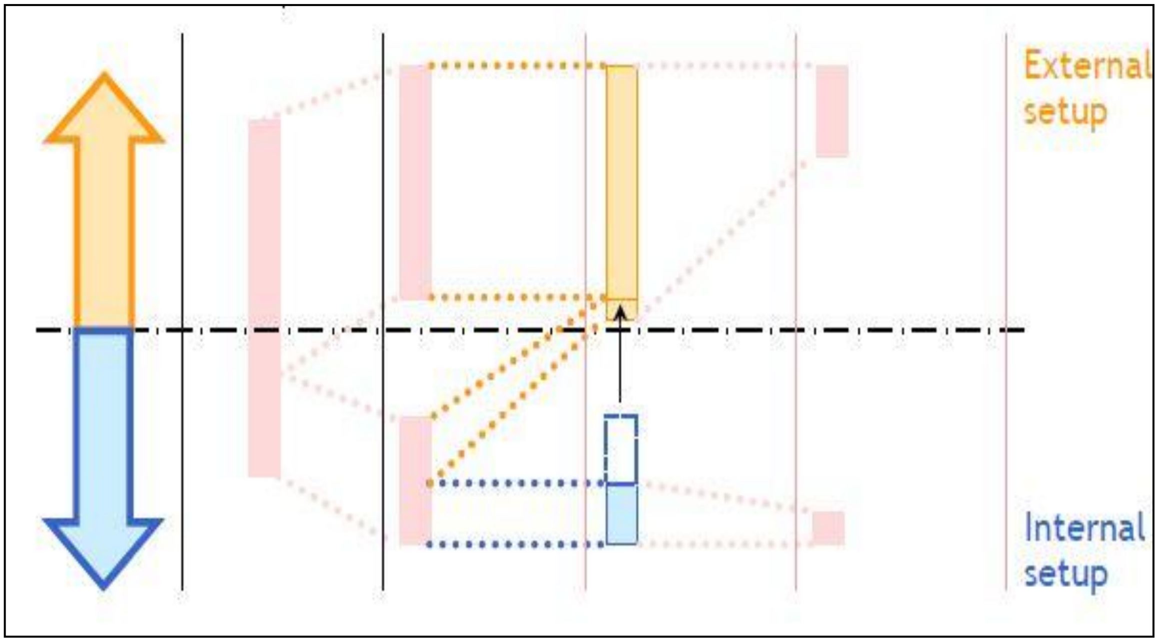


Figure 2.5: SMED second stage

Source: Paudzi Abdullah module 2013

2.6.4 Streamlining All Aspects of the Setup Process

This stage tries to improve all the setup operations, both internal and external, reducing their duration or even, if it is possible, trying to eliminate some operations. Although the SMED methodology recommends that one follows systematically these four stages, common sense can sometime dictate that, in the second stage, time and money will not be invested in operations that previously have not been optimized. For this reason, the application of the third stage usually run parallel to the second one, leaving a final "stage 3" for the improvement of the external setup operations and a revisit of the internal activities that have not been possible to convert into external.

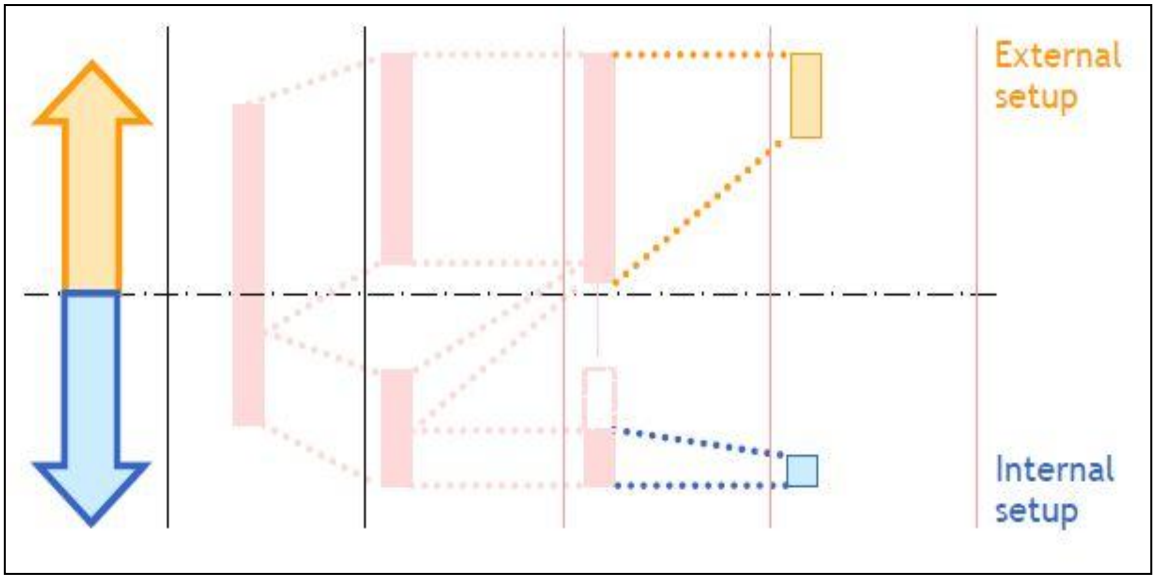


Figure 2.6: SMED third stage

Source: Paudzi Abdullah module 2013

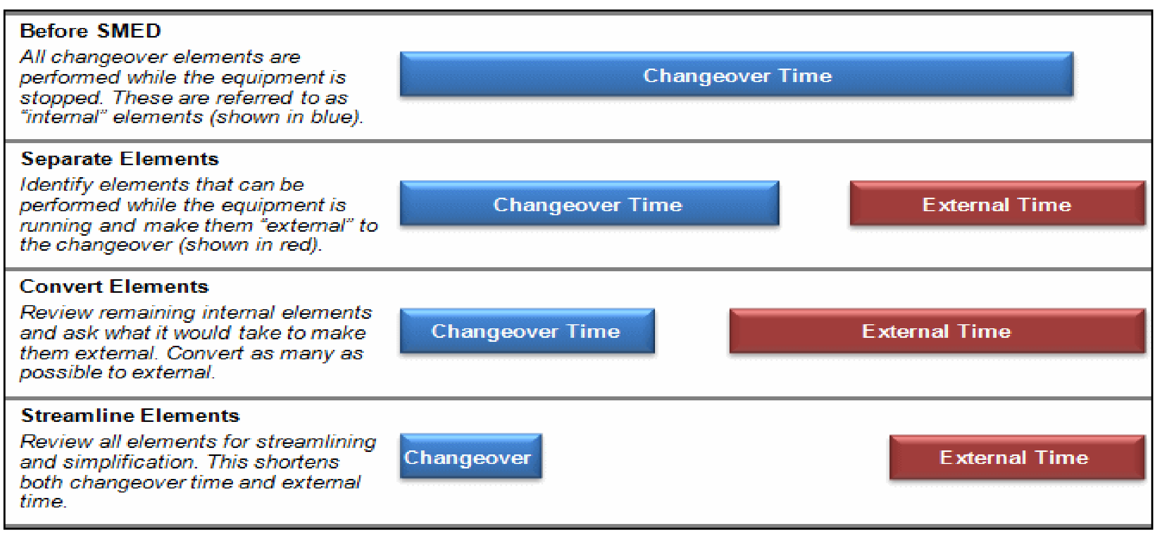


Figure 2.7: The SMED process focuses on making as many elements as possible external, and simplifying and streamlining all elements

Source: Paudzi Abdullah module 2013

2.7 EQUIPMENT FOR EXTERNAL ACTIVITIES

2.7.1 Die Carrier

After the stamping process is completed, the mold that has been used will be removed and stored in place of the original on the shelf that has been provided adjacent to the stamping machine in order to install the other die into the press machine. So a tool called as die carrier is required to make this process faster in order to reduce changeover time.

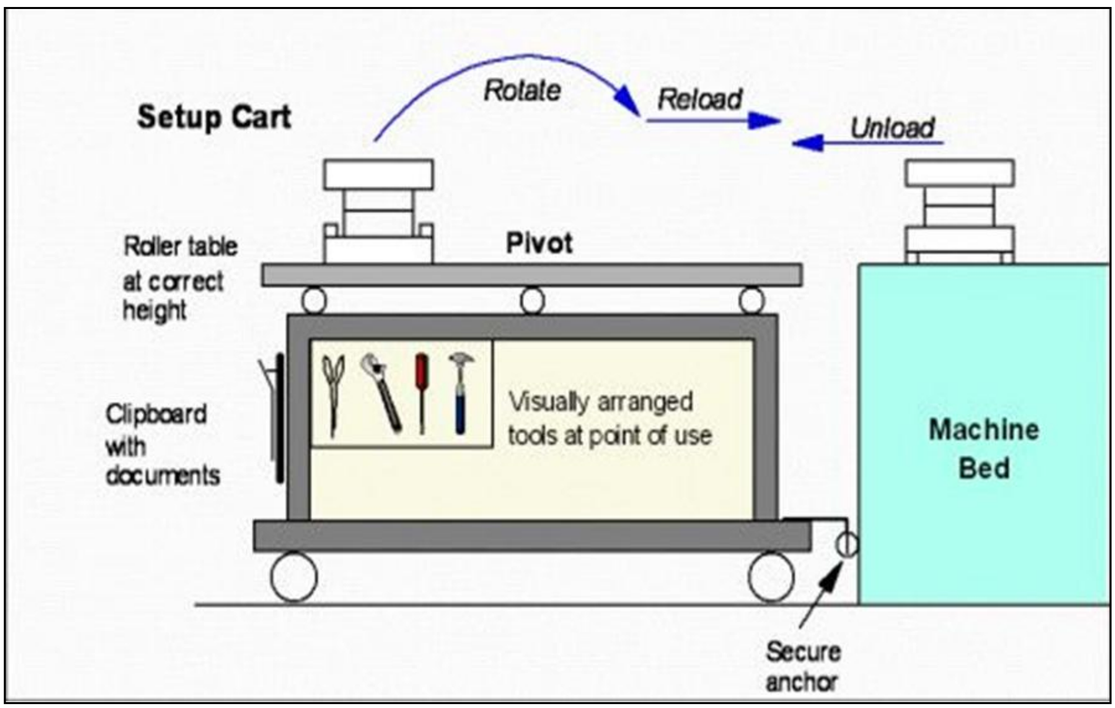


Figure 2.8: Illustration of how die carrier works

Source: Paudzi Abdullah module 2013

2.7.2 Die Storage Racking

Molds that have been used should be stored in a place nearby to facilitate the loading and unloading process. So a shelf to place the mold that was used to be placed close to the shock machine to in order to avoid wasting time and to reduce the operator's motion during the process of changing dies.

