

DESIGN AND DEVELOPMENT OF GOLD BRACELET STAMPING DIE



BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

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Faculty of Mechanical and Manufacturing Engineering Technology



Muhd. Afiq Hafizuddin Bin Azman

Bachelor of Manufacturing Engineering Technology (Process and Technology) With Honours

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MUHD. AFIQ HAFIZUDDIN BIN AZMAN



Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this thesis entitled "Design And Development of Gold Bracelet Stamping Die " is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature AYSI : Muhd. Afiq Hafizuddin Bin Azman Name 28 January 2022 Date UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

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Supervisor Name	Ts. Hassan Bin Attan	1	
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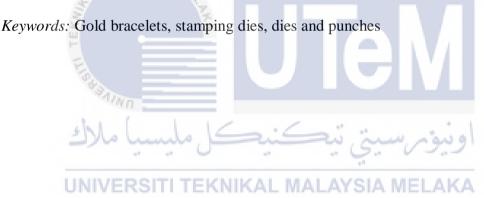
DEDICATION

This report is dedicated first and foremost to my beloved parents, for their endless love, support and encouragement. To my lecturer Ts. Hassan Bin Attan, who guided me along the way to complete this project. Thank you for all your support and give me strength till this project is completed.



ABSTRACT

On gold bracelets, many goldsmith workshops in Malaysia use traditional handcrafting techniques. Because the jewellery manufactured in these factories is usually heavy and timeconsuming to make, the expense and thus the pricing are relatively high. As a result, goldsmiths require tools that can mass-produce gold bracelets in order to meet market demand. This study will employ locally available materials and establish studio processes that goldsmiths may use to translate their designs into stamping dies that can be used to mass produce lightweight, three-dimensional design parts. Within qualitative research, the study blended industrial-based research and descriptive research approaches. Practicing goldsmiths in Malaysia were the study's target population. The study's accessible population consisted of a few Malaysian goldsmith businesses. Many motifs and images that symbolise Malaysian culture might be translated into dies and punches to create gold bracelets, according to the study. As a result, goldsmiths should build basic tools like dies and punches in the workshop using a press machine in order to produce high quality and mass manufacturing.



ABSTRAK

Pada gelang emas, banyak bengkel tukang emas di Malaysia menggunakan teknik kraftangan tradisional. Oleh kerana barang kemas yang dikeluarkan di kilang-kilang ini biasanya berat dan memakan masa untuk membuat, perbelanjaan dan dengan itu harganya agak tinggi. Akibatnya, tukang emas memerlukan alat yang boleh menghasilkan gelang emas secara besar-besaran untuk memenuhi permintaan pasaran. Kajian ini akan menggunakan bahan-bahan tempatan dan mewujudkan proses studio yang mungkin digunakan oleh tukang emas untuk menterjemah reka bentuk mereka ke dalam cetakan cetakan yang boleh digunakan untuk menghasilkan bahagian reka bentuk tiga dimensi yang ringan secara besarbesaran. Dalam penyelidikan kualitatif, kajian ini menggabungkan pendekatan penyelidikan berasaskan industri dan penyelidikan deskriptif. Mengamalkan tukang emas di Malaysia adalah populasi sasaran kajian. Populasi yang boleh diakses oleh kajian ini terdiri daripada beberapa perniagaan tukang emas Malaysia. Banyak motif dan imej yang melambangkan budaya Malaysia mungkin diterjemahkan ke dalam bentuk mati dan tumbukan untuk mencipta gelang emas, menurut kajian itu. Akibatnya, tukang emas harus membina alat asas seperti die dan penebuk di bengkel menggunakan mesin penekan untuk menghasilkan pembuatan yang berkualiti tinggi dan besar-besaran.

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TABLE OF CONTENTS

		PAGE
DECI	LARATION	
APPR	ROVAL	
DEDI	CATION	
ABST	TRACT	i
ABST	'RAK	ii
ACK	NOWLEDGEMENTS	iii
TABI	LE OF CONTENTS	iv
LIST	OF TABLES	vi
LIST	OF FIGURES	vii
	OF SYMBOLS AND ABBREVIATIONS	9
LIST	OF APPENDICES	10
CHAI	PTER 1 INTRODUCTION	11
1.1	Background	11
1.2	Problem Statement	12
1.3	Project Objective	13
1.4	Scope of Project	13
CHAI	PTER 2 LITERATURE REVIEW MALAYSIA MELAKA	14
2.1	Introduction	14
2.2	Concept of Design	15
2.3	Concept of Embossing	17
2.4	Concept of Dies	19
2.5	Materials Used for Dies and Punches	21
2.6	Types of Dies	25
2.7	Methods of Die Production	28
2.8	Jewelry	28
2.9	Stamping	30
CHAI	PTER 3 METHODOLOGY	35
3.1	Introduction	35
3.2	Research Design	36
	3.2.1 Gantt Chart	38
3.3	Analysis on the Study	39
	3.3.1 Gold Mechanical Properties	39
	3.3.2 Carbon Steel Mechanical Properties	40
	3.3.3 Punching Force Calculation Formula	45
3.4	Data Collections Instruments Used for the Study	45

3.5	Product Design Development	46
	3.5.1 House Of Quality	46
3.6	3D Modelling Drawing	49
	3.6.1 Product of Gold Bracelet Stamping Die	49
	3.6.2 Gold Bracelet Stamping Die	50
3.7	Machining Process	53
	3.7.1 Generate G-code	53
	3.7.2 3D Printing Process	55
	3.7.3 3D Printing Machine Setup	57
СНА	PTER 4 RESULT AND DISCUSSION	62
4.1	Introduction	62
4.2	3D Printing Machine	62
4.3	Failure Mode and Effect Analysis (FMEA) on Gold Bracelet Stamping Die	63
	4.3.1 Upper Die Simulation	63
4.4	Design Analysis	69
	4.4.1 Prototype Defect	74
	4.4.1.1 Circle Inaccuracies	74
4.5	Software Analysis	80
4.6	Summary WALAYSIA	84
СНА	PTER 5 CONCLUSION AND RECOMMENDATION	85
5.1	Conclusion	85
5.2	Recommendations	87
REF		88
APP	ENDICES	91
	اونيۈم,سيتي تيكنيكل مليسيا ملاك	
	UNIVERSITI TEKNIKAL MALAYSIA MELAKA	

LIST OF TABLES

TABLE	TITLE	PAGE
Table 1 Gantt Chart		38
Table 2 Types of Carbon Steel a	and Their Properties	42
Table 3 Comparison of Propertie	es and Applications of Different Grades	43
Table 4 Standard Operational Pr	cocedure (SOP) on 3D Printer	58
Table 5 Upper Die Volumetric I	Properties	64
Table 6 Material Properties of U	Jpper Die	64
Table 7 Resultant Force, Fixture	e Name, Image and Details	65
Table 8 Load Name, Image and	Details	66
Table 9 Von Mises Stress Study	Result	67
Table 10 Resultant Displacemen	nt Study Result	68
Table 11 Equivalent Strain Stud	y Result	69
Table 12 Upper Die Prototype	اونيۇبرسىتى تېكنىكل،	70
Table 13 Lower Die Prototype	EKNIKAL MALAYSIA MELAKA	72
Table 14 Test Print Prototype		74
Table 15 Dynamic and Super Q	uality Parameter Setup	82

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1 Project Process Flowchart		36
Figure 2 Gold Mechanical Properties		39
Figure 3 Fatigue Strength Model (stress ran	nge) Graph	40
Figure 4 Carbon Steel Mechanical Properti	es	41
Figure 5 House Of Quality		47
Figure 6 Charm Bracelet		48
Figure 7 Gold Bracelet Product		49
Figure 8 Product Drawing Template		50
Figure 9 Upper Die Isometric View		51
Figure 10 Upper Die Drawing Template		51
Figure 11 Lower Die Isometric View		52
Figure 12 Lower Die Drawing Template	اونىۋىرسىتى تىكنىە	52
Figure 13 Full Assembly	AL MALAYSIA MELAKA	53
Figure 14 Convert Drawing into STL file		54
Figure 15 3D Model on Ultimaker Cura So	ftware	54
Figure 16 G-code		55
Figure 17 Parameter Setup for 3D Printing	Process	56
Figure 18 Simulation Process of 3D Printin	ıg	56
Figure 19 Creality Ender-3 Pro		57
Figure 20 Upper and Lower Die		62
Figure 21 Test Print		63
Figure 22 Circle Inaccuracies Defect Exam	ple	75

Figure 23 Layer Splitting on Upper Die	76
Figure 24 Layer Splitting on Lower Die	76
Figure 25 Test Print Stringing or Oozing	77
Figure 26 Upper Die Blobs and Zits	78
Figure 27 Dimensional Error on Lower Die	79
Figure 28 Dimensional Error on Upper Die	79
Figure 29 Standard Printing Quality Parameter Setup	81

APPENDIX

UTERSITI TEKNIKAL MALAYSIA MELAKA

PAGE

TITLE

LIST OF SYMBOLS AND ABBREVIATIONS

Ν	-	Newton
kg	-	Kilogram
mm	-	Millimeter
m^3	-	Cubic metre
m^2	-	Square metre
kN	-	kiloNewton



LIST OF APPENDICES

APPENDIX

TITLE

PAGE

Thesis Status Verification Form

Thesis Classification Letter

Turitin Report



CHAPTER 1

INTRODUCTION

1.1 Background

Metal stamping is a cold-forming process that makes use of dies and stamping presses to transform sheet metal into different shapes. Pieces of flat sheet metal, typically referred to as blanks, is fed into a sheet metal stamping press that uses a tool and die surface to form the metal into a new shape. Production facilities and metal fabricators offering stamping services will place the material to be stamped between die sections, where the use of pressure will shape and shear the material into the desired final shape for the product or component.

Metal stamping, also referred to as pressing, is a low-cost high-speed manufacturing process that can produce a high volume of identical metal components. Stamping operations are suitable for both short or long production runs, and be conducted with other metal forming operations, and may consist of one or more of a series of more specific processes or techniques such as punching, blanking, embossing, coining, bending and flanging.

Based on the title which are design and development of gold bracelet stamping die, we mainly focused on the tool that have been used for the production of gold bracelet. There are many types of stamping operation that have been used on the production of the gold bracelet based on the design and shape of the product. Generally, some of the familiar process that always been used on the gold bracelet production are punching, blanking, embossing and bending. One of the famous types of tool that have been used was progressive stamping die tool which were suitable for low-cost and high-speed production.

1.2 Problem Statement

Gold which known as a jewellery materials popular for it's precious metals are sold mainly by the weight; therefore if the precious metal weight of jewellery is high, the overall cost is also high. For this reason, many people are unable to afford precious metal jewellery because of very high market prices. However, the cost and for that matter the final unit price of jewellery, can be lowered by reducing the weight. This can be achieved by employing cost effective tooling technique in the production process such as the usage of dies and punches. This is significant because in the gold industry, the technique which is used to produce articles has a direct bearing on the cost of the finished product.

However, many jewellery workshops rely on traditional hand fabrication techniques including piercing and cuttlefish bone casting for making gold jewellery. Jewellery items produced by these outfits are generally heavy or flat and the methods of production are not mass production friendly. Reduction of the unit weight of precious metal jewellery through the use of dies and punches should result in the decrease of the unit price of jewellery. One way of reducing the unit weight is by making the jewellery pieces thin walled and hollow while also ensuring good strength and high quality design.

In spite of the numerous benefits that can be derived from the use of dies and punches in jewellery production, a survey carried out by the researcher has revealed that currently gold jewellery producers are not employing this forming method because they do not have any knowledge about them. In this regard, there is need for research to explore locally accessible materials including tools and equipment, to develop methods at the studio level and produce samples of dies and punches to serve as a blue print to be by the goldsmith. This is to enable them convert their designs into embossing dies and punches suitable for mass production of light weight.

1.3 Project Objective

The objectives of this project are as follow:

- 1. Study and analyse the properties of gold bracelet stamping die.
- 2. Design and develop drawing of gold bracelet stamping die.
- 3. Produce a prototype of gold bracelet stamping die by using 3D printer.

1.4 Scope of Project

The scope of this project are as follows:

- Develop the most suitable stamping die tool of gold bracelet for industrial use.
- Design a proper and detail drawing for stamping die tool of gold bracelet for Uindustrial use. TEKNIKAL MALAYSIA MELAKA
- Study on consideration to figure the most suitable type of material used to produce a stamping die tool for gold bracelet.
- Figure the most suitable standard tool to produce the stamping die tool based on the drawing specification.
- Enhance the product quality of gold bracelet by reducing the number of scrap for low-cost and high-speed mass production.
- Invetigate on how to reduce the time consumption of gold bracelet production to increase the production.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

To understand and clarify clearly the problem on how to design and fabricate of gold bracelet stamping die, certain factors have been reviewed to accomplished the objective. These factors are:

i.	Concept of design
	P WALAYSIA ME
ii.	Concept of embossing
iii.	Concept of Dies
	*AINO
iv.	Materials used for die/punch manufacturing
	UNIVERSITI TEKNIKAL MALAYSIA MELAKA
v.	Types of dies
vi.	Methods of die/punch production

vii. Usefulness of Dies and Punches.

2.2 Concept of Design

Design plays an important role in an innovation in all types of fileds of artistic study whether in enginering or other fields of sector. In jewellery, or we can say in bracelet specifically, design is not much different from other plastics arts such as sculpture and ceramics because in all fields of arts, planning preceds execution of the medium.

Amenuke et al (1991) consider a design as a process or the result of a process. This means that design can be understood in two ways: (1) as a process and (2) as a final product. When a designer plans his or her work, he or she puts together certain qualities such as point, line, shape, and colour, and it is the relationship of these qualities that the viewer sees. These qualities, sometimes referred to as the elements of design according to Amenuke et al, are the fundamental part or qualities of any design.

Untracht (1985) also shares Amenuke et al.'s view of design, noting that design in relation to jewellery can be described as an intellectual or intuitive concept (both can operate simultaneously) in which purposeful planning or mental imagery determines the way in which materials are used and arranged in a relationship of shapes, forms and surface treatments to create an integrated object.

According to Untracht, the form of the material itself may suggest a process, since any form of metal embodies a natural range of possible treatments that inspire design. He acknowledges, however, that superimposed on the basic concept of a material's original form and character in relation to process are those considerations of composition and organisation known as formal design elements, perhaps better known as design components, since it is through their use that an object is composed. Untracht adds that these elements and the above considerations, no matter how limitedly used or isolated for discussion purposes, are dynamically linked in the creation of a design in a highly flexible way, in fact one aspect can hardly be mentioned without including another.

Untreaht again explains that designing and creating a piece of gold bracelet is a reciprocal process of synthesizing the intangible into reality. This is essentially done through a sequence of judgments, decision making, and problem solving, all of which occur when materials are made into forms.

Unless the design concept is of such a nature that it can be captured in a drawing with mathematical precision and implemented without changes in the graphic representation. When designing bracelet, in addition to the design components and the shape of the material, which should be highly considered, another critical factor that must be given ultimate attention is how the design will harmonise with the human body. This is based on the form that a bracelet design takes and functional considerations of a design.

It may be inferred from the above design that in the creation of bracelet, until the final measurements for the parts of a design have been fixed and strictly adhered to, new ideas may be added in the course of working the materials into bracelet forms.

Untracht(1985) believes that the size of a piece of bracelet a person chooses to wear is directly related to the motives the person may have for wearing the bracelet. He agrees that in cases where a large mass is desired, the weight may be reduced and the mass increased by making hollow forms. He concedes that while weight tolerance is an individual issue having to do with personality differences, it is also a matter of economics when using precious metals. He reiterates the view that the greater the weight, the higher the cost and the final price. As a solution to this problem, he adds that the control of weight lies primarily in the particular choice of materials and thickness of the bracelet pieces. He goes on to say that of importance is the system of construction: solid, cast forms weigh considerably more than barcelet made from hollow, low forms.

The author agrees with the views of the authors that design components and material forms are undeniable factors that should be given due attention in jewellery design, but equally important are the cost of materials and the sale of the final product. This is one of the reasons why the design of dies and stamps to be used in the design of lightweight bracelet is the focus of this study.

2.3 Concept of Embossing

AALAYSI.

Embossing is a method of creating raised shapes on a metal surface. The raised form produced can be used either as an intaglio or a cameo, depending on the purpose the metal artist wishes to achieve with the form. According to Muldoon (2008), metal embossing adds lustre, radiance, intriguing dimension and texture to metal.

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Rajput (2007) explains that stamping is used as an operation in making recessed figures on metal sheets with corresponding relief on the other side. The metal flow is in the direction of the applied force. The forces required are much less than in embossing.

Burto (1963) also states that the main raw material required for embossing is soft sheet brass, copper, or aluminium between 0.005 and 0.010 inch thick. He relates that normal copper or brass sheet must be annealed before it can be stamped, and this is done by heating the metal until it glows red; it is then cooled in air or "immersed" in water. The actual minting process, he continues, is conceivably simple. It begins by stretching the annealed piece of sheet metal over the die and striking it with the padded hammer. This forces the metal down into the openings of the die and reproduces the pattern in the die. According to Muldoon (2008), metal stamping is an art form that has been around for centuries. A variety of easy to use tools are used to press flat metal sheets from behind to create designs.

Untracht (1985) describes embossing as an act of stamping to push out a shape in cameo or intaglio. This process, according to him, is done with the help of an embossing die or punch. If the resulting shape is positive or in high relief, it is called a cameo (from the Italian cammeo "a gem carved in relief"). If the shape is negative or concave, it is called intaglio (from Italian intaglire, "to engrave, cut, or carve a pattern into a substance below its original surface"). For sheet metal, these shapes can be used with the positive or negative side up. The moulded shape may be relatively small - as in a small, hand-made embossing die - and the resulting boss is usually one of a number of such elements placed in an array on a still intact sheet.

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The researcher agrees with the author in the above assertion that the embossed form can be used as a unit and this means that it can be added to other elements to form a whole ornament, or an embossed form could stand alone as a complete ornament.

From the above distinction between stamping and embossing, it is clear that the end product of the latter gives a shape to a blank, while the former gives a form. Embossing on metal is accomplished by the application of force, and the resulting shapes may be used with the positive or negative side up.

2.4 Concept of Dies

McCreight (1991) defines dies as rigid and reusable shapes that give form to the workpiece. He adds that they can be made from a range of materials and can have a life span from a few pieces to thousands. He goes on to say that dies can be categorized by the amount of detail they impart and their strength. The latter, he says, is important not only because it determines the life of the die, but also the difficulty of making the die in the first place. It is easier to cut a die from wood than from steel, but of course the steel die lasts longer.

A die is any structure that can give a shape to a material such as metal or wood. According to Mittler and Ragans (1992), a form is an area that is clearly delineated by visual elements of art. A shape may have an outline or a boundary around it. Some shapes stand out through color, while others are set apart only by the space that surrounds them. There are two groups of shapes: geometric shapes and organic shapes. Geometric shapes are those with precise outlines that look as if they were created with a drawing instrument. Organic shapes are irregular or uneven and their outlines curve into free forms and are often found in nature. The five basic geometric shapes are square, circle, triangle, rectangle, and oval.