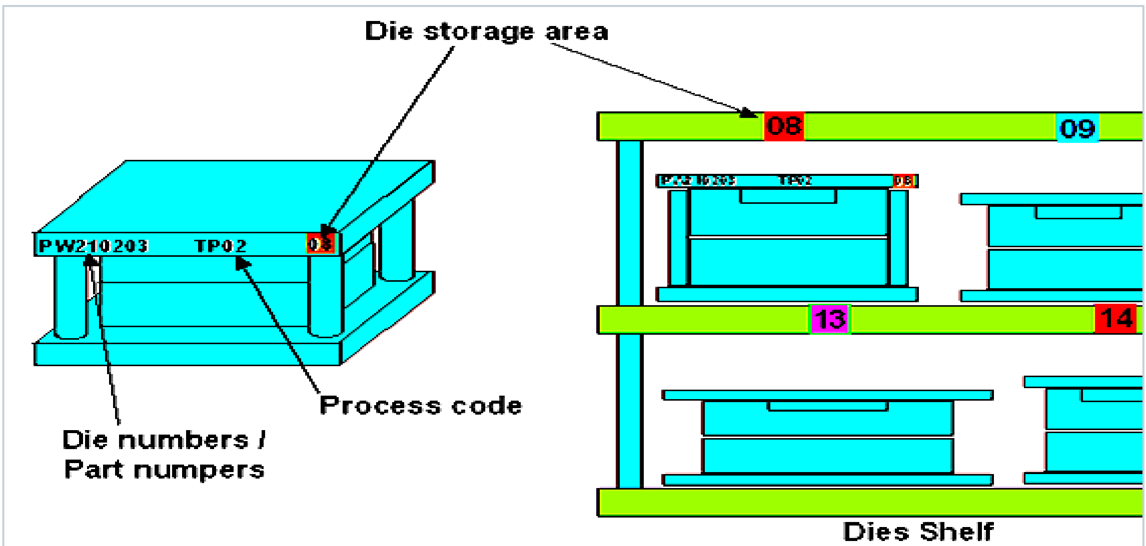


Figure 2.9: Example of die storing rack

Source: Paudzi Abdullah module 2013

2.8 ERGONOMIC

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize human well being and overall system performance. Practitioners of ergonomics, ergonomists, contribute to the planning, design and evaluation of tasks, jobs, products, organizations, environments and systems in order to make them compatible with the needs, abilities and limitations of people.

Humans are not good at doing monotonous and repetitive tasks or frequent heavy lifting. Computers, on the other hand, excel in doing massive amounts of calculations, but cannot perform tasks such as decision making or problem solving that requires adequate judgment of circumstances nor produce creative work on their own. As is clear from the above, humans and machines have their own specialties. Ergonomics is a practical science that, by understanding humans' physical, cognitive and mental characteristics and placing each system element at equal distance from humans, seeks optimal interactions between humans and system elements such as jobs, machines/tools, environments, organizations, social systems and organizational cultures (See the figure 2.9). What ergonomics deals with are interdisciplinary scientific outcomes and practical activities, such as ergonomic theories and rules, various relevant data and methods of design and evaluation, which are necessary in achieving the above mentioned goal. Ergonomics is a truly practical science that contributes to human safety, security, comfort, and the maintenance and improvement of health, and plays an important role in aiming for a safe, secure and healthy society.

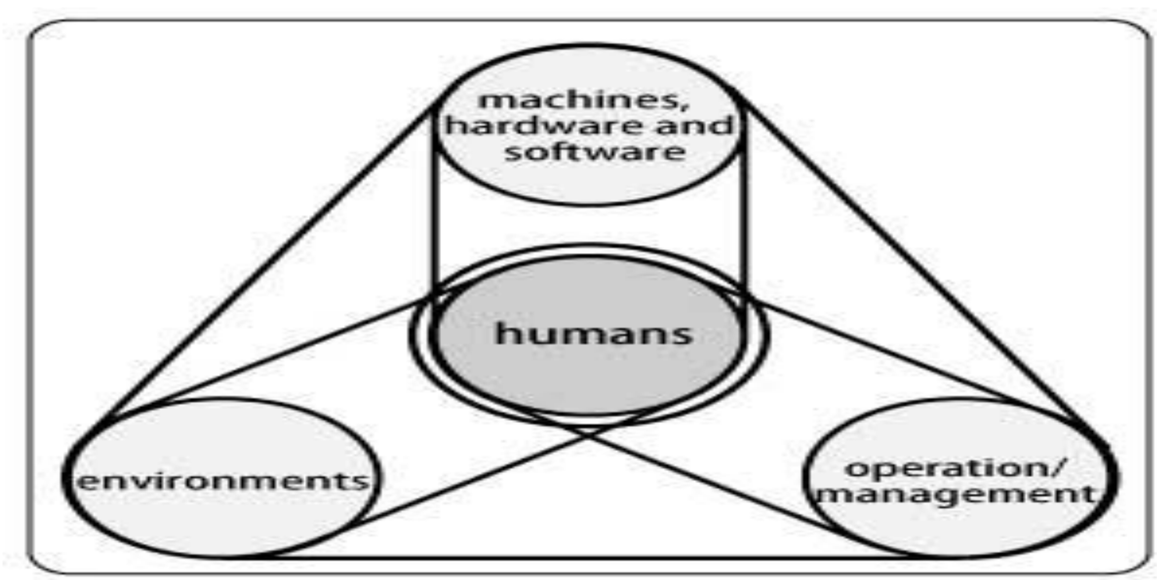


Figure 2.10: Human-centered design principles

Source: International Journal of Industrial Ergonomics 2006

2.8.1 Human Factors and Ergonomics

Human factors and ergonomics (HF&E) is a multidisciplinary field incorporating contributions from psychology, engineering, biomechanics, industrial design, graphic design, statistics, operations research and anthropometry. In essence it is the study of designing equipment and devices that fit the human body and its cognitive abilities. The two terms "human factors" and "ergonomics" are essentially synonymous. (University of Manchester, 2012)

Ergonomics or human factors is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. (International Ergonomics Association, 2010)

HF&E is employed to fulfill the goals of health and safety and productivity. It is relevant in the design of such things as safe furniture and easy-to-use interfaces to machines and equipment. Proper ergonomic design is necessary to prevent repetitive strain injuries and other musculoskeletal disorders, which can develop over time and can lead to long-term disability. Human factors and ergonomics are concerned with the "fit" between the user, equipment and their environments. It takes account of the user's capabilities and limitations in seeking to ensure that tasks, functions, information and the environment suit each user.

To assess the fit between a person and the used technology, human factors specialists or ergonomists consider the job (activity) being done and the demands on the user; the equipment used (its size, shape, and how appropriate it is for the task), and the information used (how it is presented, accessed, and changed). Ergonomics draws on many disciplines in its study of humans and their environments, including, biomechanics, mechanical engineering, industrial engineering, industrial design and information design.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter describes the method used to perform this research. Methodology is referred to a process or a tool used to conduct a research to obtain information and accomplish the targeted research. Further analysis of data collection is required in order to achieve the objectives as mentioned in Chapter 1 previously. A flowchart in Figure 3.1 depicts the methods for gathering data and information. The approaches used are entitled with:

a) Study the current state condition of the small press machine at Manufacturing Engineering Laboratory
b) Pilot visit to PHN Sdn Bhd
c) Comes out with the idea to design the external preparation equipment
d) Produce 2 conceptual designs using CAD Software
e) Compare and select the best design to be produced
f) Stimulate the design into Rapid Prototyping machine
g) Run the CAD data using Rapid Prototyping machine to fabricate the prototype
h) Conclusion and recommendation

3.2 PROCESS FLOW CHART

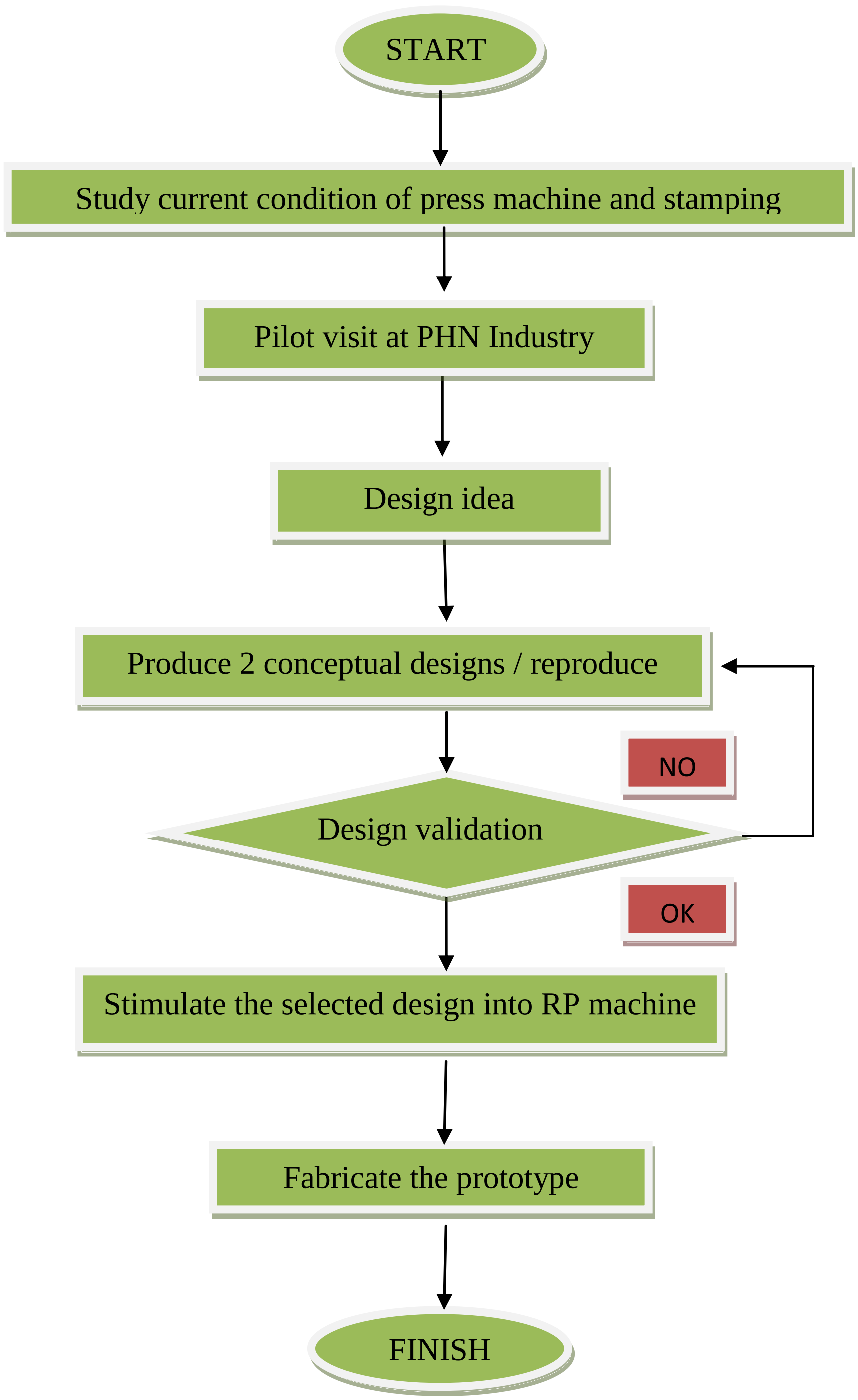


Figure 3.1: Flow Chart for methodology

3.3 LITERATURE REVIEW

Literature study is an initial move to acquire the primary vision with the purpose to identify problems and scope of the study. Literature review engages with reading process, discussion and observation which is completed before the data collection begins. The main area of study is to design and developing good external preparation equipment for small press machine.

3.4 LOCATION BACKGROUND

This project is focusing on the stamping machine that is located at Manufacturing Engineering Laboratory. There are two types of press machine which are 60 tonnes and 80 tonnes capacities. However, this project only involved press machine 60 tonnes. Studying the current condition of press machine to see the lack of that need to be improved to ensure the production process can be done in a quick and there is no waste in term of time and labor. A video recorder was used to analyze how setup tasks are executed in the current case. Then, based on the activities, total time is analyzed. Through the study, it can be concluded that there is a lack of a need to be improved to produce a complete stamping process cycle and do not waste time and labor. The most significant deficiencies that need improvement are in terms of equipment preparation to carry out the process of converting a die. As this project focused on SMED’s external preparation, a prototype of die change carrier is designed and fabricated. This prototype will bring the idea and also can help to determine the best manufacturing materials and process to the person who will continue this project in order to produce the actual product.

3.5 INDUSTRIAL BENCHMARKING

In the course of this study, a subject is required to serve as a benchmark for this project. So in this case, PHN Industry Sdn Bhd has been chosen as a benchmark or an idol of this project. From the observation, there are several types of die carries that has been used at PHN industry to do the changing dies process. There are three types size of dies which are small, medium and big. Every type of the dies have the different size of dies carrier in order to make the changing process of dies at each stamping machine run smoothly. The die carriers size is determine based on the weight of the dies that will be used. The heavier the dies, the greater size of the die carrier will be used.

3.5.1 SEPARATING INTERNAL AND EXTERNAL SETUP

The most important step in implementing SMED is distinguishing between internal and external Set up. By doing obvious things preparation and transport while the machine is running, the time needed for internal Set up, with the machine stopped, can usually cut by as much as 30 to 50 percent. There are three techniques help us separate internal external Set up tasks. These techniques are: using checklists, performing function checks, and improving transport of die and other parts.

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. Appendix 3 is showed the check sheet.

3.5.2 Checklists

A checklist lists everything required to set up and run the next operation. The list includes such items as:

- Tools, specifications, and workers required.
- Proper values for operating conditions such as temperature, pressure.
- Correct measurement and dimensions required for each operation

Checking items of the list before the machine is stopped helps prevent mistakes that come up after internal set up begun.

3.5.3 Function Checks

Function checks should be done well before Set up begins so that repair can be made if something does not work right. If broken dies, moulds, or jigs are not discovered until test runs are done, a delay will occur in internal Set up. Making sure such items are in working order before they are mounted will cut down set up time a great deal.

3.5.4 Improved Transport of Parts and Tools

Dies, tools, jigs, gauges, and other items needed for an operation must be moved between storage areas and machines, and then back to storage once a lot is finished. To shorten the time the machine is shut down, transport of these items should be done during external set up. In other words, new parts and tools should be transported to the machine before the machine is shutdown for changeover.

3.5.5 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. Figure 3.2 is show the SMED operation check list.

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.			
Prepared by		Verified by	

Figure 3.2: SMED operation check list

3.6 CONVERTING INTERNAL SET UP TO EXTERNAL SETUP

Perhaps the easiest way to achieve a significant reduction in a processes set-up time is to move certain aspects of the set-up to the external stage where, for example, adjustments can be made and tools prepared before the machine actually stops production. Shingo' cites the case of Arakawa Auto Body, where the provision of an external set-up table reduced set-up time from ten and half minutes to 30 seconds. Extensive use has been made of central tooling stores/ offline optical pre-setters to facilitate changeovers for machining processes. These will pre-set a group of tooling for a particular run. In one instance, the set-up time was reduced from 12 minutes to 30 seconds per spindle on a. transfer machine. However, it should be noted that centralized tooling areas can cause problems if the scheduling system is not adequate.

A subset of pre-setting is the rectification of any tool faults prior to changeover. Using last lift inspection, where the tooling and its performance are examined at the end of each run, the operators can ascertain what problems, if any, have occurred with the tooling. Rectification can then be undertaken whilst the machine is still set-up and running, hence avoiding the situation where a tool is brought to the machine for a changeover and is then found to be faulty. In addition, the settings, etc. for a good part produced at the end of a run can be recorded and used so that the system can be quickly adjusted for the next run.

As stated previously an effective scheduling system is required to enable changeover elements to be carried out externally, and for more efficient set-ups in general. This ensures that the correct tools and resources are at the machine at exactly the right time for the changeover. A number of cases have been noted where this has not been the case.

3.6.1 Advance Preparation of Conditions

Advance preparation of conditions means getting necessary parts tools and conditions ready before internal set up begins. Conditions like temperature, pressure, or position of material can be prepared externally while the machine is running. (Example, pre-heating of mould or material).

3.6.2 Function Standardization

SMED uses a targeted approach call function standardisation. It would be expensive and wasteful to make external dimensions of every die, tool or part the same, regardless of the size or shape of the product it forms. Function standardisations avoid this waste by focusing on standardising only those elements whose functions are essential to the set up. Function standardisation might apply to dimensioning, centring, securing, expelling, or gripping for instance.

3.7 STREAMLINING EXTERNAL SETUP

External set up improvement include streamlining the storage and transport of parts and tools. In dealing with small tools, dies, jigs, and gauges, it is vital to address issue of tool and die management. The objective in this phase is to accomplish the different setup operations in an easier, faster and safer way. In order to obtain positive result of the SMED implementation, a die change table is needed to help reducing changeover time. While pre staging, a die change table must be able to rotate while the new die is loading to the machine. A safety precaution must be follow by the user especially the using of stopper to avoid the die slide to the floor. After the die change is completed, the die must be returned to its own place. A die rack must be placed near to the machine area to reduce motion. The die rack must be marking with the die number and coloring the die. In order to make the operation smooth, a standard operation must be placed at the machine. All the procedure must be clearly states in the standard operation procedure. A checklist must be creating to ensure external activities are complete before stopping machine.

3.8 DESIGN IDEA

In PHN Industry, there are several types of stamping machine used sizes of large, medium and sedans. Types of mold carriers are also used by a particular machine capacity. Each machine has a carrying capacity of different dies. For example, the large stamping machine used crane system as die carrier. This is because the size of the die used is very large and weighs about 10 tons to 20 tons. The medium-sized stamping machine used a rotating table of die carrier. This type of mold carrier can accommodate loads within 3 tons to 7 tons. For small stamping, t-shaped mold carrier used and the load that can be covered by this type mold carrier is in the range of 0.5 tons to 3 tons. After a visit to the PHN Industry, insight to design mold carrier that will support the weight of mold in the laboratory FKP was imaginable.