Mittler and Ragans (1992) distinguish between shapes and forms, explaining that shapes are like forms, but while shapes are two-dimensional and therefore have length and width, forms are three-dimensional and therefore have length, width, and depth. They add that shapes are also divided into either geometric shapes or organic shapes. Although McCreight states that dies could be made to produce shapes, dies could also be made to produce shapes that would have length, width and depth and could be used as bracelet.

Burto (1963) explains that at least half of the work in stamping sheet metal is in making the dies. Since the die is simply a metal matrix that is harder than the sheet to be embossed, there

is an almost unlimited variety of finished dies available to the do-it-yourselfer - in the form of perforated or spent metal, hardware cloth, even ordinary wire cloth.

Rajput (2007) states that the die set consists of a die and a punch with the desired contours, so that when the punch and die meet, the distance between them is equal to the thickness of the sheet.

Codina (2007), explaining how steel dies and stamps are developed and used on an industrial level, states that making a steel die and stamp is the most common method used in industry because it offers greater durability and precision. Likewise, it is the most costly method, requiring a fairly large stamping press and thus requiring expensive production to pay for itself. He goes on to say that prior evaluation of production goals and costs is recommended before using this method. He adds that a properly hardened steel die, however, has unmatched durability and the quality of the stampings produced is comparable to the original designs. He goes on to say that a die can be made from a block of steel that matches the type of relief the punch is intended to produce. He goes on to say that this steel, once annealed and made ductile, can be shaped with cutters, files and tombstones. It must be as smooth and polished as possible - as if it were a piece of jewellery - so that the piece of metal stamped into the mould can be easily released. Next, the soft steel is hardened; this is a process that must be done in specialised workshops, as it is more costly than simply hardening a chisel.

Codina (2007) again explains tempering as a heat treatment that gives the steel sufficient hardness and flexibility to hammer the punch into another piece of steel that actually serves as a die. To do this, Codina continues, the punch is heated to about 9000 °C and quenched in water or oil; now that it is too hard and prone to breakage, it must be tempered. This

involves heating it to a lower temperature for a certain time to achieve the right balance between hardness and flexibility, thus increasing toughness.

Once the punch is tempered, it is stamped into another piece of steel that will serve as a die: it must be polished as needed and properly tempered. The punched die is used to make the parts.

Codina (2007) also explains that the steel punch is only used to make the original model; it must be kept carefully because if the die is damaged during punching, the punch must be struck into the die again. This implies that a well-developed punch could be used to create dies for further metal part fabrication.

The above comments by the authors show that dies and punches are given a longer life by the materials from which they are made. Those made for industrial purposes are usually made of steel.

2.5 Materials Used for Dies and Punches

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Different materials can be used to make dies or stamps to achieve a specific purpose. Davis (1995) discusses that the materials used to make dies and punches range from plastics for the production of simple to moderately heavy parts in small quantities to extremely wear-resistant (nitride) tool steels for the production of highly formed parts. Parts of even greater severity, or those produced in quantities exceeding one million, may require dies or inserts made of carbide.

Miller and Miller (2004) state that a good grade of tool steel is used for making punches and dies. The steel should be free from harmful impurities. Sometimes the body of the die can

be made of cast iron with steel bushings inserted to reduce the material cost. The advantage of this type of construction, he said, is that an insert can be replaced when worn. Soft steel that has been case-hardened does not change shape as easily as tool steel, and any minor changes in shape can be easily corrected because the interior is soft. Residual stresses or strains are built up in steel during the manufacturing process. In mould making, these stresses must be relieved before the mould is brought to its final size, otherwise they will cause deformation. The presence of stresses in the steel cannot be determined in advance, but the mould maker can relieve the stresses in the steel by annealing after the mould has been worked out.

According to Sharma (1999), hot forging dies operate under very severe service conditions as the forging process is characterized by high interface pressure combined with high temperatures; therefore, the die and die materials are selected and manufactured with utmost care. The materials used for the manufacture of dies must be heat resistant, have adequate strength with a low wear rate and be well suited for machining with cutting tools. A compromise must be made between hardness and ductility as the dies are subjected to thermal shocks. Die blocks used for making forging dies are made of high quality special tool steels.

Youssef et al (2011) state that another attractive feature of die construction is the versatility of the processes used to produce dies using castable die materials such as glass fiber reinforced plastic (GRP), urethane, epoxy resin, ductile cast iron, kirksite (a zinc-based casting alloy) or concrete. A simple wooden or Styrofoam model can be used to make such dies. For higher pressures and longer service life, hardened steel dies are used. Altan (2011) explains that steels are mainly used for hot dies because they retain their hardness at elevated temperatures while having sufficient strength and toughness to withstand the stresses encountered during forging. There have also been some successful applications of other materials such as ceramics, carbides and superalloys, although their use is limited due to design and manufacturing costs. The choice of die material and subsequent treatment will influence the type of failure and the failure rate of the tool.

From the above, there are a number of materials that can be used to make dies and punches. These materials may be divided into metallic and non-metallic. The non- metallic include plywood or hardwood, ceramics, plastics, cemented carbide, nitrides, mesonite, carbides, fibreglass reinforced plastics, urethane, epoxy resin and styrofoam, and hardware cloth. The metallic materials are steel, ductile iron, superalloy and kirksite (zinc-based cast alloy). Other materials such as plywood or hardwood, ceramics and cement can be sourced locally, but it is evident that most of these materials are only available through importation, making them expensive to procure.

Secondly, the above materials are mostly used in the manufacture of industrial dies and stamps. On initial investigation by the researcher, it was found that all the doming blocks used by goldsmiths and silversmiths were made of brass. Brass was preferred to the other materials mentioned for the following reasons: its availability in Ghana; its physical and mechanical properties that make it suitable for making dies and stamps at studio level. The selection of brass in this study for the manufacture of dies and punches also stems from the fact that the available facilities support the casting of brass more than other materials such as steel.

According to Margot et al (1998), brass is an alloy of the mixture of copper and zinc. Cobb (2012) states that brass is known for its beauty and corrosion resistance. Again, Margot et al. show that the colour of brass varies depending on the amount of zinc in the mixture and whether or not other metals are added. Brass with relatively large amounts of zinc has a yellow colour; the addition of aluminium gives it a high gold colour; a small percentage of manganese gives a bronze, and the addition of nickel gives a metal called nickel silver. This means that although copper and zinc are the main metals alloyed to give brass, sometimes other small amounts of other metals are added to give a particular result. However, it is the amount of zinc in a brass that determines its type.

Cobb (2012) claims that there are three types of brass, depending on their crystalline structure. The alpha (α)-brass, with up to 30% Zn, is the most ductile. The alpha - beta brass have 30-43.5% Zn; and beta (β) brass include those of 43.5 - 50% Zn. The hardness and strength increase with increasing zinc content, while the cost of the alloy decreases.

Historically, Cobb (2012) states that artefacts made of copper with 23% Zn have been found from at least 1000 BC, but brass was not in common use until about a thousand years later, in Roman times. It is one of the strangest storeys in the history of metallurgy because zinc, one of the constituents of brass, was unknown and in fact was not identified until 1526. Roman craftsmen engaged in the process they describe as dyeing copper. Pieces of copper, along with powdered calamine and charcoal, were packed into a clay crucible with a tightfitting lid and fired in a kiln for 24 hours at a temperature much too low to melt the copper. The Romans called it "aurichalcum" which translates as "golden copper", we call it brass. The coloured copper was smelted and made into ornaments, clothing armour, utensils, and sestertius (Roman coins). Unknown to the Romans, calamine was actually zinc carbonate, which evaporates the zinc absorbed by the copper in the furnace to form a copper-zinc alloy. The galmei brass process remained the preferred method of producing brass for many years after the discovery and production of metallic zinc in the 18th century.

Brass became popular for church ornaments and for its figures in floors engraved to commemorate the deceased. One of the most important commercial uses of brass was in the manufacture of brass pins used for carding in wool processing. Margot et al (1998), listing some properties of brass, point out that it is a hard, durable and useful metal that is excellent for casting, hot working and extrusion. These properties of brass mentioned by the above authors indicate that it could be procured and used for the manufacture of dies and punches. The brass used in this study was obtained from scrap of automobile parts which were made robust to withstand pressure.

2.6 Types of Dies

Dies are grouped based on different functionalities. Schwan et al. (2002) state that stamping dies are broadly divided into single dies and multiple dies. They explain that single-use dies are further divided into the following categories:

1. Cutting Dies: These dies are designed to cut sheets into blanks. The operation thus performed is called the stamping operation.

2. Forming Dies: These dies are used to change the shape of the workpiece material by deformation. No cutting takes place in these dies. These dies are used to change the shape and size configuration of metal blanks. Boljanovic (2005) states that depending on the production, quality of pieces: high, medium or low punching dies can be classified into A, B and C classes.

Class A dies are used for high production only. The best materials are used in this class of dies. All easily worn parts or delicate sections are carefully constructed to permit easy replacement. In this class, a combination of long die life, consistent accuracy throughout the life of the die, and ease of maintenance regardless of die cost is paramount. Class B dies are suitable for medium production volumes and are designed to produce only a certain quantity. Die cost relative to total production becomes an important consideration. Cheaper materials can be used, provided they are capable of producing the full quantity. The problem of ease of maintenance is less considered. Class C tools are the cheapest tools that can be built. They are suitable for the production of parts in small quantities.

Untracht (1985) groups the stamps into (1) embossing stamps, (2) a two-part disc-scissors stamp, (3) a one-part open intaglio stamp, and (4) a two-part closed stamp. Its grouping is as follows:

1. The die is a device used for cutting or shearing a shape or blank of a certain contour and / or striking a relief pattern into a sheet. This is done by striking the die with a hammer, as in hand stamping, or by mechanical pressure. AL MALAYSIA MELAKA

2. A two-piece disc shear die is a more complicated die consisting of a die used in conjunction with a shear punch to shear a blank from sheet metal.

3. A one-piece open intaglio die is used for all open dies, in which the metal is not restricted in its external shape, but is allowed to flow in the direction of least resistance and enter freely into the die cavity. To make an embossment of more than small depth from such a die, place the die on an anvil and lay the annealed sheet over the die, cover it with a washer, and strike it with a convex hammer. 4. A two-part closed die has a lower part called the anvil or lower stacking die, which contains the design in intaglio. The upper or second part, which is held in the hand, is called the trussel, and contains either the observed design in intaglio, or, when a thin sheet is punched, the same design in cameo, matching that of the other half.

Boljanovic (2009) groups stumps according to their use as follows:

1. stamping dies: a stamping die produces a blank by cutting the entire circumference in a single operation.

2. cut-off tool: the basic operation of a cut-off tool is to separate strips into short lengths to produce blanks.

3. punching tool : A punching tool punches holes in a workpiece.

4. Compound Die: In a compound die, the holes are punched at the same station where the part is punched out, rather than at a previous station, as is the case with a punch and die.

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5. Bending punch: A bending punch deforms a portion of a flat blank to a specific angular position. The bending line is straight along its entire length.

McCreight (1991) says that silhouette stamps are simply an outline shape cut from a tough material such as masonite, plywood, or steel. He adds, however, that there are several families of dies, but identifies two basic types: conformal dies and nonconformal dies. Conforming dies consist of two corresponding parts. They are usually held in some sort of superstructure to ensure that the parts line up when they are brought together. This die controls every aspect of the mould and ensures accurately duplicated units time after time. Nonconforming dies, also known as silhouette dies, are made of rigid material that is pierced with an outline of a desired shape. The process is extremely versatile, as the outline and depth of the image can be changed each time the die is used.

2.7 Methods of Die Production

The methods of making the stumps vary from stage to stage. Sharma (1999) states that the most common methods used to make dies are as follows: Turning, machining or planing, milling and grinding. Turning is used for rough machining with rotary machines, while for rectangular and square dies - blocks the operations are done on a planer. Grinding is mainly used for finishing the surfaces. The impressions are cut into the die block by highly skilled men using the milling machine specially designed for die sinking. Different types of cutters are used depending on the shape of each section of the impression. But much of the accuracy of the die depends on the manual work that is done after the die is countersunk. The impressions are machined either by manual countersinking after layout and/or by copy or pattern.

2.8 Jewelry IVERSITI TEKNIKAL MALAYSIA MELAKA

As long as there are humans, the use of jewelry will continue unabated. Untracht (1985) explains the motivations behind why people wear jewelry, noting that they are elemental and eternal human concerns, and since jewelry is a wearable, intimate art that can be worn and enjoyed constantly, it is reasonable to assume that the use of bracelet in one form or another will continue as long as the human race survives.

Untracht goes on to say that jewelry is for men and women (and occasionally animals), and that it must relate to the human anatomy; its scale or proportions must deal with dimensions.

He adds that the form a piece of jewelry takes is determined primarily by the place on the body or clothing where it is to be worn, modified by considerations related to how it is to be placed there and whether it can be worn with relative comfort (although the latter is sometimes neglected because of other considerations). Such considerations may dictate whether the design is conceived as fundamentally frontal, cylindrical, or three-dimensional. Untracht goes on to explain that the three forms a piece of jewelry can take are:

i. Frontally conceived forms: In frontally conceived forms, the jewel is best shown from its front, implying that it has a back. The latter is usually flat, or its points of contact with the body lie in a flat plane in a direction parallel to the body. The front or visible part may take any dimensions from flat to projections at right angles to the plane of the body. This category includes brooches, clips, pendants, medals, etc.

ii. Cylindrical Forms : The overall shape of these concepts is cylindrical, conical or curved in relation to similarly shaped parts of the anatomy to which they are attached. When actually used on the body, the work may not be seen as a whole, but initially the design is conceived as an overall unit encompassing the basic shape. Such forms may include frontal or even back elements. Ornaments of this class may be worn on the head, neck, arm, wrist, fingers, waist, leg, ankle, and toe. Head ornaments include crowns, tiaras, wreaths, fillets, and forehead ornaments; neck ornaments include necklaces, chokers, chains, pendants on chains, etc.; arm ornaments include bracelets, bangles, watch bracelets, and upper arm bracelets; rings are worn on the fingers; waist ornaments include belts and girdles; anklets are worn on the ankles; and toe rings are worn on the toes.

iii. Dimensional ornaments: These are meant to be round and worn on parts of the body or in a way that allows the shape to be seen from all sides, or at least several sides. Such jewelry may be hanging earrings, hair ornaments, brooches, pendants suspended from chains, or other hanging, moving, or spring-mounted and therefore fully circulating objects.

Turning to the functional considerations in the jewelry concept, Untracht states that the size, weight, and shape of the piece of jewelry, as well as its position on the body or costume, determine the system by which it is held to the clothing and secured from loss. These general considerations must also be taken into account in the design of jewelry.

Findings of jewelry, that is, the metal parts by which pieces of jewelry are fastened together and to the body or to the clothing, are naturally included in this subject.

The weight that different people can tolerate in a single piece of jewelry varies greatly. Some individuals will be comfortable wearing very heavy jewelry and not be bothered by possible discomfort, while others will insist on extreme lightness.

In this study, the elements created by using the punches and dies will include jewelry elements that can be assembled into jewelry pieces such as necklace or choker, bracelet, and universiti teknikal malaysia melaka earring.

2.9 Stamping

According to Codina (2007), ancient craftsmen realized that cast tools and weapons became more durable when forged or beaten; these cold forging and minting processes are very old. The minting of coins as objects of value has its origins in coinage, which was also often used as an ornamental technique as early as the second century BC. He describes minting as the impressing and deforming of metal by applying pressure with a harder and more resistant tool. Mohammed (2011) explains that sheet metal stamping can be defined as the process of forming the shape of the sheet metal blank in a state of plastic deformation into a usable shape using a die and a mechanical press; stamping is considered a net forming process. It adds, however, that the stamping effort is not limited to the manufacturing technology (i.e., the stamping process), but also includes the development of the necessary tooling (i.e., the stamping technology).

Untracht (1985) explains stamping as a process in which a tool or die is forcibly driven into a sheet for one of the following three purposes: Stamping, Punching, or Embossing. He explains stamping as the act of making a mark by pressure. He goes on to say that in embossing, a pattern is made on a flat sheet of metal by means of an embossing die which bears at its working end a linear figure in a comparatively sharp projection which leaves an impression on the surface of the metal when struck with a hammer. Improvised punches may be used for the same effect.

The pattern is transferred directly to the metal surface by striking the stamp with a hand-held hammer while the metal rests on a support. The impression stamp is called an impact stamp because the pattern is usually created by a single hammer blow on the stamp, which is the unifying concept behind this diversified group. Pattern stamps can be divided into two groups: those for decorative purposes, such as an indentation stamp that stamps a decorative figure, and those that stamp a normally non-decorative figure on metal, such as a trademark, quality mark, letter, number, or stamp with another figure used for identification or other purposes.

Punching is the term used by Untracht (1985) to describe the punching out of a flat shape with a special contour or a three-dimensional shape, called a blank, by the use of a sharpedged punch, alone or in conjunction with a punching die. The larger or more dimensional the blank, the more likely it is that greater mechanical force must be applied to produce the blank.

Loney (2009) explains that stamping is the process of placing a design into metal using chasing tools or embossing dies. She explains that the design end of the embossing tool is placed on the metal while a hammer strikes the other end of the tool.

Szumera (2003) explains that metal stamping process is divided into five different and distinct types and the types used for production at industrial level are as follows: Forging or coining, bending or multiple bending, drawing, deep drawing and stamping or fine forming.

Die forging or stamping is the process of reducing the original thickness by applying a certain force to it. The process is used to make coins, kitchen utensils such as spoons and knives. Szumera explains that bending is a type of metal forming in which metal is formed into angular or radial shapes. Brackets, switch boxes, parts of stapling machines, and appliance parts are examples of items made using this method.

Drawing is a process in which material is stretched into various shapes. The shapes are usually round, oval, or rectangular, with the depth of the part not exceeding its diameter. The metal starts as a flat blank and is placed over a die opening. A force must be applied to the blank to restrict the flow of the metal so that it does not wrinkle. This technique is used to make ashtrays, bottle caps and lids, ceiling fan housings, and door panel parts.

Deep drawing is essentially the same as drawing, except that the metal is drawn to a greater depth. A part can be said to be deep drawn if the depth exceeds the diameter of the part. This

type of metal forming is usually done in steps or tees. Deep drawing applications may also require special types of machinery such as hydraulic or double-acting presses. Annealing may also be required during the process to relax the metal before subsequent forming. Typical deep drawn parts include fire extinguishers, canisters, beverage cans, containers and oil filters.

Punching is usually considered the simplest type of punching because it involves only a cutting operation. Punching operations can be performed with conventional tools. They can be simple, compound or progressive. Fine blanking is a cutting process that produces a straight edge with no signs of metal breakage. This usually requires a special fine blanking press. A straight edge can also be produced in a conventional tool and press, using a shearing operation. Examples of blanks include wedges, washers, and spacers. Fine blanking blanks are used to make small gears that require straight edges for engagement.