3.9 CONCEPTUAL DESIGN

Product design is conceptualization of an idea about a product and transformation of the idea into the reality. To transform the idea into reality, a specification about the product is prepared. This specification is prepared by considering different constraints such as production process.

3.9.1 Reverse Engineering

Reverse engineering is a process of carefully dismantling a product, understanding its design and developing a product which is better than the existing one.

3.9.2 Cad-Cam

By using 3D modeling software system, a computerized model of the product was developed. After computer aided design (CAD), computer aided manufacturing (CAM) system produce the product by using rapid prototyping machine.

3.10 DESIGN VALIDATION

Design verification is an essential step in the development of any product. Also referred to as qualification testing, design verification ensures that the product as designed is the same as the product as intended.

3.10.1 Prototype Testing

This testing occurs with items that closely resemble the final product. This test stresses the product up to and beyond specified uses conditions and may be destructive. Testing occur at many levels. Generally, the more complex the product, the more levels of testing. For a complex system, tests might be conducted at the unit level, subsystem level then finally at the system level. Testing with prototypes allows the correction of deficiencies and subsequent re-testing before large commitments is made to inventory and production readiness.

3.10.2 Proof Testing

Proof tests also run through this project. This test is designed to test the product to failure. For example, if a table is designed to move (by roller) and support a certain amount of weight, prototype testing will be used to ensure that the table will able to move and also able to support the specified weight plus a pre-determined safety factor. Proof testing would continue loading the table until failure is reached - likely beyond the specified limits. These tests are often used to identify where eventual failures might occur.

3.11 STIMULATING AND FABRICATING

The complete Die T-Table design drawn in CAD software will be stimulated first to the rapid prototyping machine to ensure the size of the design fits the platform of the machine. In this case, if the size of the CAD drawing exceeds the size of rapid prototyping machine's platform, the fabricating process of the prototype cannot be run. The size of the drawing must be in the range of the machine's platform. After the stimulating process completed, the fabricating process of the prototype will began. The time taken to complete the fabricating process is depending on the size of the prototype model.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter will briefly discuss on the analysis data collection from the pilot visit at PHN Industry, result and discussion regarding on the project. This part will be discussed on the designing and fabricating of the external preparation activities equipment for small press dies. The results were obtained by using two different tools which are CAD software (Catia V5) and Rapid Prototyping machine.

4.2 PRODUCT FUNCTION

The main function of this Die T-Table is to make the changing process of the dies runs smoothly and at the same time reducing the changeover time of the dies. The components of this product consist of mild steel body frame, roller and bowl bearing. These components can support and allow the movement of dies. This prototype will serve as a reference for next semester final year project student who the ahead in their quest to produce actual product. A developed prototype helps to work out the details of the invention. Identifying design flaws and weaknesses is much easier when we can actually test the invention. Engineering drawings and artwork alone cannot prove the concept in the same manner that a prototype can, where the prototypes help to ensure that the invention will work the way we intended.

4.2.1 Working principle

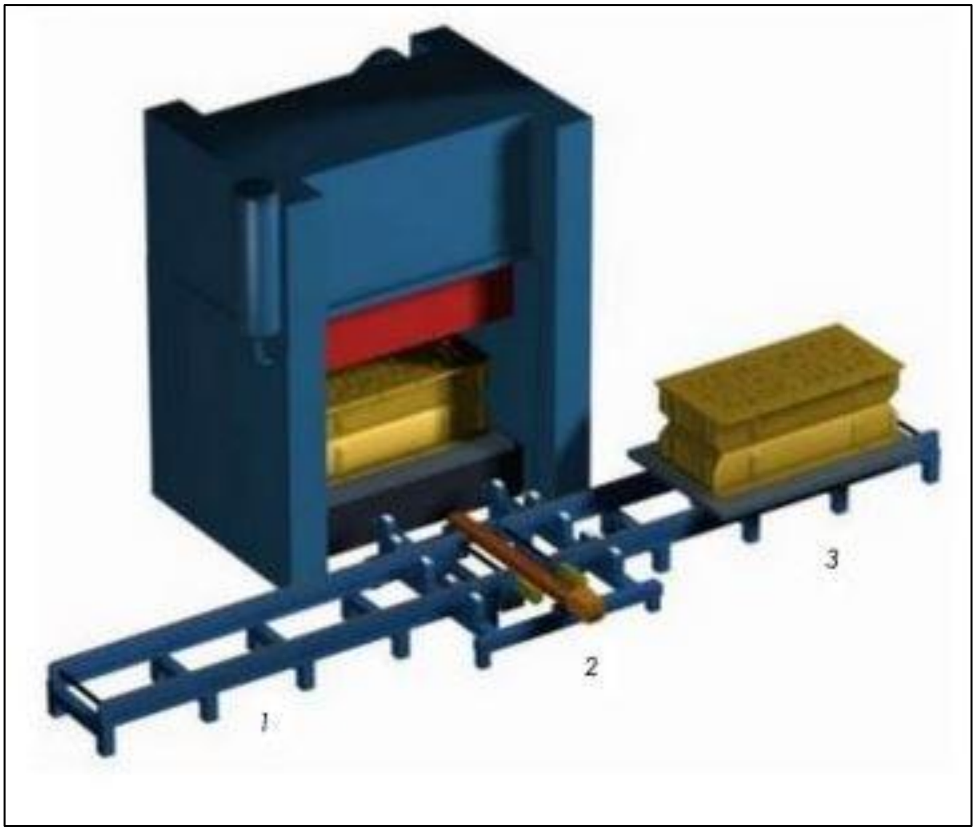


Figure 4.1: Working principle of Die T-Table

This Die T-Table is attached on the side of stamping machine and it is in stationary position and not moving. When the machine is stop running after completing the production of certain product, another dies is needed to be attached to the machine in order to produce the new product. So, new die that will be use delivered to station 1 and conveyed to station 3 for pre staging and waiting for changeover. Then the out-going die is pulled to station 2. The conveyor indexes both dies to the left to move the out-going die to station 1 for pick up and move the incoming die to station 2 and then the die are pulled to the machine.

4.3 DESIGN CONSIDERATION

In order to ensure the moving parts of the Die T-Table is function, there are a few design of the product that should be considered.

1) The roller must a little bit higher than C bar so that it can move when certain load is applied on it. If the level of the higher surface of the roller is same or lower than the height of C bar, the roller will not function.
2) The height of bowl bearing also must be same with the height of the roller.
3) For safety element, levels of the angle bar barriers must higher so that the moving dies cannot slide down on the floor.

4.4 SAFETY

Element of safety is very important to produce the product that will withstand heavy loads such as dies. The equipment to be used must be equipped with high safety features to avoid any injuries to the person that will use that equipment. There are several safety elements that should be considered during the designing stage for this Die T-Table. They are:

4.4.1 Adjustable stopper

It is compulsory to have a set of stopper at the end of Die T-Table. The stopper is needed to avoid the heavy dies slip down on the floor that might causes severe injuries to the person who operated the press machine.

4.4.3 Angle bar barriers

The height of the angle bar barrier will avoid the dies slip out from the table. Other than the adjustable stopper, angle bar barrier also is needed to avoid the dies slip down on the floor.

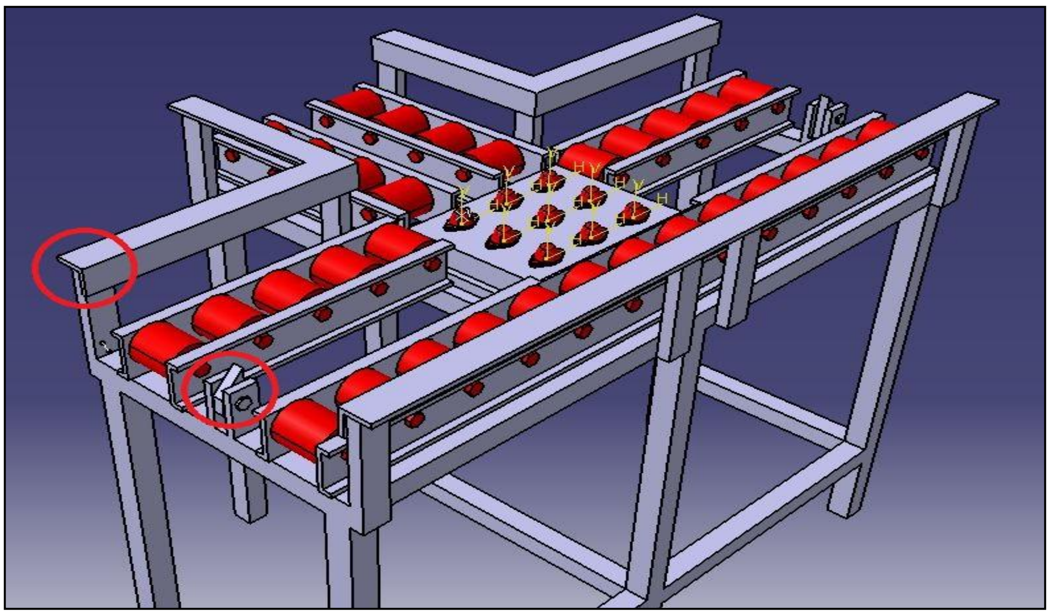


Figure 4.2: Safety elements of Die T-Table (stopper and angle bar barrier)

4.5 DESIGN OF DIE T-TABLE

The design of Die T-Table is the result of a visit to the PHN Industry. There are several types of die carrier there but this type of design is more appropriate to the environment of FKP laboratory, machine capacity and weight of dies that available here. (Please refer to appendix B).