Codina (2007) also explains that stamping is often used in the manufacturing process, as most everyday objects are made in some production process based on stamping and embossing. He acknowledges that contemporary stamping with complex dies has evolved tremendously and that the technology is currently associated with industrial engineering rather than craft. He adds that by using older production methods and taking advantage of resources and products that are available and affordable in today's market, it is possible to produce very attractive, interesting shapes and decorative features at a reasonable price.

This is very important as it facilitates the mass production of bracelet and ensures that the cost of the items is affordable to the customers.

Codina in turn reveals that stamping is commonly used especially in the mass production of jewelry such as bracelet as this process produces a very fine thickness of metal which is also very strong and durable. Considering the large number of pieces that can be produced, this leads to huge savings in production costs. He further added that making a steel punch and die is the most commonly used method in the industry as it offers greater durability and precision. However, he was quick to add that it is the most expensive process as it requires a fairly large stamping press and therefore requires extensive production to pay for itself.

Bawa (2004) gives the following as advantages of metal stamping:

(i) Weights of fabricated parts are less;



(v) Cost of labor is low.

Considering the production benefits of metal stamping compared to the cost of tooling, adapting the method in studio practice and using a simple technology that costs less but achieves the same results will go a long way in reducing the cost of making jewelry. Bawa confirms that metal stamping is used extensively in the manufacture of automotive, aerospace, electrical and other industrial components due to its advantages. He further adds that a variety of products include automobile bodies, shells, structural grinders, car and truck frames, furniture legs, beer cans and wheel rims.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter deals with the methodology of the research. It includes the research design, analysis on the study, data collection instruments used for the study, product design development and 3D modelling drawing.



3.2 Research Design

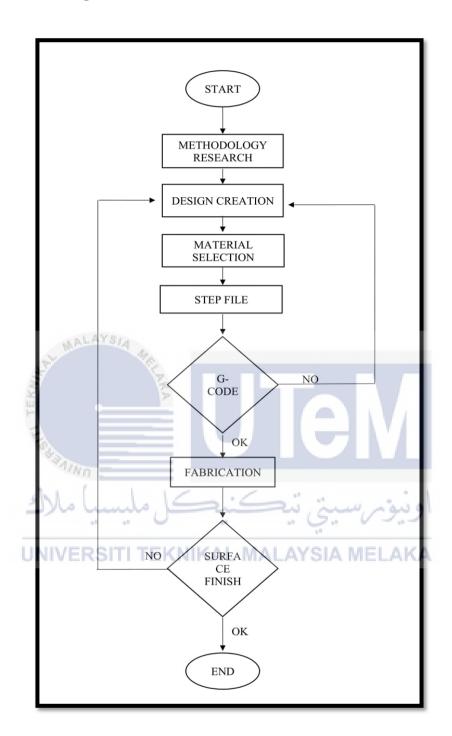


Figure 1 Project Process Flowchart

For the methodology research, the practical of any piece of research is referred to as research technique. It's about how a researcher plans a study in a methodical way to produce accurate

and reliable results that address the study's goals and objectives. Research on past experiments and projects have been made to ensure a proper project run smoothly.

For design creation, SolidWorks software was selected as the main platform to sketch the gold bracelet stamping die design. The software was chosen because of the easiest user interface and familiarity that provided by SolidWorks to design gold bracelet stamping die.

Next, the fabrication is where the gold bar stamping die design is run by the machine. To make this process, a proper 3D printing machine is needed and proper laboratory apparatus is required. Running the design into machine also take some time to ensure there is no error occured.

Lastly, the goal of finishing procedures is to change the surface of a produced component to obtain a certain feature. Improved aesthetics, adhesion, solderability, chemical, corrosion, tarnish, or wear resistance, hardness, electrical conductivity, defect elimination, and surface friction management are all desirable features.

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Table 1 Gantt Chart

Activity/week	1	2	3	4	5	6	7	8	9	10	11	12
Meeting with supervisor on conducting Bachelor Degree Project 2.												
												<u> </u>
Tutorial with lab instructor on the 3D printing machine.												<u> </u>
Reworked on design development.			-									
Study and analyze on the material of the stamping die.												
Getting approval from the supervisor on the new design.			Y	1								
Setting parameter on the 3D printing machine.												
Transfer the data and input to the 3D printing machine.												
Finalize the parameter setup on the 3D printing machine.	J	/	1.0	ŝ	4							
Develop the stamping die by using 3D printer.	-	1	1		-							
Doing some finishing process on the stamping die prototype. EKNIKAL MALAYSIA	M	E	Ļ	K	A							
Submit draft of thesis report to supervisor.												
Submit thesis report and slide presentation.												

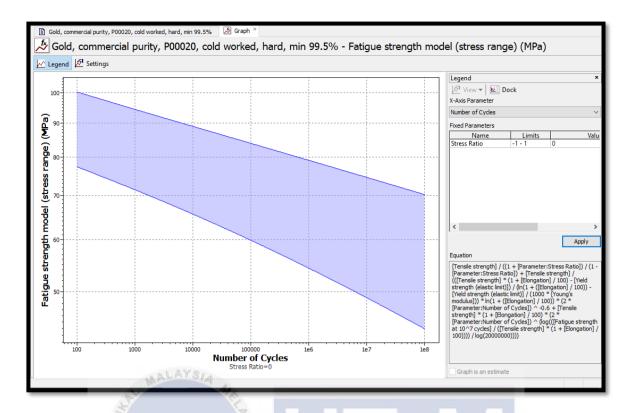
3.3 Analysis on the Study

3.3.1 Gold Mechanical Properties

CES Edupack software is chosen to determine the mechanical properties of gold. This software provides more than enough about the gold material itself from the description of the material, general properties, composition overview, composition detail, mechanical properties, thermal properties electrical properties and many more. Figure 2 below shows the mechanical properties of gold material.

Gold, commercial purity, P00020, cold worked, hard, min 99.5%					
Eayout: All attributes	~	Show/H	lide		
Density Price Composition overview Composition (summary) Au/<0.5 other elements Base			/m^3 /R/kg		
Composition detail (metals, ceramics and gl	asses)	%			
Mechanical properties Young's modulus Flexural modulus Bulk modulus Bulk modulus Bulk modulus Shaar factor	76 * 76 26 M 0.415 AY 5	70 81 GF 81 GF 30 GF 180 GF 0.425	a a a a a a a a a a a a a a a a a a a		
Yield strength (elastic limit) Tensile strength Compressive strength Flexural strength (modulus of rupture) Elongation Hardness - Vickers Fatigue strength at 10^7 cycles Fatigue strength model (stress range) Parameters: Stress Ratio = 0, Number of Cycles = 1e7	165 - 180 - * 165 - * 165 - 2 - 50 - * 70 -	205 MF 220 MF 205 MF 205 MF 6 % 70 HV 110 MF 74.5 MF	2a 2a 2a strain 7 2a		
Fracture toughness Mechanical loss coefficient (tan delta)		66.5 MF 0.0021	°a.m^0.5		

Figure 2 Gold Mechanical Properties

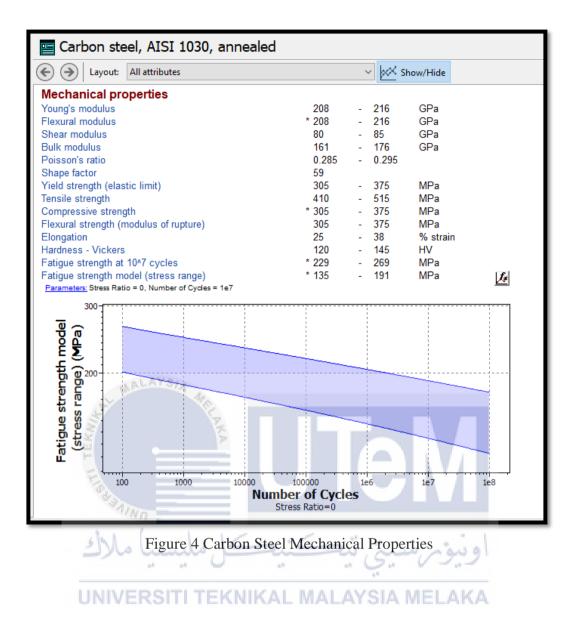




3.3.2 Carbon Steel Mechanical Properties

Carbon steel is the most suitable material to make a die. Due to their high wear-resistance and hardness, high-carbon steels are used in cutting tools, springs high strength wire and dies. Carbon concentration ranges from 0.60 to 1.25 wt%, with manganese level ranging from 0.30 to 0.90 wt% in high-carbon steel. Carbon steels have the highest hardness and toughness, but the lowest ductility. Because high-carbon steels are virtually always hardened and tempered, they are extremely wear resistant.

High-carbon steels, such as tool steels and die steels, contain additional alloying elements such as chromium, vanadium, molybdenum, and tungsten. The production of carbide compounds such as tungsten carbide arises from the inclusion of these metals, resulting in an extremely hard wear-resistant steel (WC).



	Carbo n conten t (wt.%)	Microstructur e	Properties	Examples
Low- carbon stee I	< 0.25	Ferrite, pearlite	Low hardness and cost. High ductility, toughness, machinabilit y and weldability	<u>AISI</u> 304, <u>ASTM</u> <u>A815, AISI</u> <u>316L</u>
Medium- carbon stee I	0.25 - 0.60	Martensite	Low hardenability , medium strength, ductility and toughness	AISI 409, <u>ASTM</u> <u>A29</u> , <u>SCM43</u> <u>5</u>
High- carbon stee	0.60 - 1.25		High hardness, strength, low ductility	AISI 440C, EN 10088-3

Table 2 Types of Carbon Steel and Their Properties

Туре	AISI/ASTM name	Carbon content (wt.%)	Tensile strengt h (MPa)	Yield strength (MPa)	Ductility (% elongation in 50 mm)	Applications
Low	<u>1010</u>	0.10	325	180	28	Automobile panels, nails, wire
Low	<u>1020</u>	0.20	380	205	25	Pipes, structural steel, sheet steel
Low	<u>A36</u>	0.29	400	220	.23	Structural
Low	A516 Grade 70	E ^{0.31} SITI TEI	485KAI	260ALAY	S ² A MELA	Low-temperature pressure vessels

Table 3 Comparison of Properties and Applications of Different Grades

Medium	<u>1030</u>	0.27 – 0.34	460	325	12	Machinery parts, gears, shifts, axles, bolts
Medium	<u>1040</u>	0.37 – 0.44	620	415	25	Crankshafts, couplings, cold headed parts.
High	<u>1080</u>	0.75 – 0.88	924	440	12	Music wire
High	<u>1095</u>	0.90 - 1.04	665	380	10	Springs, cutting tools

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3.3.3 Punching Force Calculation Formula

If you punch round holes or square holes, or some other forms of holes through a given thickness of metal, you just want to know the force required to punch a hole in steel.

You can calculate the punching tonnage been required with the help of the following punching force calculation formula (blanking force formula):

Punching Force (KN) = Perimeter (mm) * Plate Thickness (mm) * Shear Strength (kn /

 mm^2)

- <u>Perimeter</u>: add up the continuous line forming the boundary of a closed geometric figure.
- Thickness: the thickness which will be piecing through by the punching mold.
- Shear Strength: The physical properties of the plate, determined by the material of the sheet and can be found in the material manual.

3.4 Data Collections Instruments Used for the Study

Based on the finding and research from the literature review, these are the most important considerations for design a gold bracelet stamping die. Important points should be considered while designing a die set are listed below:

(a) Cost of manufacturing depends on the life of die set, so selection of material should be done carefully keeping strength and wear resistant properties in mind.

(b) Die is normally hardened by heat treatment so design should accommodate all precautions and allowances to overcome the ill effects of heat treatment.

(c) Accuracy of production done by a die set directly depends on the accuracy of die set components. Design should be focused on maintaining accurate dimensions and tight tolerances.

(d) Long narrow sections should be replaced by block shaped sections to avoid warpage.

(e) Standardized components should be used as much as possible.

(f) Reinforcing grips should be used as per the requirements of the sections.

(g) Easy maintenance should be considered. Replacement of parts should be easy.

3.5 Product Design Development

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To determine the design of the gold bracelet stamping die, it is compulsory to consider the design that meet the requirement based on the mechanical properties and technical requirements on producing the design of gold bracelet stamping die. Therefore, by using the House of Quality tool, we can finalize the design based on the requirements and technical aspects on designing the gold bracelet stamping die.

3.5.1 House Of Quality

The term "House of Quality" refers to a well-known product development process that is motivated by consumer needs for new products or processes and anchored by the skills and resources of the company attempting to fulfil those needs. It's a method of listening to consumers, converting their wishes into a written plan, prioritising execution stages based on the customer's priorities, and putting a feasible plan on paper.

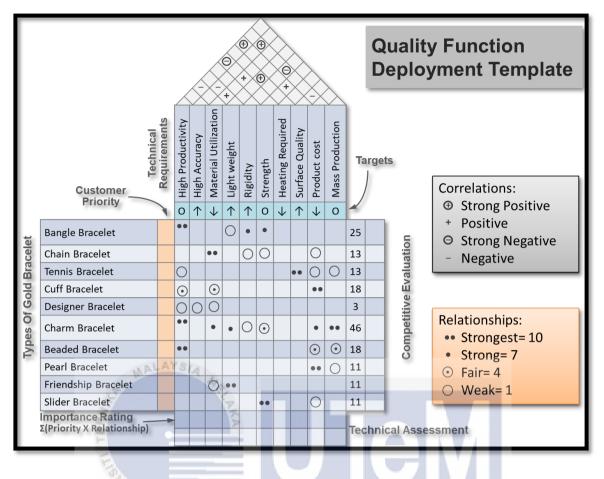


Figure 5 House Of Quality

Based on the House of Quality tool that has been used to determine the design of the gold bracelet, charm bracelet has the highest marks among the 10 types of gold bracelet. This tool is important to measure the technical requirements on gold bracelet stamping die such as the high productivity, high dimensional accuracy, material utilization rate, light weight, good rigidity, high strength, heating requirement, product cost and mass production ability on the production of the gold bracelet stamping die.



Figure 6 Charm Bracelet

In term of the design of gold bracelet stamping die, charm bracelet has the most higher point compared to other types of bracelet. Based on result, the design concept of charm bracelets captured the imagination of jewelry lovers, becoming an ideal way to keep mementos and symbolic items at hand. Nowdays, there are so many types of charms available representing varius topics, hobbies and themes. Charm bracelets are versatile, allowing you to take on and put on charms as you wish, depending on your mood and preferences. They make excellent gifts and are a nice way to show your personality.

3.6 3D Modelling Drawing

From the product design development and analysis from the House of Quality, design for the gold bracelet stamping die prototype has been produced. Below shows the design of the gold bracelet stamping die drawing produced by the drawing software known as Solidwork.



3.6.1 Product of Gold Bracelet Stamping Die

Figure 7 Gold Bracelet Product

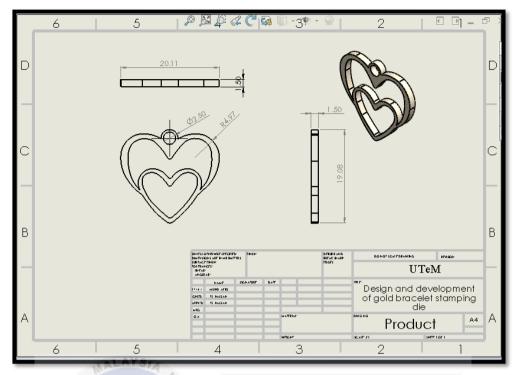


Figure 8 Product Drawing Template

3.6.2 Gold Bracelet Stamping Die

By produce the end product of the gold bracelet, we can develop the mould of the stamping die consists upper mould and lower mould by using the mold tool. The mold tool consists of draft analysis, identifying the split line, identifying the parting lines, shut-off surfaces, parting surface. After take consideration on the elements to produce the mold, finally the upper and lower die produced. Figure below shows the upper die and lower die in 3D drawing.

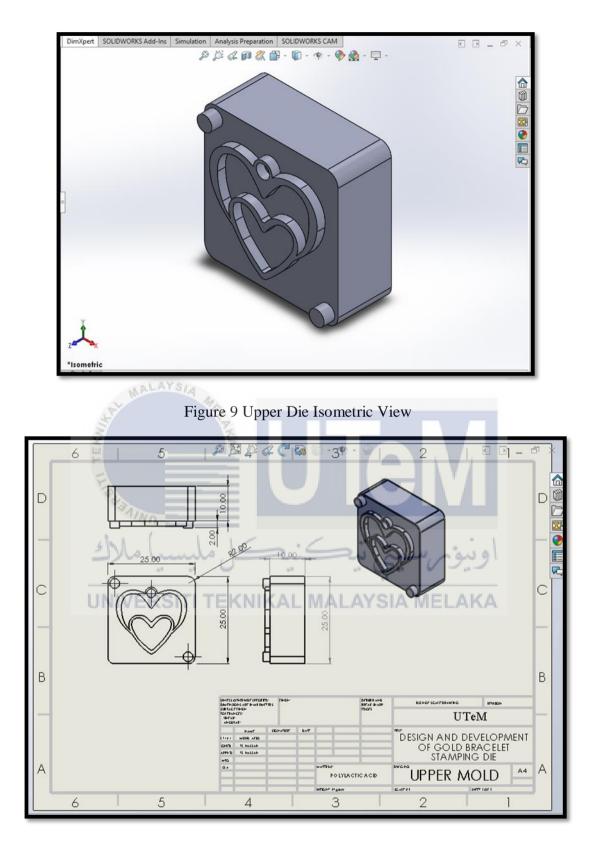


Figure 10 Upper Die Drawing Template

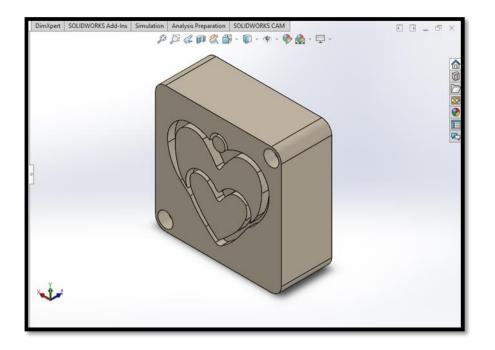


Figure 11 Lower Die Isometric View

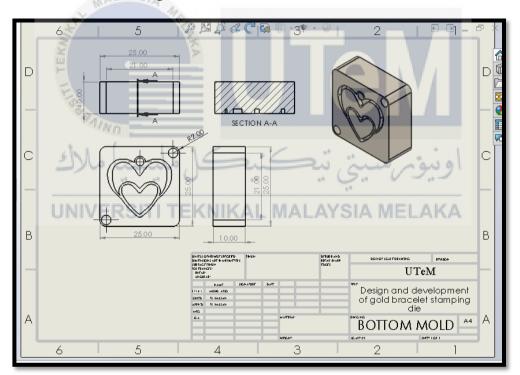


Figure 12 Lower Die Drawing Template

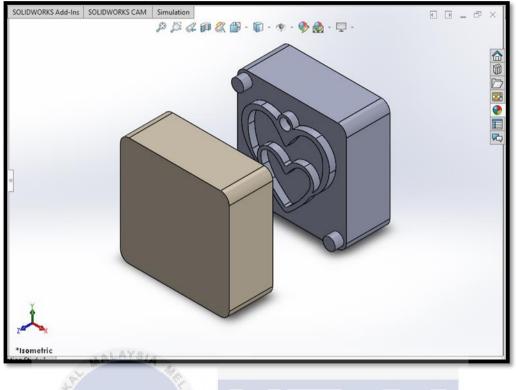


Figure 13 Full Assembly

3.7 Machining Process

3D printing machine was used to develop the prototype of the gold bracelet stamping die from the upper die, lower die and the end product itself.