4.6 PARTS OF THE DIE T-TABLE

1) Angle bar
2) Bowl bearing
3) Bolt
4) Roller
5) Shaft
6) Stopper

(Please refer to Appendix C).

4.7 PROTOTYPE OF DIE T-TABLE

Figure 4.3 show the prototype of Die T Table. The scale of the prototype size to the actual size is 1:5.

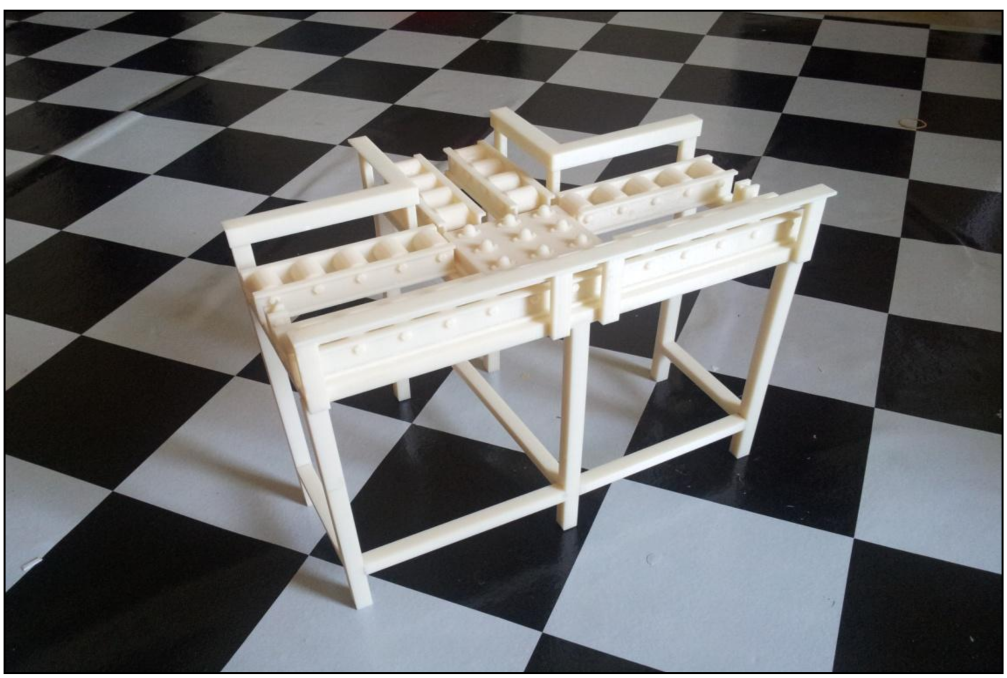


Figure 4.3: Prototype of Die T-Table

4.8 ERGONOMICS ANALYSIS USING JACK

There are few steps before analyzing the ergonomic of the implementation die carrier for small press die using jack. An environment is required and human must be created before run the simulation and analysis. After setup the environment, ergonomics analysis can be created using a few different types of tools. In this study, the tools that were used are Force Solver, Low Back Analysis and Ovako Working Posture Analysis System (OWAS). (Normala Zulkufli 2013)

Table 4.1: Human Task

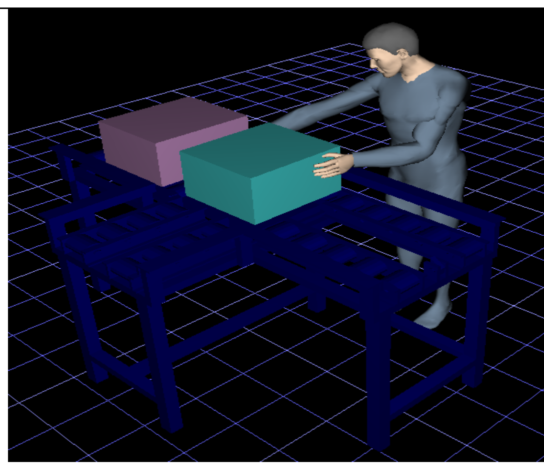
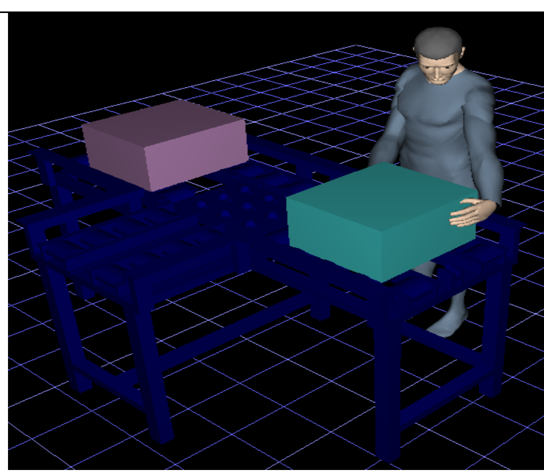
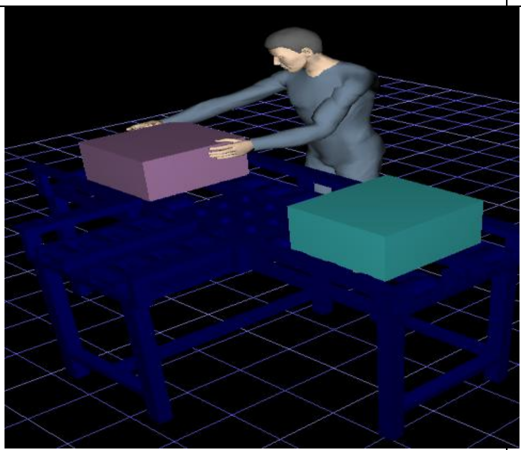
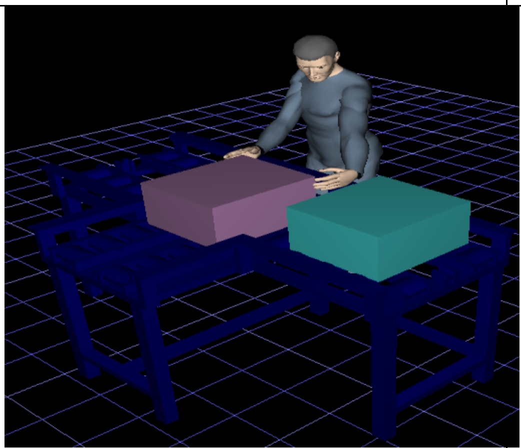
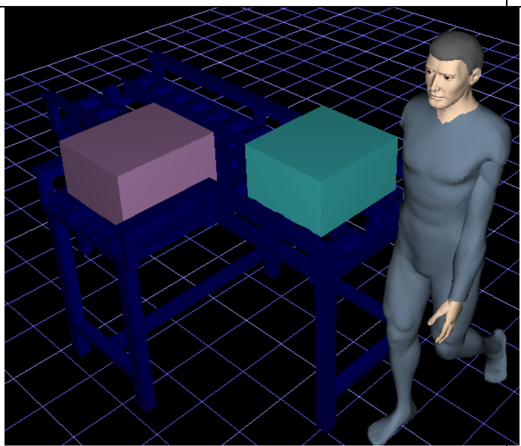
Task	Description
	Motion 1 • Operator moves both his hand and touch the die A.
	Motion 2 • Operator moves die A to the left. • The die stayed on the carrier.

Table 4.1: Continued

Task	Description
	Motion 4 • Operator moves both his hand and touch the die B.
	Motion 5 • Operator moves die B toward press machine base.
	Motion 6 • Operator walks to the die B and continues stamping process.

Source: Normala Zulkufli 2013

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter will discuss about conclusion of the project about design and development an ergonomic SMED's external preparation for small press dies at FKP lab. The final chapter concludes with a summary of entire research project. This conclusion was examined whether the objective is achieved or not, the discussion of the problems faced during the project also mentioned. Further, this chapter will also conclude this study and provide suggestions for next researchers in the future.

5.2 CONCLUSION

The project of design and development a prototype for ergonomic equipment focused on small press dies at FKP lab had achieved its overall target. There are two main objectives stated in the early stage of the project. The first objective is to design ergonomic of SMED's external preparation. The ergonomic design of the equipment for external preparation at the small press machine is one of the most important elements that should be considered to ensure the machine can be operated in good and comfort condition. Besides, the ergonomic design also can avoid the people who use that machine face with the body pain or long term injury. The design is depend on the normal height of the human because if the design of the T-Table is too height or too low than the normal height of the human, it will causes the pain and several types of injuries to the person who operated that machine. The second objective is to fabricate a prototype of ergonomic external preparation equipment for small press dies. A prototype is an original model on which something is patterned. A prototype can range from a crude mock-up developed by the inventor to professionally designed virtual prototypes and/or fully-functioning working samples. The process of taking the idea and turning it into a tangible product is called “reducing the invention to practice” and the first step in this process is the development of a prototype. A developed prototype helps to work out the details of the invention. Identifying design flaws and weaknesses is much easier when you can actually test the invention. In fact, engineering drawings and artwork alone cannot “prove” the concept in the same manner that a prototype can – prototypes help to ensure that the invention will work the way you intended. Developing a working prototype can also help to determine the best manufacturing materials and processes. The original invention may be altered based on the prototype.

5.3 PROBLEM ENCOUNTERED

There are not much problems encountered during the study of this project. The main requirement for doing this project is CAD software either Catia, SolidWorks, Pro Engineer and AutoCad. I prefer to use CATIA V5 because it is available at the CAD/CAM laboratory of Manufacturing Engineering and it can be installed at my own laptop. Over all at the designing stage, there is no problem associated with CAD software. But there are several problems at the stage of fabricating the prototype. The availability of the rapid prototyping machine is limited. Too many students wait their turn to use the rapid prototyping machine. I also have to rescale down the size of my CAD drawing because of the drawing is a little bit bigger than the platform of the rapid prototyping machine. When the fluctuations of the electricity occur at FKP, the rapid prototyping machine totally out and the process of fabricating the prototype stopped and cannot be run. So the fabricating process of the prototype needs to be re-run again because of when the machine stops, it will cause the damage to the product that being fabricate.

5.4 RECOMMENDATION FOR THE FUTURE

For future projects, it is being proposed that this design can be fabricate and attach to the small press machine at FKP laboratory. After attach the die carrier, do new time study in order to prove the efficiency of the die carrier. The implementation of die carrier is not just can be used for stamping process but can help students to understand SMED very well. Die carrier is an ergonomics product which is able to be used for SMED external preparation for small press machine. I hope this project bring the idea for the next semester final year student who will continue this project and will assist them in order to produce the actual Die T-Table to be attached at stamping machine in FKP Laboratory.

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APPENDIX A

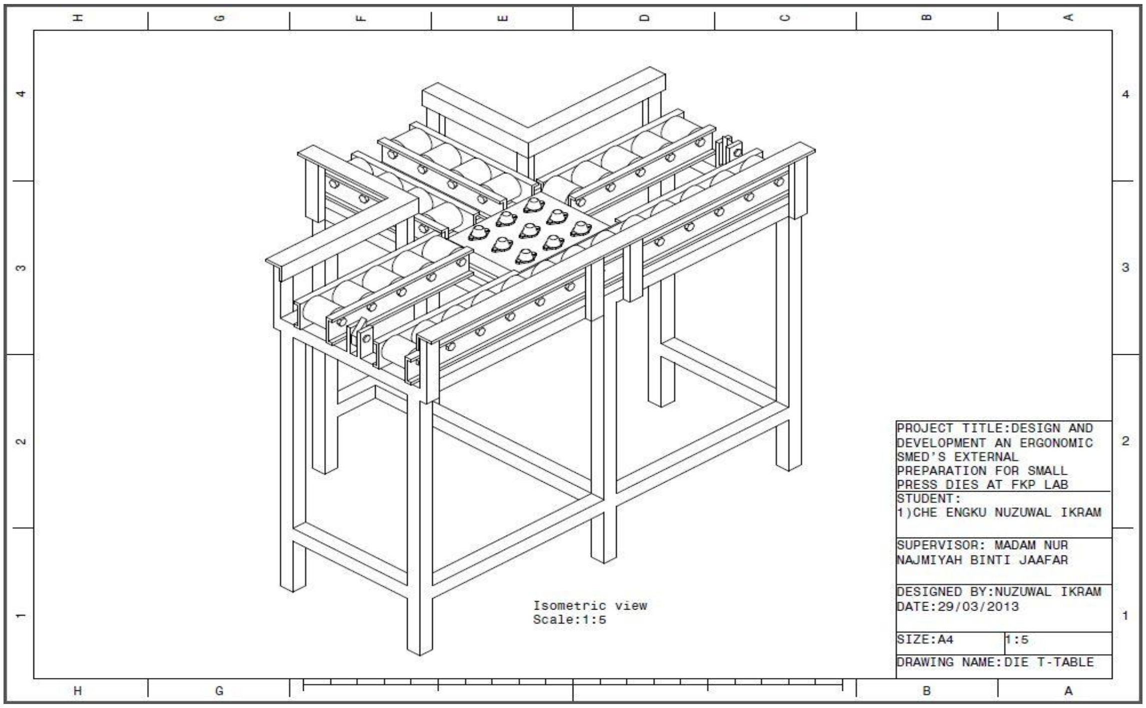
Appendix A1 (Gantt chart FYP 1)

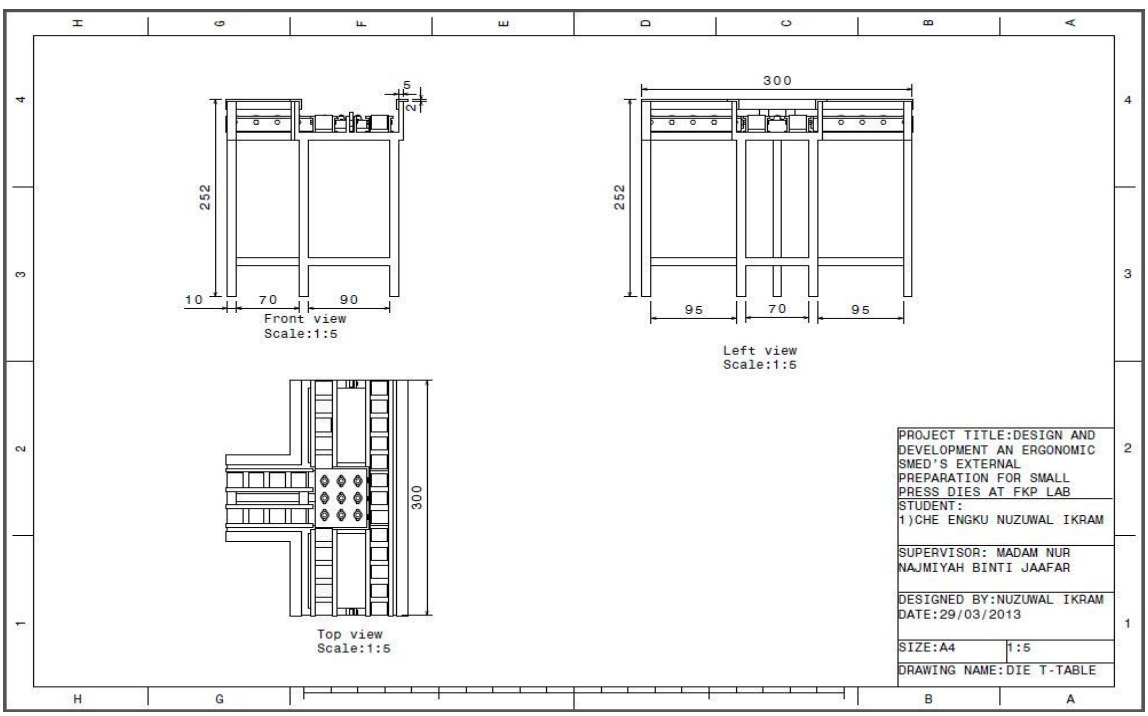
NO	PROJECT ITEM	OWNER		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	Study current condition of press machine	Ikram	Plan														
	and stamping process		Action														
2	Run time study for small press die at FKP	Mala	Plan														
			Action														
3	Pilot visit at PHN	Ikram	Plan														
		Mala	Action														
4	Compare and analyze time taken for	Mala	Plan														
	stamping process at FKP and PHN Sdn Bhd		Action														
5	Produce 3 conceptual design	Ikram	Plan														
	of die change table		Action														
6	Design validation	Mala	Plan														
			Action														
7	Order material	Mala	Plan														
			Action														
8	Fabricate die change table	Ikram	Plan														
			Action														
9	Assemble part	Ikram	Plan														
			Action														
10	Attach die carrier at stamping machine area	Ikram	Plan														
		Mala	Action														
11	Testing	Ikram	Plan														
			Action														
12	Collect and record data	Mala	Plan														
			Action														
13	Analyze result	Mala	Plan														
			Action														

Appendix A2 (Gantt chart FYP 2)

NO	PROJECT ACTIVITIES		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	Order material	P														
		A														
2	Visit PHN Industry	P														
		A														
3	Change the project title	P														
		A														
4	Produce 2 conceptual design	P														
		A														
5	Design validation	P														
		A														
6	Fabricating the prototype	P														
		A														
7	Writing report	P														
		A														
8	Presentation	P														
		A														
9	Submission of report and logbook	P														
		A														