3.7.1 Generate G-code TI TEKNIKAL MALAYSIA MELAKA

Ultimaker Cura software used to develop the g-code of the drawing. It is compulsary to convert the drawing from the Solidwork into STL (stl) file to generate the g-code of the product.

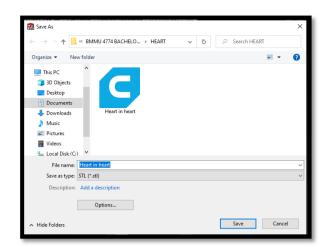


Figure 14 Convert Drawing into STL file

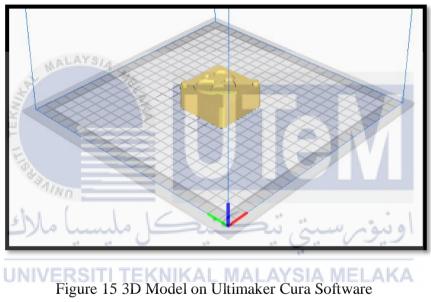




Figure 16 G-code

Once g-code has been generated by the Ultimake Cura Software, then we can proceed to the next step which is the machining process of 3D printing machine known as Creality Ender 3-Pro.

3.7.2 3D Printing Process

Lastly, after complete the generation of the g-code and setup the parameter of the product on the Ultimaker Cura software, finalize your process by simulation to generate the time estimation and material estimation. After the completion of the simulation, save the coding generated by the software to the removable disk and transfer it to the 3D printing machine, Creality Ender-3 Pro to proceed with 3D printing process.

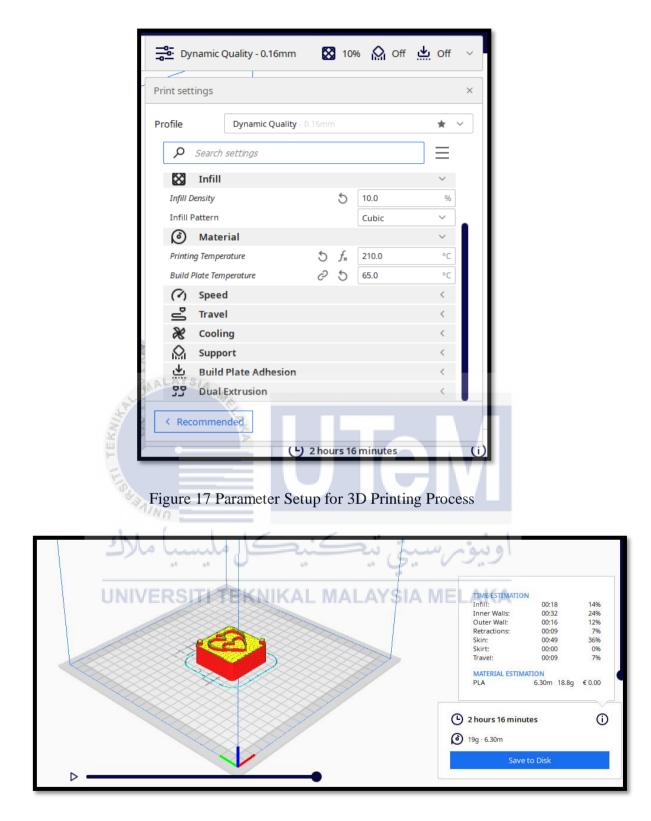


Figure 18 Simulation Process of 3D Printing

3.7.3 3D Printing Machine Setup

AALAYS!



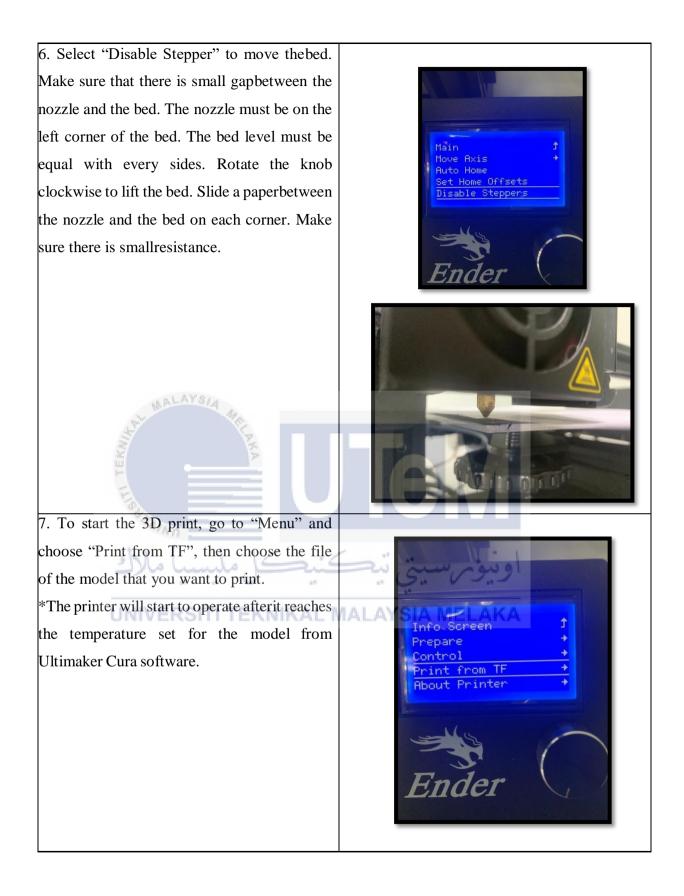
Figure 19 Creality Ender-3 Pro

Here are a number of features that make the Creality Ender-3 3d printer one of the most popular machines currently on the market. It has a build volume of 220 x 220 x 250mm, a BuildTak-like heated build plate, power recovery mode, and a tight filament pathway that makes it easier to print with flexible materials. Creality Ender-3 3D Printer is partially assembled and competed by Creality itself. It can work continuously for 200 hours without pressure.Creality Ender-3 3D Printer allows it to resume printing after power-off or lapse occurs and with thermal runaway protection itself. Patented technology, V-Slot+precision pulley, running more smoothly, more wear-resistant. Effectively reduce noise. MK8 extrusion mechanism is used, a brand-new patented infrastructure that effectively reduces the risk of plugging and poor spillage and can print almost all filaments on the market. CNC machining of the Y-rail mounting groove to make sure precise positioning and keep the solid frame with the high-precision printing quality.



Table 4 Standard Operational Procedure (SOP) on 3D Printer

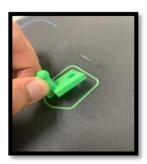




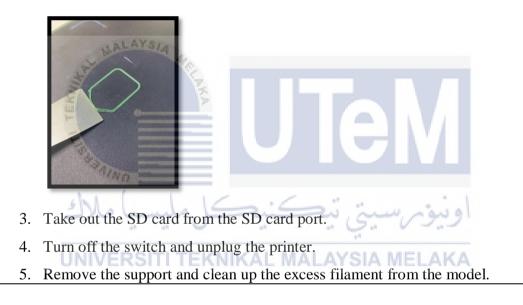
WHEN YOU FINISH:

1. Take out the printed model from the bed.

*If your print is still adhered to the build plate after cooling, you can use a spatula toremove the print.



2. Clean up filament residues on the nozzle and bed.



CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter presents the results and analysis on the design and development of gold bracelet stamping die. The prototype design has been formed through the steps that have been taken as described in Chapter 3. The topics to be discussed in this chapter such as Failure Mode and Effect Analysis (FMEA), design defect, prototype defect, software effectiveness and many more. The gold bracelet stamping die prototype analysis have been made to make sure there are no hindrance in the making of the real gold bracelet stamping die.

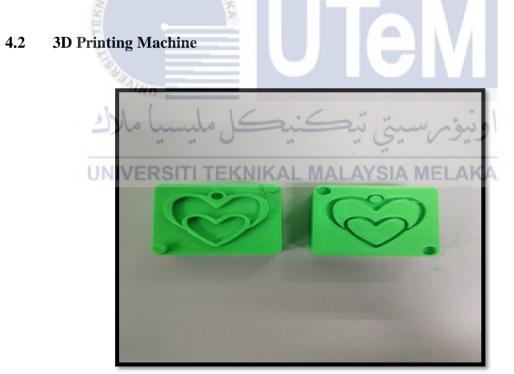


Figure 20 Upper and Lower Die





4.3 Failure Mode and Effect Analysis (FMEA) on Gold Bracelet Stamping Die

This kind of analysis is used to find all possible design defects in a systematic way. It also looks for flaws in the machining and assembly processes. Failures are graded on the severity of their consequences, the frequency with which they occur, and how easily they may be discovered. The purpose of the analysis is to remove or reduce failures, starting with the most critical.

4.3.1 Upper Die Simulation

Solidworks Simulation was used to create the simulation. The Upper Die is treated as though it were made of solid metal. The current setting has been configured to be the default. As indicated in Chapter 3, the material for the Upper Shoe is 1023 Carbon Steel Sheet (SS). Table 5 contains additional model information, such as the pre-simulation.

UPPER DIE				
TREATED AS	VOLUMETRIC PROPERTIES			
Solid Body	Mass:0.0500393 kg			
	Volume:6.36794e-06 m^3			
	Density:7858 kg/m ³			
	Weight:0.490385 N			

Table 5 Upper Die Volumetric Properties

There are various details that need to be documented as simulation preparatory material attributes because the material is set to 1023 Carbon Steel Sheet (SS). Model type, yield and tensile strength, mass density, and other data are listed in Table 6.

Table 6 Material Properties of Upper Die				
Model Reference	Properties			
*solun	Name: 1023 Carbon Steel Sheet (SS)			
كنيكل مليسيا ملاك	Model type: Linear Elastic Isotropic			
JNIVERSIT TEKNIKAL MA	Yield strength: 2.82685e+08 N/m ²			
	Tensile strength: 4.25e+08 N/m ²			
	Elastic modulus: 2.05e+11 N/m^2			
1.	Poisson's ratio: 0.29			
	Mass density: 7858 kg/m ³			
	Shear modulus: 8e+10 N/m^2			
	Thermal expansion coefficient: 1.2e-			
	05 /Kelvin			

Table 6 Material Properties of Upper Die

The value was set to the average of mechanical stamping press pressure for the load and fixtures. Because the upper die shoe surface will shift with the lower die shoe, pressure was applied to the top of the upper die shoe surface. Because the geometry does not move, the fixed geometry was established at the bottom surface of the top die shoe. Tables 7 and 8 contain all of the load and fixture information.

Fixture Name	Fixture Image	Fixture Details
Fixed-1 Resultant Forces		Entities: 1 face(s) Type: Fixed Geometry
Components 2	Y	Z Resultant
Reaction 0.0043 Force (N)	57573 -0.00650537 172	234.9 17234.9 MELAKA

Table 7 Resultant Force, Fixture Name, Image and Details

Load Name	Load Image	Load Details
Force-1		Entities: 1 face(s)
		Type: Apply normal
		force Value: 17235
		Units: N
	,	Phase Angle:0
		Units: deg

Table 8 Load Name, Image and Details

Von Mises Stress, Resultant Displacement, and Equivalent Strain are three results that can be produced from the simulation. The von Mises Stress is a criterion for determining if the Upper Die made of 1023 Carbon Steel Sheet (SS) will yield or fracture. The phrase "equivalent strain" is used to define the state of strain in solids at the Upper Die level. Tables 9, 10 and 11 show the results of von Mises Stress, Resultant Displacement, and Equivalent Strain.

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Name	Name Type Minimum		Maximum	
Stress1	VON: von	3.344e+05 N/m^2	6.956e+07 N/m^2	
	Mises Stress	Node: 13427	Node: 652	
Model name:UPPER MOLD Study name:Static 1[-Default-] Plot type: Static nodal stress Stress1			von M	
		Má-		
TEKNIF	ALAYSIA MELPINA		↓ Yield	
		ملیکی نیکنید Educational Product. For Instruction	اوينوس onal Use Only.	

Table 9 Von Mises Stress Study Result

Name	Туре	Minimum	Maximum	
Displacement1	URES: Resultant	0.000e+00 mm	2.901e-03 mm	
	Displacement	Node: 332	Node: 816	
Model name:UPPER MOLD Study name:Static 1(-Default-) Plot type: Static displacement Displacement1 Deformation scale: 1.63195e+07			URES	
Hala HALA				
بيا ملاك م	SOLIDWORKS Educational	Product. For Instructional U	o ohly.	

Table 10 Resultant Displacement Study Result

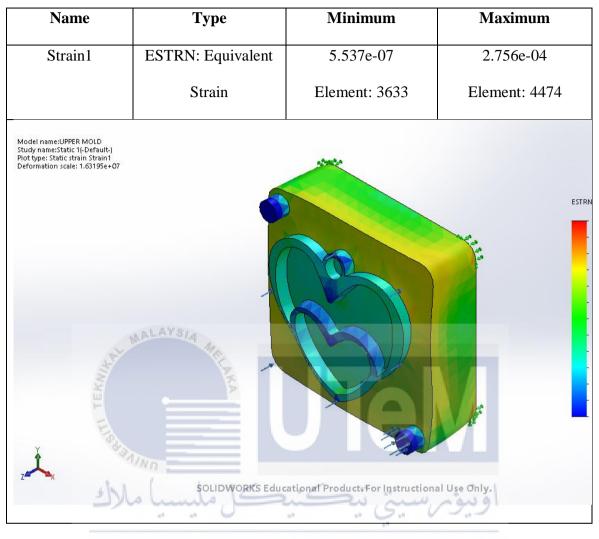
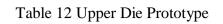


Table 11 Equivalent Strain Study Result

4.4 Design Analysis SITI TEKNIKAL MALAYSIA MELAKA

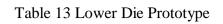
The outcome of the Gold Bracelet Stamping Die Prototype is discussed in this topic. The Creality Enders-3 3D-Printing machine was used to create the prototype. The prototype creation process can take up to 4 hours. It has both an upper and lower die in its construction. Table 12, Table 13, and Table 14 illustrate the Gold Bracelet Stamping Die prototype.













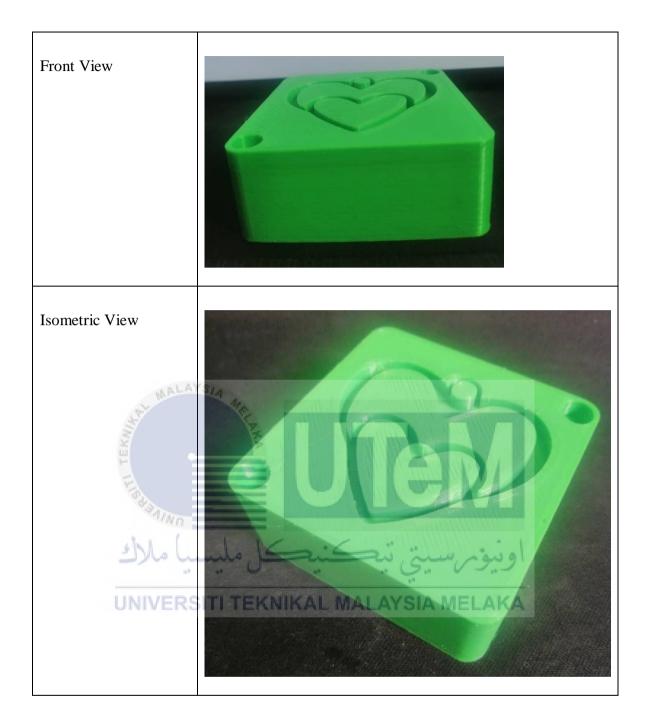
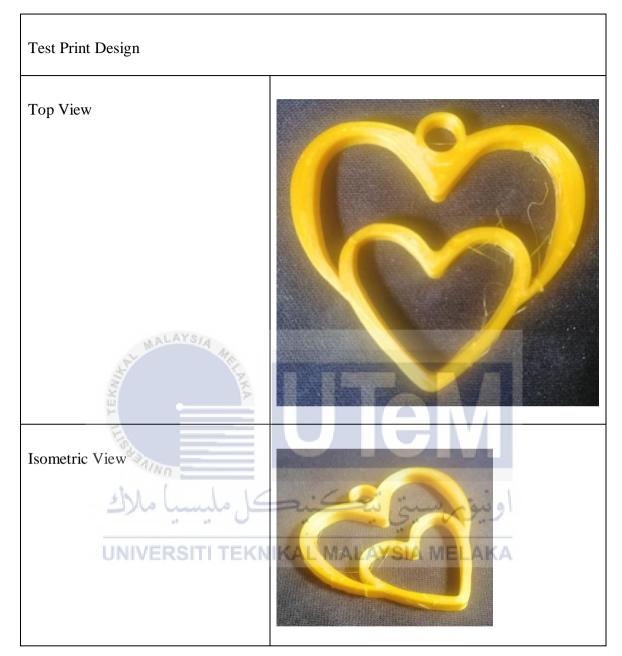


Table 14 Test Print Prototype



4.4.1 Prototype Defect

4.4.1.1 Circle Inaccuracies

The circle inaccuracies defect occurs when the heated bed and printing nozzle of a 3Dprinting machine move lateral to the X, Y, and Z axes to print the prototype. Making the circle tolerance about 0.5 mm is one of the preventive measure to avoid the defect. Even if it isn't the optimal option, it will offer the prototype design the best shape. Figure 22 shows an example of a circular inaccuracies fault inside the red circle.

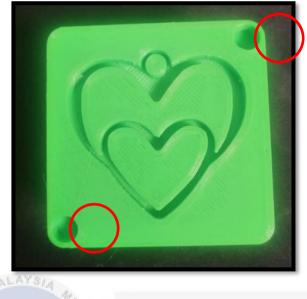


Figure 22 Circle Inaccuracies Defect Example

4.4.1.2 Layer Shifting and Splitting

When the prototype model is not produced at a good printing parameter, layer shifting and splitting occur. Because the print profile is only set to Standard Quality, the model may split. The model's durability is also influenced by the wall thickness and infill density. The wall thickness is set to 0.8 mm, and the wall line count is set to 2. The infill density is set to 10%, and the infill pattern is designated as cubic. A greater number of wall thickness and infill density may produce in a very good Gold Bracelet Stamping Die Prototype, preventing the model from splitting, but it will take longer to print, use more material, and cost more overall. Figure 23 and 24 depict the fracture of the Gold Bracelet Stamping Die.