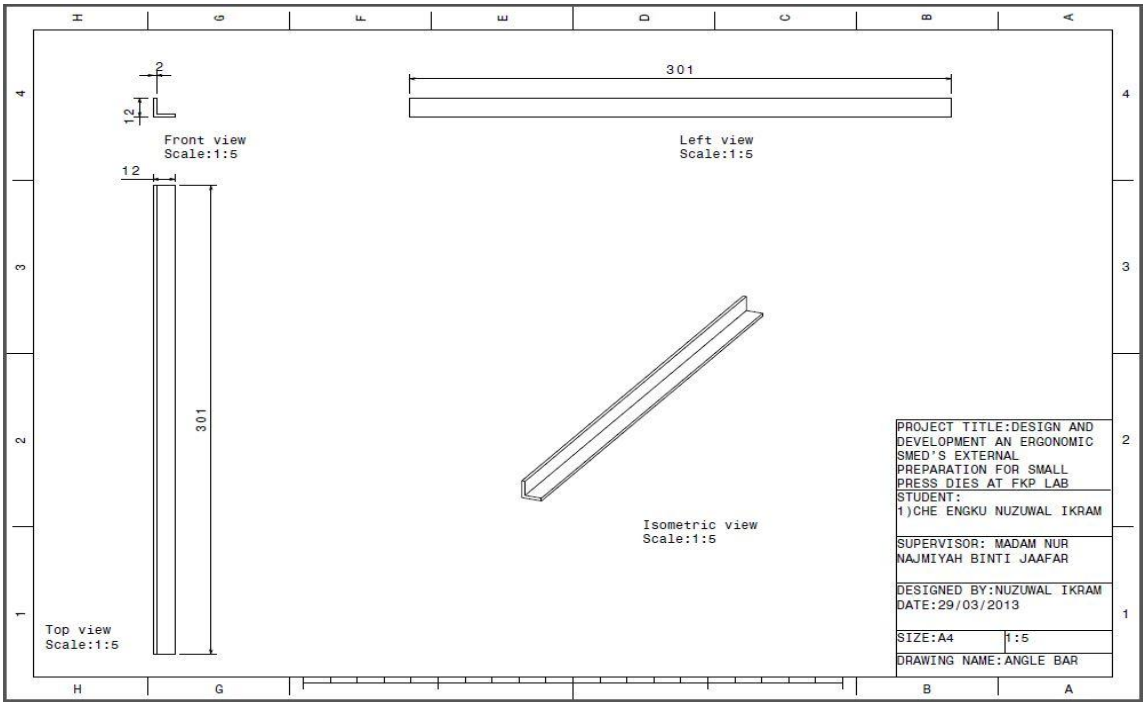
APPENDIX B

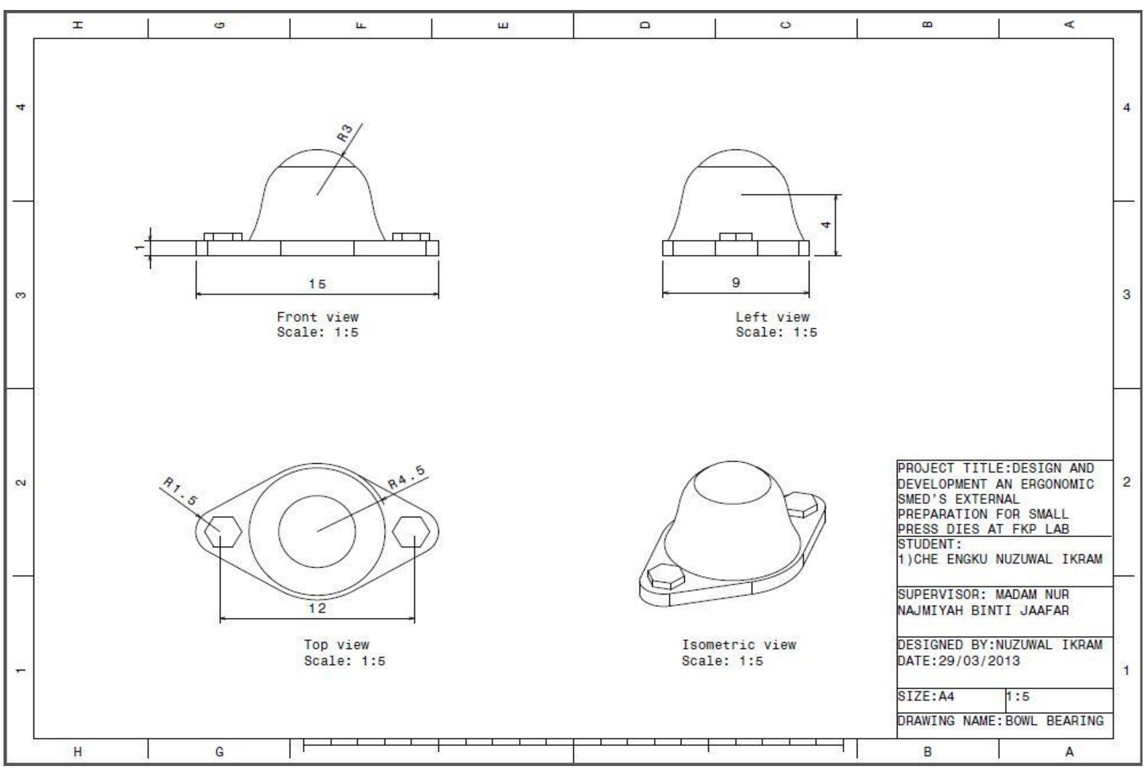


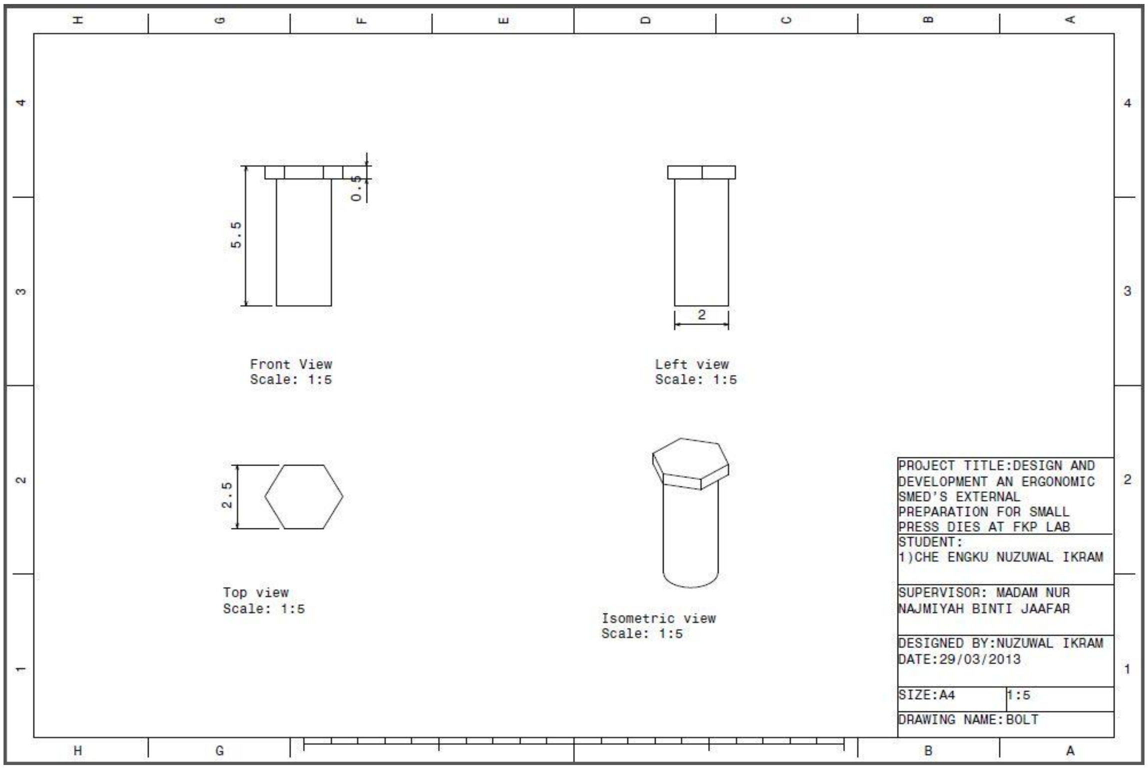


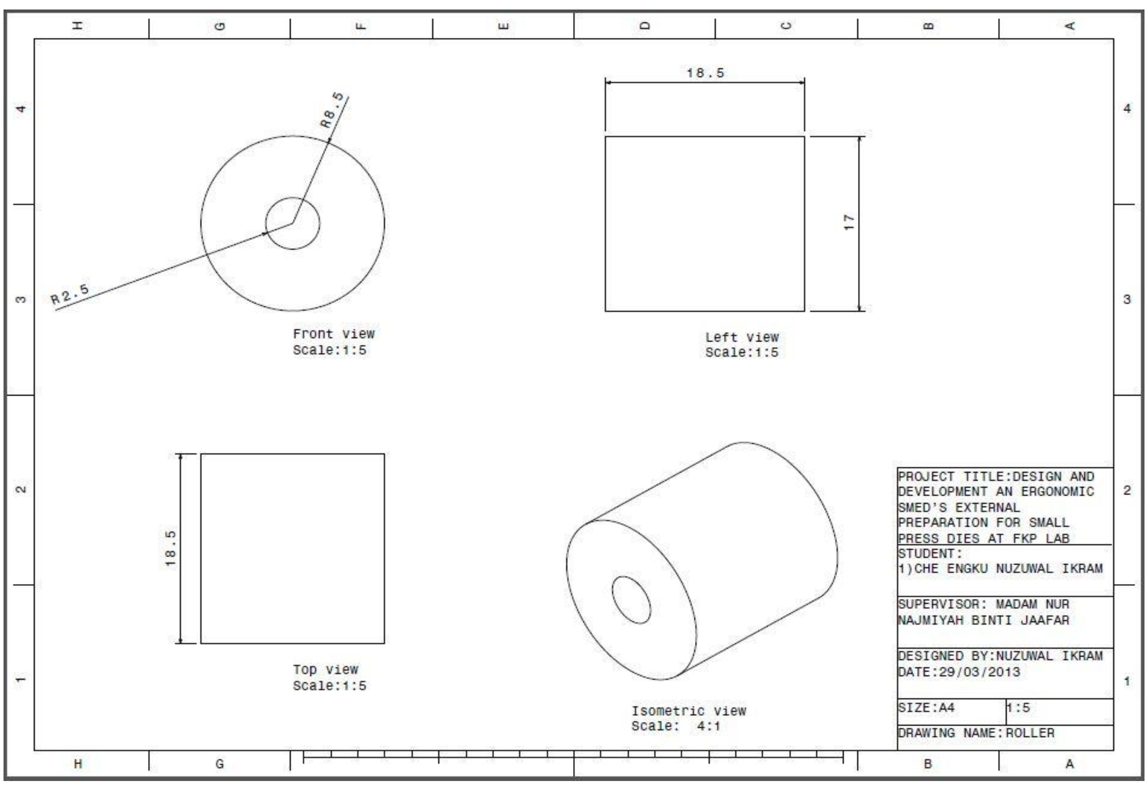
Design of Die T-Table

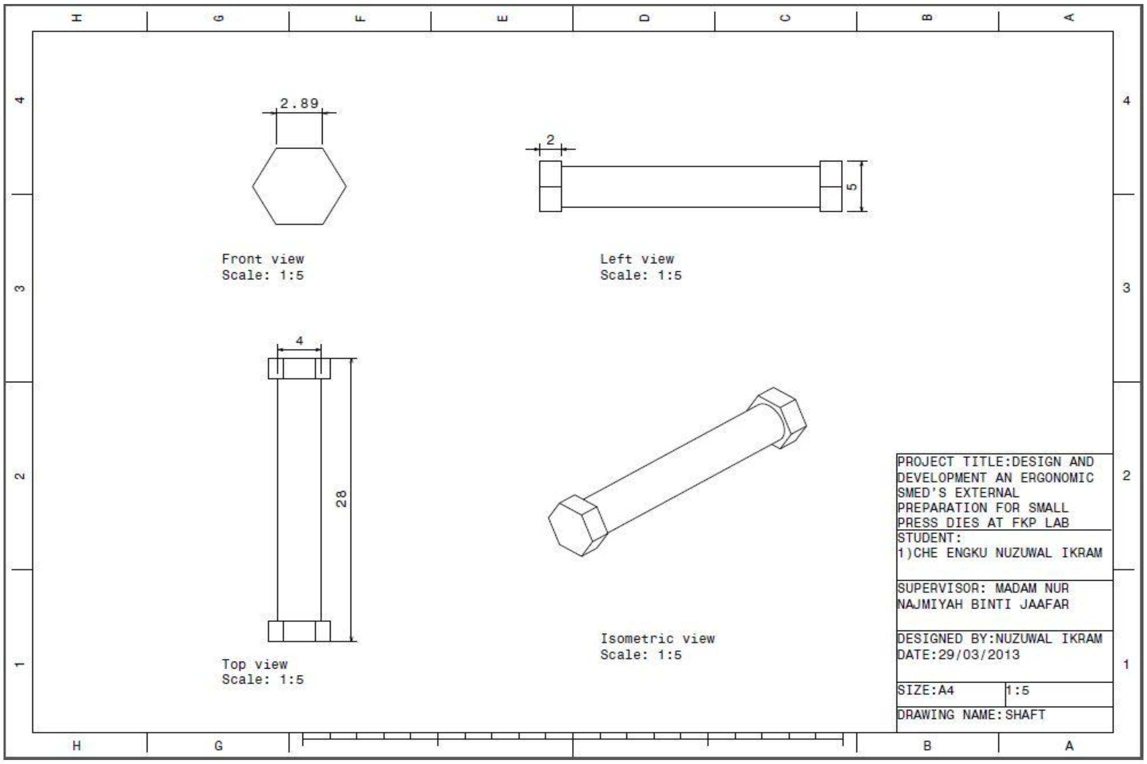
APPENDIX C


301
2
12
Front view
Scale:1:5
Left view
Scale:1:5
12
301
Isometric view
Scale:1:5
Top view
Scale:1:5
PROJECT TITLE:DESIGN AND DEVELOPMENT AN ERGONOMIC SMED'S EXTERNAL PREPARATION FOR SMALL PRESS DIES AT FKP LAB
STUDENT:
1)CHE ENGKU NUZUWAL IKRAM
SUPERVISOR: MADAM NUR NAJMIYAH BINTI JAAFAR
DESIGNED BY:NUZUWAL IKRAM
DATE:29/03/2013
SIZE:A4
1:5
DRAWING NAME:ANGLE BAR


R3
1
15
Front view
Scale: 1:5
4
9
Left view
Scale: 1:5
R1.5
R4.5
12
Top view
Scale: 1:5
Isometric view
Scale: 1:5
PROJECT TITLE:DESIGN AND DEVELOPMENT AN ERGONOMIC SMED'S EXTERNAL PREPARATION FOR SMALL PRESS DIES AT FKP LAB
STUDENT:
1)CHE ENGKU NUZUWAL IKRAM
SUPERVISOR: MADAM NUR NAJMIYAH BINTI JAAFAR
DESIGNED BY:NUZUWAL IKRAM
DATE:29/03/2013
SIZE:A4
1:5
DRAWING NAME:BOWL BEARING


H
G
F
E
D
C
B
A
4
3
2
1
0.5
5.5
2
Front View
Scale: 1:5
Left view
Scale: 1:5
2.5
Top view
Scale: 1:5
Isometric view
Scale: 1:5
PROJECT TITLE:DESIGN AND DEVELOPMENT AN ERGONOMIC SMED'S EXTERNAL PREPARATION FOR SMALL PRESS DIES AT FKP LAB
STUDENT:
1)CHE ENGKU NUZUWAL IKRAM
SUPERVISOR: MADAM NUR NAJMIYAH BINTI JAAFAR