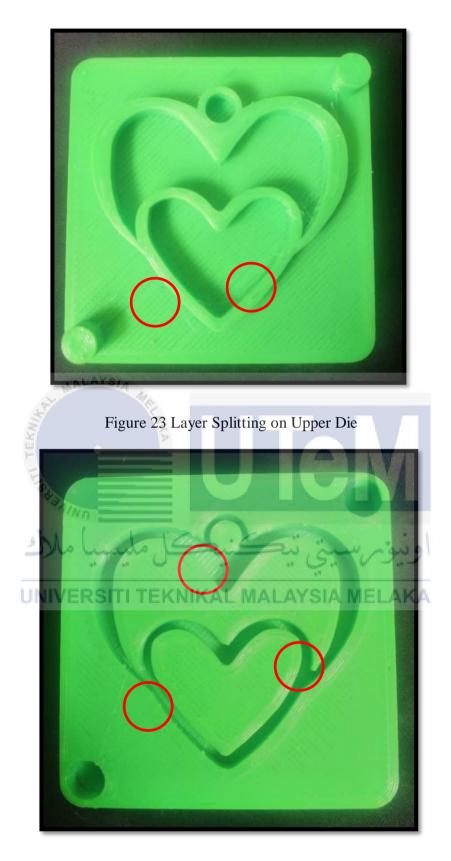


Figure 24 Layer Splitting on Lower Die

4.4.1.3 Model Stringing or Oozing

When the printing extruder moves between different sections of the print section, it causes model stringing or oozing. When the filament flowing out the nozzle while the extruder is being transferred to a new region of printing, a lot of hairs and strings are left behind. Despite the fact that the retraction command was enabled during the extruder's travel, causing the filament to be pulled backwards into the nozzle, stringing or oozing still occurs due to the small size of model printing. Furthermore, the distance between one printing part and the next is too tiny. Figure 25 depicts the Test Print model stringing or leaking.



Figure 25 Test Print Stringing or Oozing

4.4.1.4 Blobs and Zits

The blobs and zits are a minor mark on the prototype model's exterior shell surface. The extruder must frequently stop and resume extruding as it moves around the construction platform. The extruder had to begin printing the outer shell at that precise location on the prototype model, then return once the entire shell had been printed, leaving a little imprint on the surface. Figure 26 depicts the Gold Bracelet Stamping Die model blobs and zits.



4.4.1.5 Dimensional Inaccuracies

When the measured dimensions do not match the design intent, dimensional accuracy is required. Over-extrusion, thermal shrinkage, and filament characteristic are all minor factors that might affect the precision of Gold Bracelet Stamping Die Prototype. The length on lower die shoe, where the purported dimensional accuracy is 50.00 mm but the printed portion is only 49.94 mm, are the most notable dimensional accuracy on the prototype model. Aside from that, the most noticeable dimensional accuracy is on the upper die length, which is

meant to be printed on 50 mm but is only 49.74 mm. Figures 27 and 28 depict the dimensional precision of the Gold Bracelet Stamping Die.

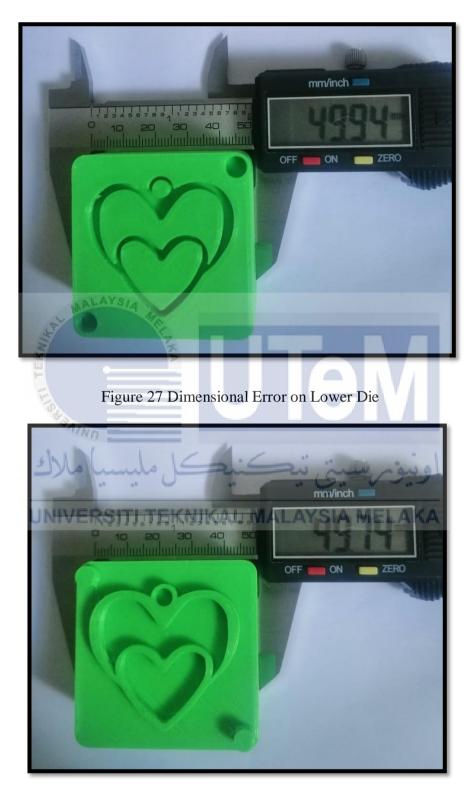


Figure 28 Dimensional Error on Upper Die

4.5 Software Analysis

The efficiency of using Ultimaker Cura software as an open source slicing application for 3D printers to create Gold Bar Stamping Die Prototype is discussed in this topic. The overall time, number of filaments used, and total length of filament used are utilized to determine whether the machine's prototype is satisfactory or not. All of the primary print settings may be configured in the software using Ultimaker Cura as a preparation step before creating the G-code.

The model for printing was the upper die shoe. The print profile for the first result was set to standard quality. The infill density has been set to 10%, and the infill pattern has been set to cubic. As a consequence, the entire print time is 24 minutes, and the filament used is 3 grams and 0.96 meters long. Figures 29 demonstrate the print settings and the result of standard quality printing.

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Print s	ettings					×
Profile	Standar	d Quality - 0.2mm			* ~	·]
٦	Search settings				∃	
	Quality				<	
	-				<	
	Top/Bottom				<	
	Infill				\sim	
Infi	ll Density		5 10.0	0	96	
\times	ill Pattern		Cut	bic	\sim	
< C					\sim	
-	nting Temperature	5			°C	-
<	ld Plate Temperature	Ċ	5 65.0	0	°C	
○) Speed			-	<	
	ecommended				- /	
ALA	ISIA Me	🕒 24 mi	nutes			(i)
	LAKA	СО-Зд-0.9 Preview		Save t	o Disk	

Figure 29 Standard Printing Quality Parameter Setup

The next profile of printing that need to be measure are dynamic quality and super quality. Each of the quality ensuing a different result. The print setting and the result of Upper Die Prototype are shown in Table 15



Table 15 Dynamic and Super Quality Parameter Setup

Super Quality - 0.12mm 🔀 20%	in off 📥 off 🗸	(49 minutes		
Print settings	×	3g · 1.26m		
Profile Super Quality - 0.12mm	~	Preview Save to Disk		
𝒫 Search settings				
Quality	~			
Layer Height C	0.12 mm			
Top/Bottom	<	• Total Print Time: 49 minutes		
Infill	~			
> Infill Density	20.0 %			
> Infill Pattern	Cubic ~	• Total Filament Weight Used: 4		
Printing Temperature	200.0 °C			
Build Plate Temperature	60 °⊂	grams		
Ch speed	/			
< Recommended				
WALAYS/4	11	• Total Filament Length Used:		
ET .	E	1.26		
K.	KA	1.26 mm		
Print Profile: Super Quality				
E =				
84 m.				
Layer Height: 0.12 mm				
لىسىا ملاك	o. Kais	اونية م سيتر تيد		
Infill Density: 20%				
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Infill Pattern: Cubic				

Following the printing profile, there are a number of factors that will have a direct impact on the prototype model. Because a part with smaller areas requires a print profile with slower production rates to preserve the piece's quality, the shape and thickness of the component have a direct impact on printing parameters like speeds and layer thicknesses. The higher the printing quality, the longer the total printing time. The ideal printing quality for printing the

Gold Bracelet Stamping Die is Dynamic Quality, because the parameter is adjusted correctly and the total time consumed is not excessive.

4.6 Summary

This chapter discusses the outcomes of prototyping a gold bracelet stamping die. The discussed issue can help fulfil the project's goal of designing and developing gold bracelet stamping dies. The Failure Mode and Effect Analysis (FMEA) simulation is used to eliminate or reduce faults in gold bracelet stamping dies, starting with the most critical. The prototype was analyzed to verify that the project went off without a hitch. Defects such as circle inaccuracy, layer shifting, and model stringing have been discovered. All of the flaws have been addressed with solutions and enhancements.



CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

There are numerous courses available for designing and developing gold bracelet stamping dies. There have been proposed activities that have been categorized using various methodologies. A "Gold Bracelet" is a quantity of pure metallic gold in any shape created by jewelry manufacturer under standard production, tagging, and track circumstances. In response to the increased demand for gold bracelet, many manufacturers plan to offer a variety of stamping dies. The designer may experiment with a few distinct concepts to see how each media functions.

The processes for designing and developing gold bracelet stamping dies are presented in this project. Research design, design sketching, design drawing, prototype creation, and material selection are all part of the product development process. To guarantee that the project follows the process flow, it is divided into three sections: project planning, design, and prototype fabrication.

The project's major feature is design sketching. 'SolidWorks 2018' was the software version that was used. The base square, which is 25 mm, is the most important aspect of the design. It is critical to develop gold bracelet stamping dies as the primary foundation for upper and lower die shoes. The term "sketching" is also crucial in the development of a gold bracelet stamping die.

Slicing is a step in the machining process that occurs before the design is put through its paces. The slicing software was decided to be Ultimaker Cura. The g-code will be generated automatically if you use this software. After the g-code has been completed, it can be delivered to the printer for physical item manufacturing. Setting the print settings to ensure a nice prototype is produced is a critical component of utilizing this software.

Machining is the first stage in creating a gold bracelet stamping die prototype. The method was carried out on a Creality Ender 3- Pro 3D printing machine. It has a 200-hour continuous working capacity. It allows printing to resume after a power interruption or lapse, as well as preventing thermal runaway. There are various concerns to be aware of when using this equipment, including a high-temperature printer nozzle that can inflict severe harm and hot filament flowing out of the nozzle.

Following thorough research, carbon tool steel was identified as the best material for gold bracelet stamping dies. Their hardness, resistance to wear and deformation, and ability to keep a cutting edge at high temperatures all contribute to their usefulness. Many of the properties of tool steel are determined by the presence of carbides in the matrix. This research was conducted on a production line in an industrial setting. Inspection of a large number of machined components is possible, which improves statistical correctness and dependability.

The gold bracelet stamping die design and development findings and analyses have been completed. The prototype design was built by following the procedures specified in Chapter 3. The Failure Mode and Effect Analysis (FMEA) is used to identify and eliminate problems, starting with the most critical. It's possible that the prototype creation process will take up to 2 hours. It is constructed with both an upper and lower die. Circle inaccuracies, layer shifting, model stringing, blobs and zits, and dimensional accuracy are among the prototype flaws

discovered. It has been demonstrated that utilizing Ultimaker Cura software as an open source slicing application for 3D printers to create Gold Bracelet Stamping Die Prototype is effective. The best print settings have been given in order to ensure the production of a good gold bracelet stamping die prototype.

Overall, the gold bracelet stamping die design and development project was a success. It has been proved that the proposed technology can be used to create a gold bracelet stamping die. The findings and analysis cover the entire process of making gold bracelet stamping dies. As a result, it lays the groundwork for the upcoming project.

5.2 **Recommendations**

The design and development of gold bracelet stamping dies could be improved in the future as follows:

i. Conduct research into additional gold bracelet manufacturers in order to broaden the design of gold bracelet stamping dies.

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- ii. Conduct further research into the development of gold bracelet stamping die in order to experiment with a wider range of manufacturing methods.
- iii. Switch to another piece of material to see whether there are any other ramifications to the error.
- iv. Develop a large number of gold bracelet stamping die prototypes in order to attract more manufacturers.

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6181

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APPENDICES





 Universiti Teknikal Malaysia Melaka Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia. № +606 270 1000
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 ⊕ www.utem.edu.my

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DESIGN AND DEVELOPMENT OF GOLD BRACELET STAMPING DIE



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

2021



Faculty of Mechanical and Manufacturing Engineering Technology

DESIGN AND DEVELOPMENT OF GOLD BRACELET STAMPING DIE



Bachelor of Manufacturing Engineering Technology (Process and Technology) With Honours

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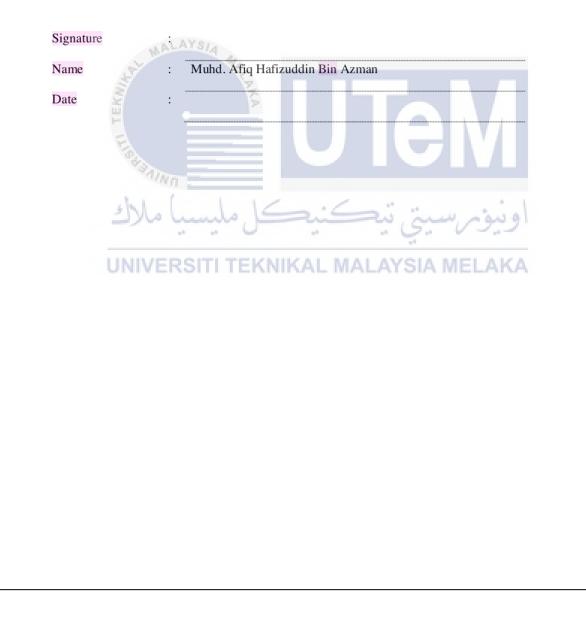


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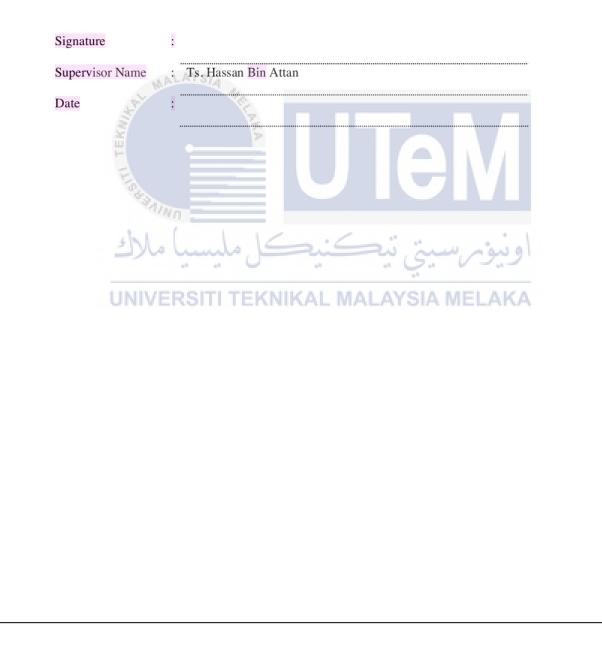
DECLARATION

I declare that this thesis entitled "Design And Development of Gold Bracelet Stamping Die " is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.



DEDICATION

This report is dedicated first and foremost to my beloved parents, for their endless love, support and encouragement. To my lecturer Ts. Hassan Bin Attan, who guided me along the way to complete this project. Thank you for all your support and give me strength till this project is completed.



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ABSTRACT

On gold bracelets, many goldsmith workshops in Malaysia use traditional handcrafting techniques. Because the jewellery manufactured in these factories is usually heavy and timeconsuming to make, the expense and thus the pricing are relatively high. As a result, goldsmiths require tools that can mass-produce gold bracelets in order to meet market demand. This study will employ locally available materials and establish studio processes that goldsmiths may use to translate their designs into stamping dies that can be used to mass produce lightweight, three-dimensional design parts. Within qualitative research, the study blended industrial-based research and descriptive research approaches. Practicing goldsmiths in Malaysia were the study's target population. The study's accessible population consisted of a few Malaysian goldsmith businesses. Many motifs and images that symbolise Malaysian culture might be translated into dies and punches to create gold bracelets, according to the study. As a result, goldsmiths should build basic tools like dies and punches in the workshop using a press machine in order to produce high quality and mass manufacturing.



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

i

ABSTRAK

Pada gelang emas, banyak bengkel tukang emas di Malaysia menggunakan teknik kraftangan tradisional. Oleh kerana barang kemas yang dikeluarkan di kilang-kilang ini biasanya berat dan memakan masa untuk membuat, perbelanjaan dan dengan itu harganya agak tinggi. Akibatnya, tukang emas memerlukan alat yang boleh menghasilkan gelang emas secara besar-besaran untuk memenuhi permintaan pasaran. Kajian ini akan menggunakan bahan-bahan tempatan dan mewujudkan proses studio yang mungkin digunakan oleh tukang emas untuk menterjemah reka bentuk mereka ke dalam cetakan cetakan yang boleh digunakan untuk menghasilkan bahagian reka bentuk tiga dimensi yang ringan secara besarbesaran. Dalam penyelidikan kualitatif, kajian ini menggabungkan pendekatan penyelidikan berasaskan industri dan penyelidikan deskriptif. Mengamalkan tukang emas di Malaysia adalah populasi sasaran kajian. Populasi yang boleh diakses oleh kajian ini terdiri daripada beberapa perniagaan tukang emas Malaysia. Banyak motif dan imej yang melambangkan budaya Malaysia mungkin diterjemahkan ke dalam bentuk mati dan tumbukan untuk mencipta gelang emas, menurut kajian itu. Akibatnya, tukang emas harus membina alat asas seperti die dan penebuk di bengkel menggunakan mesin penekan untuk menghasilkan pembuatan yang berkualiti tinggi dan besar-besaran.