DESIGNED BY:NUZUWAL IKRAM
DATE:29/03/2013
SIZE:A4
1:5
DRAWING NAME:BOLT


H
G
F
E
D
C
B
A
4
3
2
1
R8.5
R2.5
18.5
17
Front view
Scale:1:5
Left view
Scale:1:5
18.5
Top view
Scale:1:5
Isometric view
Scale: 4:1
PROJECT TITLE:DESIGN AND DEVELOPMENT AN ERGONOMIC SMED'S EXTERNAL PREPARATION FOR SMALL PRESS DIES AT FKP LAB
STUDENT:
1)CHE ENGKU NUZUWAL IKRAM
SUPERVISOR: MADAM NUR NAJMIYAH BINTI JAAFAR
DESIGNED BY:NUZUWAL IKRAM
DATE:29/03/2013
SIZE:A4
1:5
DRAWING NAME:ROLLER


2.89
2
5
Front view
Scale: 1:5
Left view
Scale: 1:5
4
28
Top view
Scale: 1:5
Isometric view
Scale: 1:5
PROJECT TITLE:DESIGN AND DEVELOPMENT AN ERGONOMIC SMED'S EXTERNAL PREPARATION FOR SMALL PRESS DIES AT FKP LAB
STUDENT:
1)CHE ENGKU NUZUWAL IKRAM
SUPERVISOR: MADAM NUR NAJMIYAH BINTI JAAFAR
DESIGNED BY:NUZUWAL IKRAM
DATE:29/03/2013
SIZE:A4
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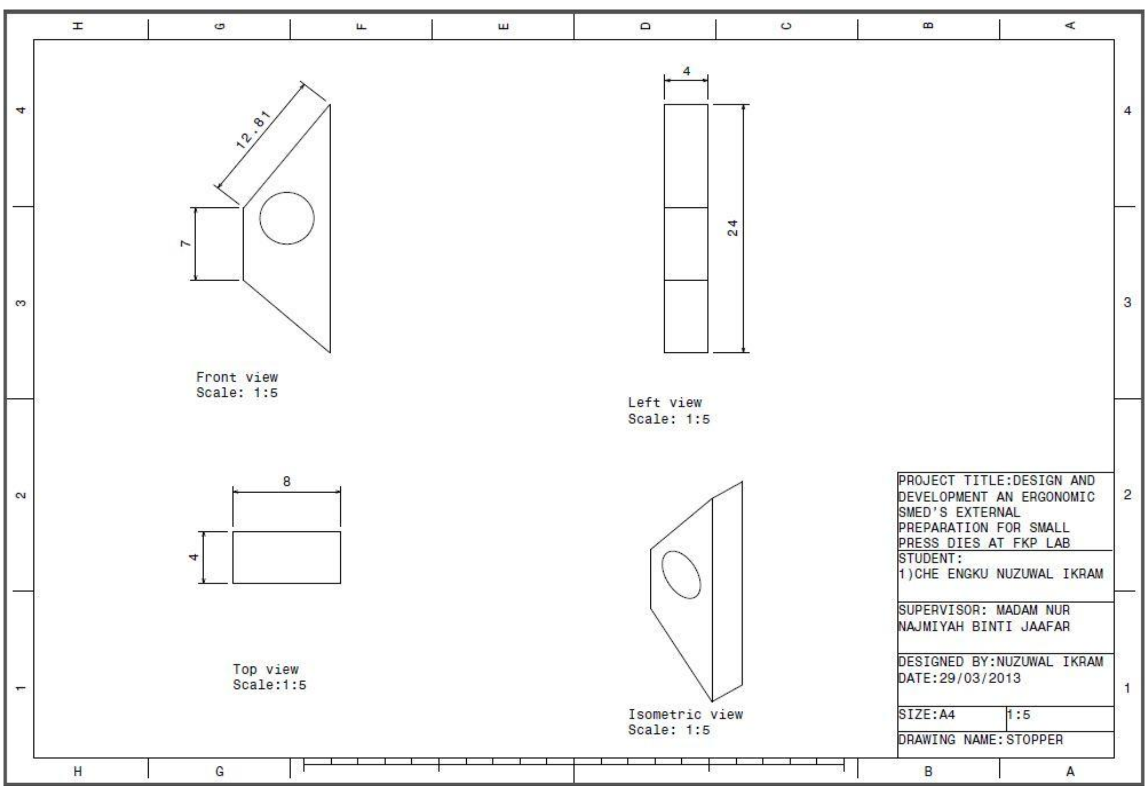
DRAWING NAME:SHAFT


12.81
7
4
24
Front view
Scale: 1:5
Left view
Scale: 1:5
8
4
Top view
Scale:1:5
Isometric view
Scale: 1:5
PROJECT TITLE:DESIGN AND DEVELOPMENT AN ERGONOMIC SMED'S EXTERNAL PREPARATION FOR SMALL PRESS DIES AT FKP LAB
STUDENT:
1)CHE ENGKU NUZUWAL IKRAM
SUPERVISOR: MADAM NUR NAJMIYAH BINTI JAAFAR
DESIGNED BY:NUZUWAL IKRAM
DATE:29/03/2013
SIZE:A4
1:5
DRAWING NAME:STOPPER