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TABLE OF CONTENTS

	F	PAGE
DECL	ARATION	
APPR	OVAL	
DEDI	CATION	
ABST	RACT	i
ABST	RAK	ii
ACKN	NOWLEDGEMENTS	iii
TABL	E OF CONTENTS	iv
LIST	OF TABLES	vi
LIST	OF FIGURES	vii
CHAF	PTER 1 INTRODUCTION	9
1.1	Background	11
1.2	Problem Statement	12
1.3 1.4	Research Objective Scope of Research	13 13
28	Scope of Research	15
	PTER 2 LITERATURE REVIEW	14
2.1	Introduction alumning alumning	.14
2.2	Concept of Design	15
2.3 2.4	Concept of Dies	18
2.4	Materials Used for Dies and Punches KAL MALAYSIA MELA Types of Dies	24
2.6	Methods of Die Production	24
2.7	Jewelry	27
2.8	Stamping	29
28		
	PTER 3 METHODOLOGY	34
3.1 3.2	Introduction Research Design	34 35
5.2	3.2.1 Gantt Chart	37
3.3	Analysis on the Study	38
0.0	3.3.1 Gold Mechanical Properties	38
	3.3.2 Carbon Steel Mechanical Properties	39
	3.3.3 Punching Force Calculation Formula	43
3.4	Data Collections Instruments Used for the Study	43
3.5	Product Design Development	44

	3.5.1 House Of Quality	44
3.6	3D Modelling Drawing	47
	3.6.1 Product of Gold Bracelet Stamping Die	47
	3.6.2 Gold Bracelet Stamping Die Mould	48
3.7	Machining Process	51
	3.7.1 Generate G-code	51
	3.7.2 3D Printing Process3.7.3 3D Printing Machine Setup	53 55
	3.7.3 3D Printing Machine Setup	55
	PTER 4 RESULT AND DISCUSSION	60
4.2	3D Printing Machine	60
4.3	Failure Mode and Effect Analysis	61
	4.3.1 Upper Die Simulation	61
4.4	Design Analysis	67
	4.4.1 Prototype Defect	72
4.5	4.4.1.1 Circle Inaccuracies	72 78
4.5 4.6	Software Analysis Summary	82
26	Summary	02
5.1 5.2	PTER 5 CONCLUSION AND RECOMMENDATION Conclusion Recommendations	83 83 85
REF	ERENCES	86
		00
APP	ENDICES	89
	UND .	
	abl I I a com	
	رسيتى بيكنيكل مليسيا ملاك	اويبوم
	19	
	UNIVERSITI TEKNIKAL MALAYSIA ME	ΙΔΚΔ
	ONTREROTT LERITICAL MALATOIA ME	67107
	V	

LIST OF TABLES

TABLE TITLE	PAGE
Table 1 Gantt Chart	37
Table 2 Types of Carbon Steel and Their Properties	41
Table 3 Comparison of Properties and Applications of Different Grades	42
Table 4 Standard Operational Procedure (SOP) on 3D Printer	56
Table 5 Upper Die Volumetric Properties	62
Table 6 Material Properties of Upper Die	62
Table 7 Resultant Force, Fixture Name, Image and Details Table 8 Load Name, Image and Details Table 9 Von Mises Stress Study Result Table 10 Resultant Displacement Study Result Table 11 Equivalent Strain Study Result Table 12 Upper Die Prototype Table 13 Lower Die Prototype Table 14 Test Print Prototype	63 64 65 66 67 68 70 70 72
Table 15 Dynamic and Super Quality Parameter Setup	80

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1 Project Process Flowchart		35
Figure 2 Gold Mechanical Properties		38
Figure 3 Fatigue Strength Model (stress ran	ge) Graph	39
Figure 4 Carbon Steel Mechanical Propertie	28	40
Figure 5 House Of Quality		45
Figure 6 Charm Bracelet		46
Figure 7 Gold Bracelet Product		47
Figure 8 Product Drawing Template		48
Figure 9 Upper Die Isometric View		49
Figure 10 Upper Die Drawing Template		49
Figure 11 Lower Die Isometric View		50
Figure 12 Lower Die Drawing Template	ېرسېتى تېكنىڭ	50
Figure 13 Full Assembly		
Figure 14 Convert Drawing into STL file	IIKAL MALAYSIA MEL	5 2
Figure 15 3D Model on Ultimaker Cura So	îtware	52
Figure 16 G-code		53
Figure 17 Parameter Setup for 3D Printing	Process	54
Figure 18 Simulation Process of 3D Printin	g	54
Figure 19 Creality Ender-3 Pro		55
Figure 20 Upper and Lower Die		60
Figure 21 Test Print		61
	vii	

Figure 22 Circle Inaccuracies Defect Example	73
Figure 23 Layer Splitting on Upper Die	74
Figure 24 Layer Splitting on Lower Die	74
Figure 25 Test Print Stringing or Oozing	75
Figure 26 Upper Die Blobs and Zits	76
Figure 27 Dimensional Error on Lower Die	77
Figure 28 Dimensional Error on Upper Die	77
Figure 29 Standard Printing Quality Parameter Setup	79

APPENDIX

تر بي تركيب المعالم الم معالم المعالم ا

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF SYMBOLS AND ABBREVIATIONS

Ν	-	Newton
kg	-	Kilogram
mm	-	Millimeter
m^3	-	Cubic metre
m^2	-	Square metre
kN	-	kiloNewton



UNIVERSITI TEKNIKAL MALAYSIA MELAKA



CHAPTER 1

INTRODUCTION

1.1 Background

Metal stamping is a cold-forming process that makes use of dies and stamping presses to transform sheet metal into different shapes. Pieces of flat sheet metal, typically referred to as blanks, is fed into a sheet metal stamping press that uses a tool and die surface to form the metal into a new shape. Production facilities and metal fabricators offering stamping services will place the material to be stamped between die sections, where the use of pressure will shape and shear the material into the desired final shape for the product or component.

Metal stamping, also referred to as pressing, is a low-cost high-speed manufacturing process that can produce a high volume of identical metal components. Stamping operations are suitable for both short or long production runs, and be conducted with other metal forming operations, and may consist of one or more of a series of more specific processes or techniques such as punching, blanking, embossing, coining, bending and flanging.

Based on the title which are design and development of gold bracelet stamping die, we mainly focused on the tool that have been used for the production of gold bracelet. There are many types of stamping operation that have been used on the production of the gold bracelet based on the design and shape of the product. Generally, some of the familiar process that always been used on the gold bracelet production are punching, blanking, embossing and bending. One of the famous types of tool that have been used was progressive stamping die tool which were suitable for low-cost and high-speed production. 1.2 Problem Statement

Gold which known as a jewellery materials popular for it's precious metals are sold mainly by the weight; therefore if the precious metal weight of jewellery is high, the overall cost is also high. For this reason, many people are unable to afford precious metal jewellery because of very high market prices. However, the cost and for that matter the final unit price of jewellery, can be lowered by reducing the weight. This can be achieved by employing cost effective tooling technique in the production process such as the usage of dies and punches. This is significant because in the gold industry, the technique which is used to produce articles has a direct bearing on the cost of the finished product.

However, many jewellery workshops rely on traditional hand fabrication techniques including piercing and cuttlefish bone casting for making gold jewellery. Jewellery items produced by these outfits are generally heavy or flat and the methods of production are not mass production friendly. Reduction of the unit weight of precious metal jewellery through the use of dies and punches should result in the decrease of the unit price of jewellery. One way of reducing the unit weight is by making the jewellery pieces thin walled and hollow while also ensuring good strength and high quality design.

In spite of the numerous benefits that can be derived from the use of dies and punches in jewellery production, a survey carried out by the researcher has revealed that currently gold jewellery producers are not employing this forming method because they do not have any knowledge about them. In this regard, there is need for research to explore locally accessible materials including tools and equipment, to develop methods at the studio level and produce samples of dies and punches to serve as a blue print to be by the goldsmith. This is to enable them convert their designs into embossing dies and punches suitable for mass production of light weight.

1.3 Research Objective

The objectives of this study are as follow:

- 1. Study and analyse the properties of gold bracelet stamping die.
- 2. Design and develop drawing of gold bracelet stamping die.
- 3. Produce a prototype of gold bracelet stamping die by using 3D printer.

21.4 Scope of Research

The scope of this research are as follows:

- Develop the most suitable stamping die tool of gold bracelet for industrial use.
- Design a proper and detail drawing for stamping die tool of gold bracelet for industrial use.
- Study on consideration to figure the most suitable type of material used to produce a stamping die tool for gold bracelet.
- Figure the most suitable standard tool to produce the stamping die tool based on the drawing specification.
- Enhance the product quality of gold bracelet by reducing the number of scrap for lowcost and high-speed mass production.
- Invetigate on how to reduce the time consumption of gold bracelet production to increase the production.



LITERATURE REVIEW

2.1 Introduction

To understand and clarify clearly the problem on how to design and fabricate of gold bracelet stamping die, certain factors have been reviewed to accomplished the objective. These factors are:

i.Concept of design

ii. Concept of Embossing iii. Concept of Dies iv. Materials used for die/punch manufacturing v. Types of dies vi. Methods of die/punch production UNIVERSITI TEKNIKAL MALAYSIA MELAKA vi. Usefulness of Dies and Punches.

2.2 Concept of Design

Design plays an important role in an innovation in all types of fileds of artistic study whether in enginering or other fields of sector. In jewellery, or we can say in bracelet specifically, design is not much different from other plastics arts such as sculpture and ceramics because in all fields of arts, planning preceds execution of the medium.

Amenuke et al (1991) consider a design as a process or the result of a process. This means that design can be understood in two ways: (1) as a process and (2) as a final product. When a designer plans his or her work, he or she puts together certain qualities such as point, line, shape, and colour, and it is the relationship of these qualities that the viewer sees. These qualities, sometimes referred to as the elements of design according to Amenuke et al, are the fundamental part or qualities of any design.

Untracht (1985) also shares Amenuke et al.'s view of design, noting that design in relation to jewellery can be described as an intellectual or intuitive concept (both can operate simultaneously) in which purposeful planning or mental imagery determines the way in which materials are used and arranged in a relationship of shapes, forms and surface treatments to create an integrated object.

According to Untracht, the form of the material itself may suggest a process, since any form of metal unversity to the process of the material itself may suggest a process, since any form of metal embodies a natural range of possible treatments that inspire design. He acknowledges, however, that superimposed on the basic concept of a material's original form and character in relation to process are those considerations of composition and organisation known as formal design elements, perhaps better known as design components, since it is through their use that an object is composed. Untracht adds that these elements and the above considerations, no matter how limitedly used or isolated for discussion purposes, are dynamically linked in the creation of a design in a highly flexible way, in fact one aspect can hardly be mentioned without including another. Untreaht again explains that designing and creating a piece of gold bracelet is a reciprocal process of synthesizing the intangible into reality. This is essentially done through a sequence of judgments, decision making, and problem solving, all of which occur when materials are made into forms.

Unless the design concept is of such a nature that it can be captured in a drawing with mathematical precision and implemented without changes in the graphic representation. When designing bracelet, in addition to the design components and the shape of the material, which should be highly considered, another critical factor that must be given ultimate attention is how the design will harmonise with the human body. This is based on the form that a bracelet design takes and functional considerations of a design.

It may be inferred from the above design that in the creation of bracelet, until the final measurements for the parts of a design have been fixed and strictly adhered to, new ideas may be added in the course of working the materials into bracelet forms.

Untracht(1985) believes that the size of a piece of bracelet a person chooses to wear is directly related to the motives the person may have for wearing the bracelet. He agrees that in cases where a large mass is desired, the weight may be reduced and the mass increased by making hollow forms. He concedes that while weight tolerance is an individual issue having to do with personality differences, it is also a matter of economics when using precious metals. He reiterates the view that the greater the weight, the higher the cost and the final price. As a solution to this problem, he adds that the control of weight lies primarily in the particular choice of materials and thickness of the bracelet pieces. He goes on to say that of importance is the system of construction: solid, cast forms weigh considerably more than barcelet made from hollow, low forms.

The author agrees with the views of the authors that design components and material forms are undeniable factors that should be given due attention in jewellery design, but equally important are the cost of materials and the sale of the final product. This is one of the reasons why the design of dies and stamps to be used in the design of lightweight bracelet is the focus of this study.

2.3 Concept of Embossing

Embossing is a method of creating raised shapes on a metal surface. The raised form produced can be used either as an intaglio or a cameo, depending on the purpose the metal artist wishes to achieve with the form. According to Muldoon (2008), metal embossing adds lustre, radiance, intriguing dimension and texture to metal.

Rajput (2007) explains that stamping is used as an operation in making recessed figures on metal sheets with corresponding relief on the other side. The metal flow is in the direction of the applied force. The forces required are much less than in embossing.

Burto (1963) also states that the main raw material required for embossing is soft sheet - brass, copper, or aluminium between 0.005 and 0.010 inch thick. He relates that normal copper or brass sheet must be annealed before it can be stamped, and this is done by heating the metal until it glows red; it is then cooled in air or "immersed" in water.

The actual minting process, he continues, is conceivably simple. It begins by stretching the annealed piece of sheet metal over the die and striking it with the padded hammer. This forces the metal down into the openings of the die and reproduces the pattern in the die. According to Muldoon (2008), metal stamping is an art form that has been around for centuries. A variety of easy to use tools are used to press flat metal sheets from behind to create designs.

Untracht (1985) describes embossing as an act of stamping to push out a shape in cameo or intaglio. This process, according to him, is done with the help of an embossing die or punch. If the resulting shape is positive or in high relief, it is called a cameo (from the Italian cammeo "a gem carved in relief"). If the shape is negative or concave, it is called intaglio (from Italian intaglire, "to engrave, cut, or carve a pattern into a substance below its original surface"). For sheet metal, these shapes can be used with the positive or negative side up. The moulded shape may be relatively small - as in a small, hand-made embossing die - and the resulting boss is usually one of a number of such elements placed in an array on a still intact sheet.

The researcher agrees with the author in the above assertion that the embossed form can be used as a unit and this means that it can be added to other elements to form a whole ornament, or an embossed form could stand alone as a complete ornament.

From the above distinction between stamping and embossing, it is clear that the end product of the latter gives a shape to a blank, while the former gives a form. Embossing on metal is accomplished by the application of force, and the resulting shapes may be used with the positive or negative side up.

2.3 Concept of Dies

McCreight (1991) defines dies as rigid and reusable shapes that give form to the workpiece. He adds that they can be made from a range of materials and can have a life span from a few pieces to thousands. He goes on to say that dies can be categorized by the amount of detail they impart and their strength. The latter, he says, is important not only because it determines the life of the die, but also the difficulty of making the die in the first place. It is easier to cut a die from wood than from steel, but of course the steel die lasts longer.

A die is any structure that can give a shape to a material such as metal or wood. According to Mittler and Ragans (1992), a form is an area that is clearly delineated by visual elements of art. A shape may have an outline or a boundary around it. Some shapes stand out through color, while others are set apart only by the space that surrounds them. There are two groups of shapes: geometric shapes and organic shapes. Geometric shapes are those with precise outlines that look as if they were created with a drawing instrument. Organic shapes are irregular or uneven and their outlines curve into free forms and are often found in nature. The five basic geometric shapes are square, circle, triangle, rectangle, and oval.

Mittler and Ragans (1992) distinguish between shapes and forms, explaining that shapes are like forms, but while shapes are two-dimensional and therefore have length and width, forms are three-dimensional and therefore have length, width, and depth. They add that shapes are also divided into either geometric shapes or organic shapes. Although McCreight states that dies could be made to produce shapes, dies could also be made to produce shapes that would have length, width and depth and could be used as bracelet.

Burto (1963) explains that at least half of the work in stamping sheet metal is in making the dies. Since the die is simply a metal matrix that is harder than the sheet to be embossed, there is an almost unlimited variety of finished dies available to the do-it-yourselfer - in the form of perforated or spent metal, hardware cloth, even ordinary wire cloth.

Rajput (2007) states that the die set consists of a die and a punch with the desired contours, so that when the punch and die meet, the distance between them is equal to the thickness of the sheet. Codina (2007), explaining how steel dies and stamps are developed and used on an industrial level, states that making a steel die and stamp is the most common method used in industry because it offers greater durability and precision. Likewise, it is the most costly method, requiring a fairly large stamping press and thus requiring expensive production to pay for itself. He goes on to say that prior evaluation of production goals and costs is recommended before using this method. He adds that a properly hardened steel die, however, has unmatched durability and the quality of the stampings produced is comparable to the original designs. He goes on to say that a die can be made from a block of steel that matches the type of relief the punch is intended to produce. He goes on to say that this steel, once annealed and made ductile, can be shaped with cutters, files and tombstones. It must be as smooth and polished as possible - as if it were a piece of jewellery - so that the piece of metal stamped into the mould can be easily released. Next, the soft steel is hardened; this is a process that must be done in specialised workshops, as it is more costly than simply hardening a chisel.

Codina (2007) again explains tempering as a heat treatment that gives the steel sufficient hardness and flexibility to hammer the punch into another piece of steel that actually serves as a die. To do this, Codina continues, the punch is heated to about 9000 °C and quenched in water or oil; now that it is too hard and prone to breakage, it must be tempered. This involves heating it to a lower temperature for a certain time to achieve the right balance between hardness and flexibility, thus increasing toughness.

Once the punch is tempered, it is stamped into another piece of steel that will serve as a die: it must be polished as needed and properly tempered. The punched die is used to make the parts.

Codina (2007) also explains that the steel punch is only used to make the original model; it must be kept carefully because if the die is damaged during punching, the punch must be struck into the die again. This implies that a well-developed punch could be used to create dies for further metal part fabrication.

The above comments by the authors show that dies and punches are given a longer life by the materials from which they are made. Those made for industrial purposes are usually made of steel.

2.4 Materials Used for Dies and Punches

Different materials can be used to make dies or stamps to achieve a specific purpose. Davis (1995) discusses that the materials used to make dies and punches range from plastics for the production of simple to moderately heavy parts in small quantities to extremely wear-resistant (nitride) tool steels for the production of highly formed parts. Parts of even greater severity, or those produced in quantities exceeding one million, may require dies or inserts made of carbide.

Miller and Miller (2004) state that a good grade of tool steel is used for making punches and dies. The steel should be free from harmful impurities. Sometimes the body of the die can be made of cast iron with steel bushings inserted to reduce the material cost. The advantage of this type of construction, he said, is that an insert can be replaced when worn. Soft steel that has been case-hardened does not change shape as easily as tool steel, and any minor changes in shape can be easily corrected because the interior is soft. Residual stresses or strains are built up in steel during the manufacturing process. In mould making, these stresses must be relieved before the mould is brought to its final size, otherwise they will cause deformation. The presence of stresses in the steel cannot be determined in advance, but the mould maker can relieve the stresses in the steel by annealing after the mould has been worked out.

According to Sharma (1999), hot forging dies operate under very severe service conditions as the forging process is characterized by high interface pressure combined with high temperatures; therefore, the die and die materials are selected and manufactured with utmost care. The materials used for the manufacture of dies must be heat resistant, have adequate strength with a low wear rate and be well suited for machining with cutting tools. A compromise must be made between hardness and ductility as the dies are subjected to thermal shocks. Die blocks used for making forging dies are made of high quality special tool steels.

Youssef et al (2011) state that another attractive feature of die construction is the versatility of the processes used to produce dies using castable die materials such as glass fiber reinforced plastic (GRP), urethane, epoxy resin, ductile cast iron, kirksite (a zinc-based casting alloy) or concrete. A simple wooden or Styrofoam model can be used to make such dies. For higher pressures and longer service life, hardened steel dies are used.

Altan (2011) explains that steels are mainly used for hot dies because they retain their hardness at elevated temperatures while having sufficient strength and toughness to withstand the stresses encountered during forging. There have also been some successful applications of other materials such as ceramics, carbides and superalloys, although their use is limited due to design and manufacturing costs. The choice of die material and subsequent treatment will influence the type of failure and the failure rate of the tool.

From the above, there are a number of materials that can be used to make dies and punches. These materials may be divided into metallic and non-metallic. The non- metallic include plywood or hardwood, ceramics, plastics, cemented carbide, nitrides, mesonite, carbides, fibreglass reinforced plastics, urethane, epoxy resin and styrofoam, and hardware cloth. The metallic materials are steel, ductile iron, superalloy and kirksite (zinc-based cast alloy). Other materials such as plywood or hardwood, ceramics and cement can be sourced locally, but it is evident that most of these materials are only available through importation, making them expensive to procure.

Secondly, the above materials are mostly used in the manufacture of industrial dies and stamps. On initial investigation by the researcher, it was found that all the doming blocks used by goldsmiths and silversmiths were made of brass. Brass was preferred to the other materials mentioned for the following reasons: its availability in Ghana; its physical and mechanical properties that make it suitable for making dies and stamps at studio level. The selection of brass in this study for the manufacture of dies 22 and punches also stems from the fact that the available facilities support the casting of brass more than other materials such as steel.

According to Margot et al (1998), brass is an alloy of the mixture of copper and zinc. Cobb (2012) states that brass is known for its beauty and corrosion resistance. Again, Margot et al. show that the colour of brass varies depending on the amount of zinc in the mixture and whether or not other metals are added. Brass with relatively large amounts of zinc has a yellow colour; the addition of aluminium gives it a high gold colour; a small percentage of manganese gives a bronze, and the addition of nickel gives a metal called nickel silver. This means that although copper and zinc are the main metals alloyed to give brass, sometimes other small amounts of other metals are added to give a particular result. However, it is the amount of zinc in a brass that determines its type.

Cobb (2012) claims that there are three types of brass, depending on their crystalline structure. The alpha (α)-brass, with up to 30% Zn, is the most ductile. The alpha - beta brass have 30-43.5% Zn; and beta (β) brass include those of 43.5 - 50% Zn. The hardness and strength increase with increasing zinc content, while the cost of the alloy decreases.

Historically, Cobb (2012) states that artefacts made of copper with 23% Zn have been found from at least 1000 BC, but brass was not in common use until about a thousand years later, in Roman times. It is one of the strangest storeys in the history of metallurgy because zinc, one of the constituents of brass, was unknown and in fact was not identified until 1526. Roman craftsmen engaged in the process they describe as dyeing copper. Pieces of copper, along with powdered calamine and charcoal, were packed into a clay crucible with a tight-fitting lid and fired in a kiln for 24 hours at a temperature much too low to melt the copper. The Romans called it "aurichalcum" which translates as "golden copper", we call it brass. The coloured copper was smelted and made into ornaments, clothing armour, utensils, and sestertius (Roman coins). Unknown to the Romans, calamine was actually zinc carbonate, which 23

evaporates the zinc absorbed by the copper in the furnace to form a copper-zinc alloy. The galmei brass process remained the preferred method of producing brass for many years after the discovery and production of metallic zinc in the 18th century.

Brass became popular for church ornaments and for its figures in floors engraved to commemorate the deceased. One of the most important commercial uses of brass was in the manufacture of brass pins used for carding in wool processing. Margot et al (1998), listing some properties of brass, point out that it is a hard, durable and useful metal that is excellent for casting, hot working and extrusion. These properties of brass mentioned by the above authors indicate that it could be procured and used for the manufacture of dies and punches. The brass used in this study was obtained from scrap of automobile parts which were made robust to withstand pressure.

2.5 Types of Dies

Dies are grouped based on different functionalities. Schwan et al. (2002) state that stamping dies are broadly divided into single dies and multiple dies. They explain that single-use dies are further divided into the following categories:

1. Cutting Dies: These dies are designed to cut sheets into blanks. The operation thus performed is UNIVERSITI TEKNIKAL MALAYSIA MELAKA called the stamping operation.

Forming Dies: These dies are used to change the shape of the workpiece material by deformation.
 No cutting takes place in these dies. These dies are used to change the shape and size configuration of metal blanks. Boljanovic (2005) states that depending on the production, quality of pieces: high, medium or low punching dies can be classified into A, B and C classes.

Class A dies are used for high production only. The best materials are used in this class of dies. All easily worn parts or delicate sections are carefully constructed to permit easy replacement. In this class, a combination of long die life, consistent accuracy throughout the life of the die, and ease of maintenance regardless of die cost is paramount. Class B dies are suitable for medium production volumes and are designed to produce only a certain quantity. Die cost relative to total production becomes an important consideration. Cheaper materials can be used, provided they are capable of producing the full quantity. The problem of ease of maintenance is less considered. Class C tools are the cheapest tools that can be built. They are suitable for the production of parts in small quantities.

Untracht (1985) groups the stamps into (1) embossing stamps, (2) a two-part disc-scissors stamp, (3) a one-part open intaglio stamp, and (4)a two-part closed stamp. Its grouping is as follows:

1. The die is a device used for cutting or shearing a shape or blank of a certain contour and / or striking a relief pattern into a sheet. This is done by striking the die with a hammer, as in hand stamping, or by mechanical pressure.

2. A two-piece disc shear die is a more complicated die consisting of a die used in conjunction with a shear punch to shear a blank from sheet metal.

3. A one-piece open intaglio die is used for all open dies, in which the metal is not restricted in its external shape, but is allowed to flow in the direction of least resistance and enter freely into the die cavity. To make an embossment of more than small depth from such a die, place the die on an anvil and lay the annealed sheet over the die, cover it with a washer, and strike it with a convex hammer.

4. A two-part closed die has a lower part called the anvil or lower stacking die, which contains the design in intaglio. The upper or second part, which is held in the hand, is called the trussel, and contains

either the observed design in intaglio, or, when a thin sheet is punched, the same design in cameo, matching that of the other half.

Boljanovic (2009) groups stumps according to their use as follows:

1. stamping dies: a stamping die produces a blank by cutting the entire circumference in a single operation.

2. cut-off tool: the basic operation of a cut-off tool is to separate strips into short lengths to produce blanks.

3. punching tool : A punching tool punches holes in a workpiece.

4. Compound Die: In a compound die, the holes are punched at the same station where the part is punched out, rather than at a previous station, as is the case with a punch and die.

5. Bending punch: A bending punch deforms a portion of a flat blank to a specific angular position. The bending line is straight along its entire length.

McCreight (1991) says that silhouette stamps are simply an outline shape cut from a tough material such as masonite, plywood, or steel. He adds, however, that there are several families of dies, but identifies two basic types: conformal dies and nonconformal dies. Conforming dies consist of two corresponding parts. They are usually held in some sort of superstructure to ensure that the parts line up when they are brought together. This die controls every aspect of the mould and ensures accurately duplicated units time after time. Nonconforming dies, also known as silhouette dies, are made of rigid material that is pierced with an outline of a desired shape. The process is extremely versatile, as the outline and depth of the image can be changed each time the die is used.

2.6 Methods of Die Production

The methods of making the stumps vary from stage to stage. Sharma (1999) states that the most common methods used to make dies are as follows: Turning, machining or planing, milling and grinding. Turning is used for rough machining with rotary machines, while for rectangular and square dies - blocks the operations are done on a planer. Grinding is mainly used for finishing the surfaces. The impressions are cut into the die block by highly skilled men using the milling machine specially designed for die sinking. Different types of cutters are used depending on the shape of each section of the impression. But much of the accuracy of the die depends on the manual work that is done after the die is countersunk. The impressions are machined either by manual countersinking after layout and/or by copy or pattern.

2.7 Jewelry

As long as there are humans, the use of jewelry will continue unabated. Untracht (1985) explains the motivations behind why people wear jewelry, noting that they are elemental and eternal human concerns, and since jewelry is a wearable, intimate art that can be worn and enjoyed constantly, it is reasonable to assume that the use of bracelet in one form or another will continue as long as the human race survives.

Untracht goes on to say that jewelry is for men and women (and occasionally animals), and that it must relate to the human anatomy; its scale or proportions must deal with dimensions. He adds that the form a piece of jewelry takes is determined primarily by the place on the body or clothing where it is to be worn, modified by considerations related to how it is to be placed there and whether it can be worn with relative comfort (although the latter is sometimes neglected because of other considerations). Such considerations may dictate whether the design is conceived as fundamentally frontal, cylindrical, or three-dimensional. Untracht goes on to explain that the three forms a piece of jewelry can take are:

i. Frontally conceived forms: In frontally conceived forms, the jewel is best shown from its front, implying that it has a back. The latter is usually flat, or its points of contact with the body lie in a flat plane in a direction parallel to the body. The front or visible part may take any dimensions from flat to projections at right angles to the plane of the body. This category includes brooches, clips, pendants, medals, etc.

ii. Cylindrical Forms : The overall shape of these concepts is cylindrical, conical or curved in relation to similarly shaped parts of the anatomy to which they are attached. When actually used on the body, the work may not be seen as a whole, but initially the design is conceived as an overall unit encompassing the basic shape. Such forms may include frontal or even back elements. Ornaments of this class may be worn on the head, neck, arm, wrist, fingers, waist, leg, ankle, and toe. Head ornaments include crowns, tiaras, wreaths, fillets, and forehead ornaments; neck ornaments include necklaces, chokers, chains, pendants on chains, etc.; arm ornaments include bracelets, bangles, watch bracelets, and upper arm bracelets; rings are worn on the fingers; waist ornaments include belts and girdles; anklets are worn on the ankles; and toe rings are worn on the toes.

iii. Dimensional ornaments: These are meant to be round and worn on parts of the body or in a way that allows the shape to be seen from all sides, or at least several sides. Such jewelry may be hanging earrings, hair ornaments, brooches, pendants suspended from chains, or other hanging, moving, or spring-mounted and therefore fully circulating objects.

Turning to the functional considerations in the jewelry concept, Untracht states that the size, weight, and shape of the piece of jewelry, as well as its position on the body or costume, determine the system by which it is held to the clothing and secured from loss. These general considerations must also be taken into account in the design of jewelry.

Findings of jewelry, that is, the metal parts by which pieces of jewelry are fastened together and to the body or to the clothing, are naturally included in this subject.

The weight that different people can tolerate in a single piece of jewelry varies greatly. Some individuals will be comfortable wearing very heavy jewelry and not be bothered by possible discomfort, while others will insist on extreme lightness.

In this study, the elements created by using the punches and dies will include jewelry elements that can be assembled into jewelry pieces such as necklace or choker, bracelet, and earring.

2.8 Stamping

According to Codina (2007), ancient craftsmen realized that cast tools and weapons became more durable when forged or beaten; these cold forging and minting processes are very old. The minting of coins as objects of value has its origins in coinage, which was also often used as an ornamental technique as early as the second century BC. He describes minting as the impressing and deforming of metal by applying pressure with a harder and more resistant tool.

Mohammed (2011) explains that sheet metal stamping can be defined as the process of forming the shape of the sheet metal blank in a state of plastic deformation into a usable shape using a die and a mechanical press; stamping is considered a net forming process. It adds, however, that the stamping effort is not limited to the manufacturing technology (i.e., the stamping process), but also includes the development of the necessary tooling (i.e., the stamping technology).

Untracht (1985) explains stamping as a process in which a tool or die is forcibly driven into a sheet for one of the following three purposes: Stamping, Punching, or Embossing. He explains stamping as the act of making a mark by pressure. He goes on to say that in embossing, a pattern is made on a flat sheet of metal by means of an embossing die which bears at its working end a linear figure in a comparatively sharp projection which leaves an impression on the surface of the metal when struck with a hammer. Improvised punches may be used for the same effect.

The pattern is transferred directly to the metal surface by striking the stamp with a hand-held hammer while the metal rests on a support. The impression stamp is called an impact stamp because the pattern is usually created by a single hammer blow on the stamp, which is the unifying concept behind this diversified group. Pattern stamps can be divided into two groups: those for decorative purposes, such as an indentation stamp that stamps a decorative figure, and those that stamp a normally non-decorative figure on metal, such as a trademark, quality mark, letter, number, or stamp with another figure used for identification or other purposes.

Punching is the term used by Untracht (1985) to describe the punching out of a flat shape with a special contour or a three-dimensional shape, called a blank, by the use of a sharp-edged punch, alone or in conjunction with a punching die. The larger or more dimensional the blank, the more likely it is that greater mechanical force must be applied to produce the blank.

Loney (2009) explains that stamping is the process of placing a design into metal using chasing tools or embossing dies. She explains that the design end of the embossing tool is placed on the metal while a hammer strikes the other end of the tool.

Szumera (2003) explains that metal stamping process is divided into five different and distinct types and the types used for production at industrial level are as follows: Forging or coining, bending or multiple bending, drawing, deep drawing and stamping or fine forming.

Die forging or stamping is the process of reducing the original thickness by applying a certain force to it. The process is used to make coins, kitchen utensils such as spoons and knives. Szumera explains that bending is a type of metal forming in which metal is formed into angular or radial shapes. Brackets, switch boxes, parts of stapling machines, and appliance parts are examples of items made using this method.

Drawing is a process in which material is stretched into various shapes. The shapes are usually round, oval, or rectangular, with the depth of the part not exceeding its diameter. The metal starts as a flat blank and is placed over a die opening. A force must be applied to the blank to restrict the flow of the metal so that it does not wrinkle. This technique is used to make ashtrays, bottle caps and lids, ceiling fan housings, and door panel parts. SITI TEKNIKAL MALAYSIA MELAKA

Deep drawing is essentially the same as drawing, except that the metal is drawn to a greater depth. A part can be said to be deep drawn if the depth exceeds the diameter of the part. This type of metal forming is usually done in steps or tees. Deep drawing applications may also require special types of machinery such as hydraulic or double-acting presses. Annealing may also be required during the process to relax the metal before subsequent forming. Typical deep drawn parts include fire extinguishers, canisters, beverage cans, containers and oil filters.

Punching is usually considered the simplest type of punching because it involves only a cutting operation. Punching operations can be performed with conventional tools. They can be simple, compound or progressive. Fine blanking is a cutting process that produces a straight edge with no signs of metal breakage. This usually requires a special fine blanking press. A straight edge can also be produced in a conventional tool and press, using a shearing operation. Examples of blanks include wedges, washers, and spacers. Fine blanking blanks are used to make small gears that require straight edges for engagement.

Codina (2007) also explains that stamping is often used in the manufacturing process, as most everyday objects are made in some production process based on stamping and embossing. He acknowledges that contemporary stamping with complex dies has evolved tremendously and that the technology is currently associated with industrial engineering rather than craft. He adds that by using older production methods and taking advantage of resources and products that are available and affordable in today's market, it is possible to produce very attractive, interesting shapes and decorative features at a reasonable price.

This is very important as it facilitates the mass production of bracelet and ensures that the cost of the items is affordable to the customers.

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Codina in turn reveals that stamping is commonly used especially in the mass production of jewelry such as bracelet as this process produces a very fine thickness of metal which is also very strong and durable. Considering the large number of pieces that can be produced, this leads to huge savings in production costs. He further added that making a steel punch and die is the most commonly used method in the industry as it offers greater durability and precision. However, he was quick to add that it is the most expensive process as it requires a fairly large stamping press and therefore requires extensive production to pay for itself.

Bawa (2004) gives the following as advantages of metal stamping:

- (i) Weights of fabricated parts are less;
- (ii) Production rate is high;

(iii) Parts that are produced are very accurate in size;

(iv) Strength of components is well controlled; and

(v) Cost of labor is low.

Considering the production benefits of metal stamping compared to the cost of tooling, adapting the method in studio practice and using a simple technology that costs less but achieves the same results will go a long way in reducing the cost of making jewelry. Bawa confirms that metal stamping is used extensively in the manufacture of automotive, aerospace, electrical and other industrial components due to its advantages. He further adds that a variety of products include automobile bodies, shells, structural grinders, car and truck frames, furniture legs, beer cans and wheel rims.

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2 CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter deals with the methodology of the research. It includes the research design, analysis on the study, data collection instruments used for the study, product design development and 3D modelling drawing.



3.2 Research Design

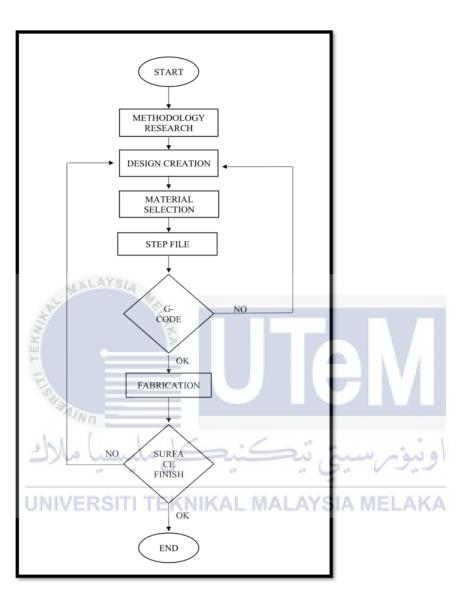


Figure 1 Project Process Flowchart

For the methodology research, the practical of any piece of research is referred to as research technique. It's about how a researcher plans a study in a methodical way to produce accurate and

reliable results that address the study's goals and objectives. Research on past experiments and projects have been made to ensure a proper project run smoothly.

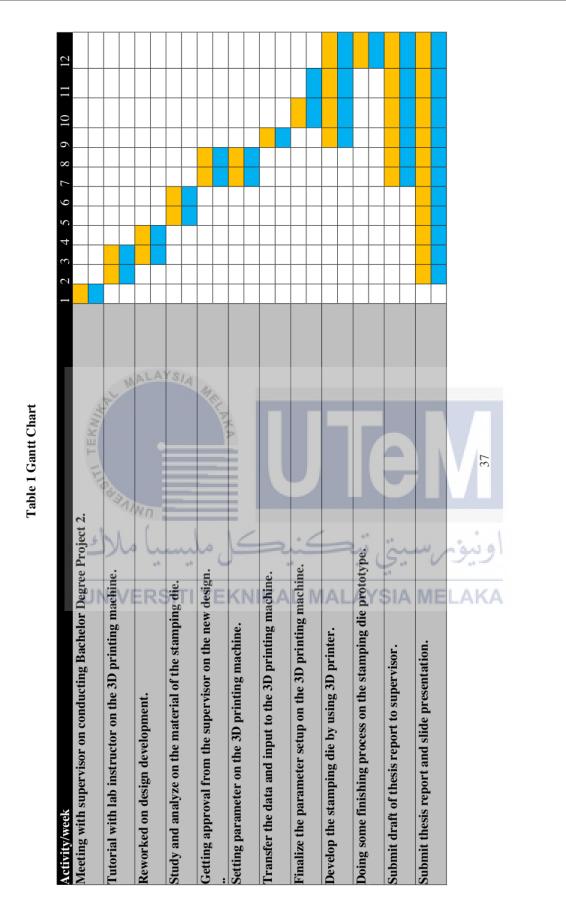
For design creation, SolidWorks software was selected as the main platform to sketch the gold bracelet stamping die design. The software was chosen because of the easiest user interface and familiarity that provided by SolidWorks to design gold bracelet stamping die.

Next, the fabrication is where the gold bar stamping die design is run by the machine. To make this process, a proper 3D printing machine is needed and proper laboratory apparatus is required. Running the design into machine also take some time to ensure there is no error occured.

Lastly, the goal of finishing procedures is to change the surface of a produced component to obtain a certain feature. Improved aesthetics, adhesion, solderability, chemical, corrosion, tarnish, or wear resistance, hardness, electrical conductivity, defect elimination, and surface friction management are all desirable features.

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3.2.1 Gantt Chart

3.3 Analysis on the Study

3.3.1 Gold Mechanical Properties

CES Edupack software is chosen to determine the mechanical properties of gold. This software provides more than enough about the gold material itself from the description of the material, general properties, composition overview, composition detail, mechanical properties, thermal properties electrical properties and many more. Figure 2 below shows the mechanical properties of gold material.

🔤 Gold, commercial purity, P00020, cold worked, hard, min 99.5%			
♦ All attributes	v 🚧 She	ow/Hide	
Density Price	1.93e4 - 1.94e4 * 1.64e5 - 1.81e5	kg/m*3 MYR/kg	
Composition overview Composition (summary) Au/<0.5 other elements		-	
Base 💆	Au (Gold)		
Composition detail (metals, ceramics and glas Au (gold)	ses) 100	%	
Mechanical properties Young's modulus Flexural modulus Shear modulus Bulk modulus	76 - 81 * 76 - 81 26 - 30 148 - 180	GPa GPa GPa GPa	
Poisson's ratio Shape factor Yield strength (elastic limit) Tensile strength Compressive strength Flexural strength (modulus of tupture) == Elonaation	0.415 - 0.425 26 165 - 205 180 - 205 165 - 205 165 - 205 2 - 6	MPa MPa MPa MPa % strain	
Hardness - Vickers Fatigue strength at 10*7 cycles - ITTEKN Fatigue strength model (stress range) - TEKN Parameter, Stress Ratio = 0, Number of Cycles = 1e7	50 - 70 170 A 110 49 A 74.5		
Fracture toughness	* 60.1 - 66.5 * 0.0016 - 0.0021	MPa.m ^{0.5}	

Figure 2 Gold Mechanical Properties

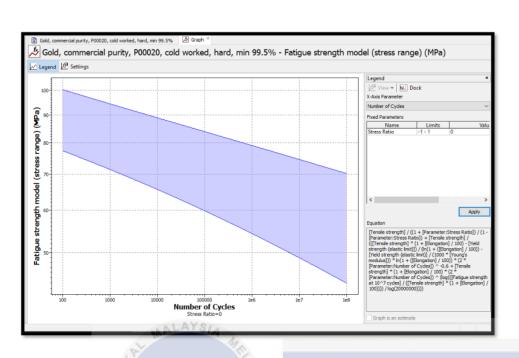
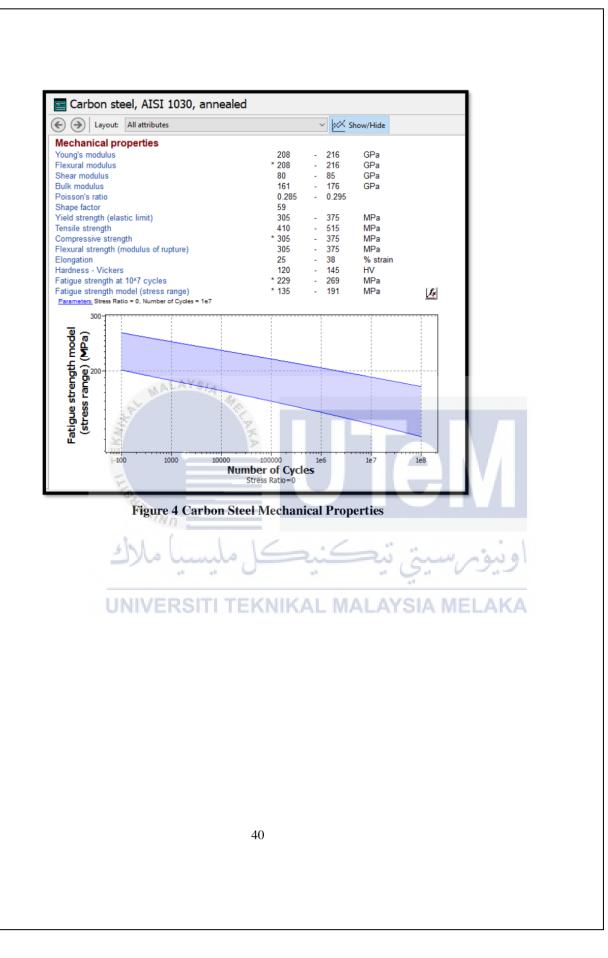


Figure 3 Fatigue Strength Model (stress range) Graph

3.3.2 Carbon Steel Mechanical Properties

Carbon steel is the most suitable material to make a die. Due to their high wear-resistance and hardness, high-carbon steels are used in cutting tools, springs high strength wire and dies. Carbon concentration ranges from 0.60 to 1.25 wt%, with manganese level ranging from 0.30 to 0.90 wt% in high-carbon steel. Carbon steels have the highest hardness and toughness, but the lowest ductility. Because high-carbon steels are virtually always hardened and tempered, they are extremely wear resistant.

High-carbon steels, such as tool steels and die steels, contain additional alloying elements such as chromium, vanadium, molybdenum, and tungsten. The production of carbide compounds such as tungsten carbide arises from the inclusion of these metals, resulting in an extremely hard wear-resistant steel (WC).



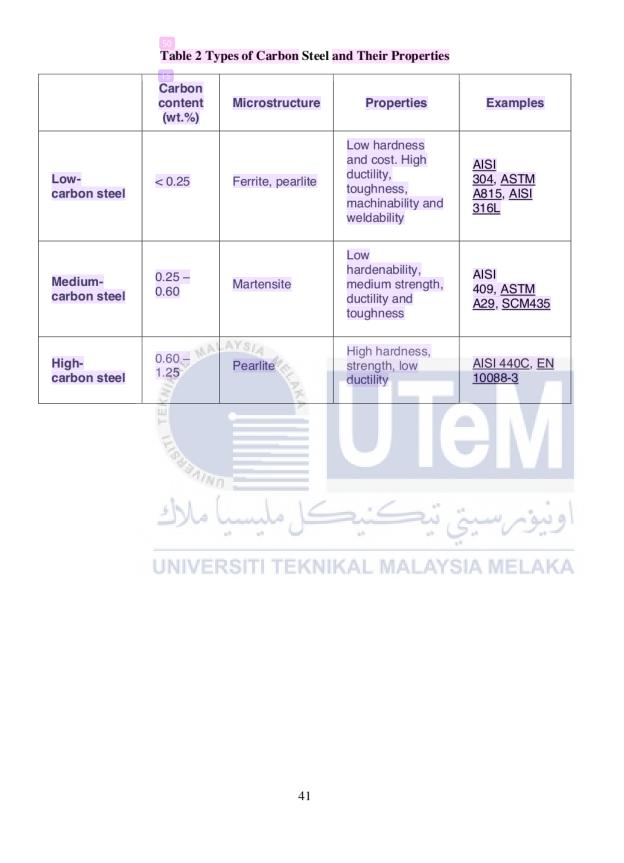


Table 3 Comparison of Properties and Applications of Different Grades

Туре	AISI/ASTM name	Carbon content (wt.%)	Tensile strength (MPa)	Yield strength (MPa)	Ductility (% elongation in 50 mm)	Applications
Low	<u>1010</u>	0.10	325	180	28	Automobile panels, nails, wire
Low	<u>1020</u>	0.20	380	205	25	Pipes, structural steel, sheet steel
Low	<u>A36</u>	0.29	400	220	23	Structural
Low	<u>A516</u> <u>Grade 70</u>	0.31	485	260	21	Low- temperature pressure vessels
Medium	<u>1030</u>	0.27 – 0.34	460	325	12	Machinery parts, gears, shifts, axles, bolts
Medium	<u>الأك</u> 1040 UNIV	0.37-44 0.44 ERSITI	620 TEKNIK	415 AL MAL	سيني AYSIA ME	Crankshafts, couplings, cold headed parts.
High	1080	0.75 – 0.88	924	440	12	Music wire
High	<u>1095</u>	0.90 – 1.04	665	380	10	Springs, cutting tools
		-				

42

3.3.3 Punching Force Calculation Formula

If you punch round holes or square holes, or some other forms of holes through a given thickness of metal, you just want to know the force required to punch a hole in steel.

You can calculate the punching tonnage been required with the help of the following punching force calculation formula (blanking force formula):

Punching Force (KN) = Perimeter (mm) * Plate Thickness (mm) * Shear Strength (kn / mm²)

- Perimeter: add up the continuous line forming the boundary of a closed geometric figure.
- Thickness: the thickness which will be piecing through by the punching mold.
- Shear Strength: The physical properties of the plate, determined by the material of the sheet and can be found in the material manual.
- 3.4 Data Collections Instruments Used for the Study

Based on the finding and research from the literature review, these are the most important considerations for design a gold bracelet stamping die. Important points should be considered while designing a die set are listed below:

(a) Cost of manufacturing depends on the life of die set, so selection of material should be done carefully keeping strength and wear resistant properties in mind.

(b) Die is normally hardened by heat treatment so design should accommodate all precautions and allowances to overcome the ill effects of heat treatment.

(c) Accuracy of production done by a die set directly depends on the accuracy of die set components.

Design should be focused on maintaining accurate dimensions and tight tolerances.

(d) Long narrow sections should be replaced by block shaped sections to avoid warpage.

(e) Standardized components should be used as much as possible.

(f) Reinforcing grips should be used as per the requirements of the sections.

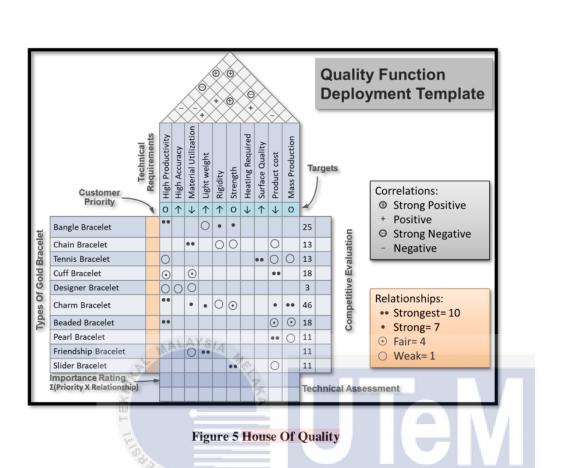
(g) Easy maintenance should be considered. Replacement of parts should be easy.

3.5 Product Design Development

To determine the design of the gold bracelet stamping die, it is compulsory to consider the design that meet the requirement based on the mechanical properties and technical requirements on producing the design of gold bracelet stamping die. Therefore, by using the House of Quality tool, we can finalize the design based on the requirements and technical aspects on designing the gold bracelet stamping die.

3.5.1 House Of Quality

The term "House of Quality" refers to a well-known product development process that is motivated by consumer needs for new products or processes and anchored by the skills and resources of the company attempting to fulfil those needs. It's a method of listening to consumers, converting their wishes into a written plan, prioritising execution stages based on the customer's priorities, and putting a feasible plan on paper.



Based on the House of Quality tool that has been used to determine the design of the gold bracelet, charm bracelet has the highest marks among the 10 types of gold bracelet. This tool is important to measure the technical requirements on gold bracelet stamping die such as the high productivity, high dimensional accuracy, material utilization rate, light weight, good rigidity, high strength, heating requirement, product cost and mass production ability on the production of the gold bracelet stamping die.



Figure 6 Charm Bracelet

In term of the design of gold bracelet stamping die, charm bracelet has the most higher point compared to other types of bracelet. Based on result, the design concept of charm bracelets captured the imagination of jewelry lovers, becoming an ideal way to keep mementos and symbolic items at hand. Nowdays, there are so many types of charms available representing varius topics, hobbies and themes. Charm bracelets are versatile, allowing you to take on and put on charms as you wish, depending on your mood and preferences. They make excellent gifts and are a nice way to show your personality.

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3.6 3D Modelling Drawing

From the product design development and analysis from the House of Quality, design for the gold bracelet stamping die prototype has been produced. Below shows the design of the gold bracelet stamping die drawing produced by the drawing software known as Solidwork.

3.6.1 Product of Gold Bracelet Stamping Die



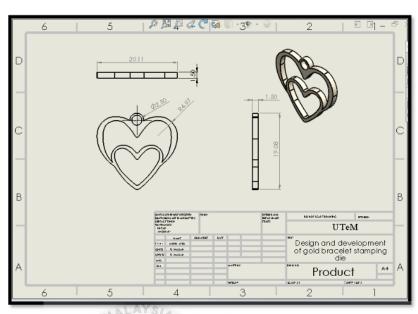
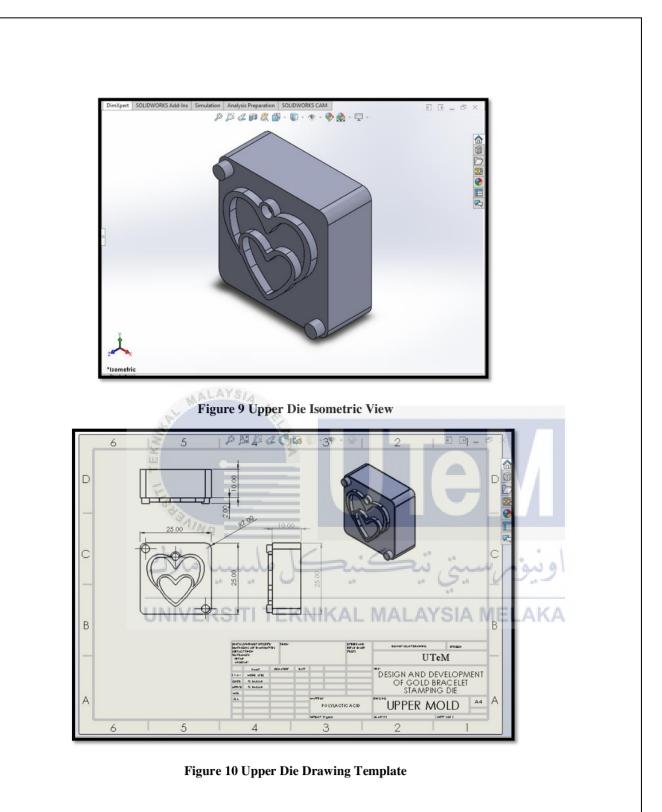


Figure 8 Product Drawing Template

3.6.2 Gold Bracelet Stamping Die

By produce the end product of the gold bracelet, we can develop the mould of the stamping die consists upper mould and lower mould by using the mold tool. The mold tool consists of draft analysis, identifying the split line, identifying the parting lines, shut-off surfaces, parting surface. After take consideration on the elements to produce the mold, finally the upper and lower die produced. Figure below shows the upper die and lower die in 3D drawing.



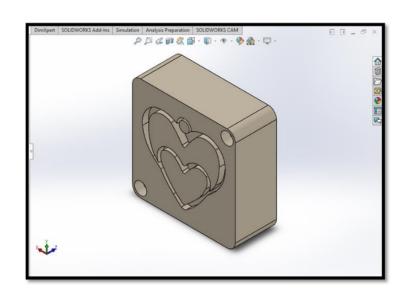


Figure 11 Lower Die Isometric View

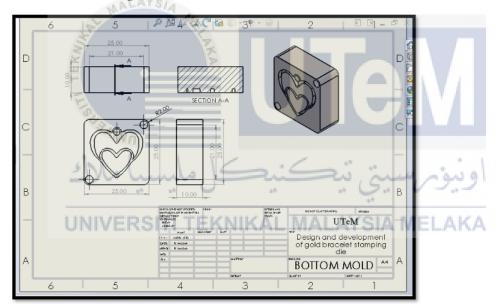


Figure 12 Lower Die Drawing Template

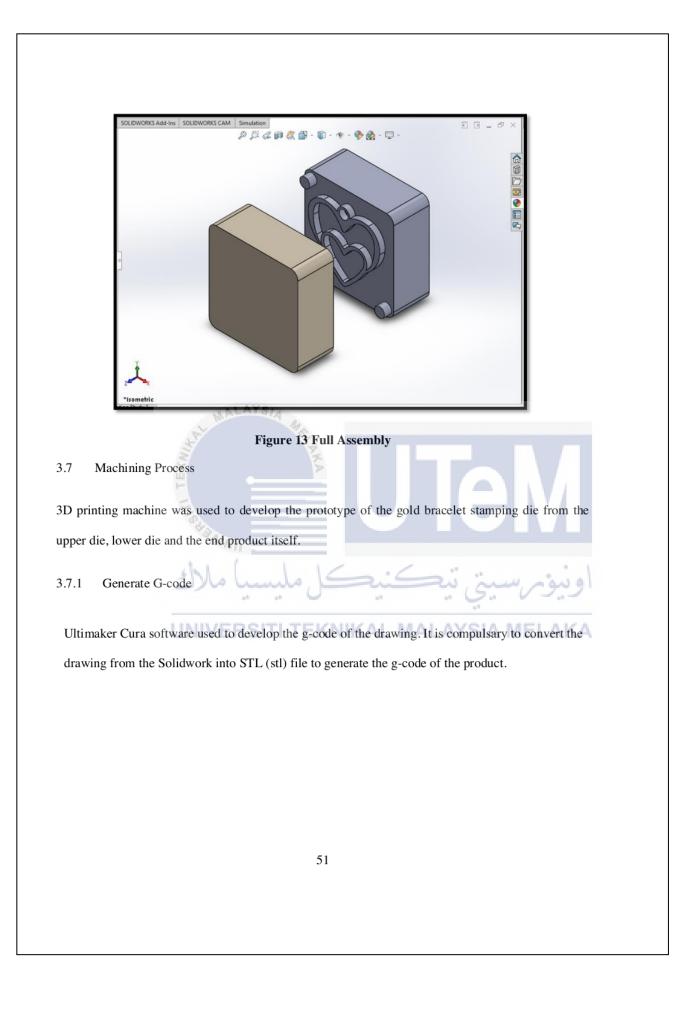
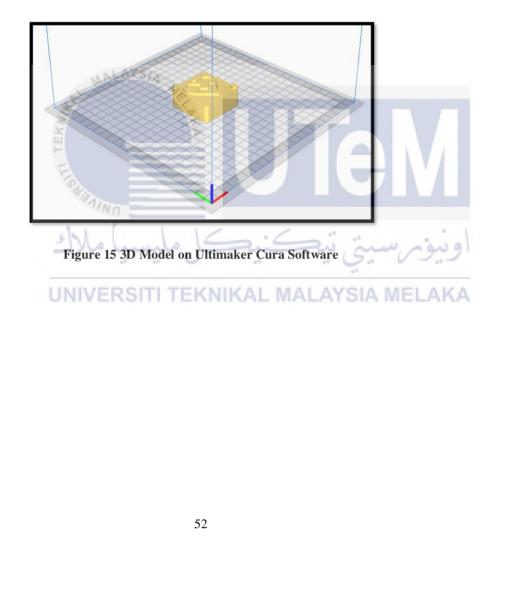




Figure 14 Convert Drawing into STL file



CESPRO_UPPER.MOLD - Notepad			- O	
File Edit Format View Help				
SFLAWOR:Marlin				
;TIME:16691				
;Filament used: 12.5033m				
;Layer height: 0.16 :MINC:42.891				
1/IDN/142.001				
:MIN2:0.2				
MAXX:173.142				
MAXY 146				
:MAX7:23.88				
Generated with Cura_SteamEngine 4.12.1				
M140 S65				
M105				
M190 S65				
M104 5210				
M105				
M109 5218				
MB2 ;absolute extrusion mode				
; Ender 3 Custom Start G-code				
G92 E0 ; Reset Extruder G28 ; Home all axes				
G1 22.0 F3000 ; Move Z Axis up little to prevent scratching of Heat Bed				
G1 X0.1 Y20 Z0.3 F5000.0 ; Move to start position				
G1 X0.1 Y200.0 20.3 F1500.0 E15 ; Draw the first line				
G1 X0.4 Y200.0 20.3 F5000.0 ; Move to side a little				
G1 X0.4 Y20 Z0.3 F1500.0 E30 ; Draw the second line				
G92 E0 : Reset Extruder				
G1 Z2.0 F3000 ; Move Z Axis up little to prevent scratching of Heat Bed				
G1 X5 Y20 20.3 F5000.0 ; Move over to prevent blob squish				
G92 E0				
G92 E0				
G1 F1500 E-6.5				
;LAYER_COUNT: 121				
; LAYER:0				
M107				
G0 F6000 X49.672 Y76.469 Z0.2 :TYPE:SKIRT				
1797E:SKIRT G1 F1500 E0				
11 F1300 C0				
		Lange Lange a second		
	Ln 1, Cel 1	100% Windows (CRLF)		

Figure 16 G-code

Once g-code has been generated by the Ultimake Cura Software, then we can proceed to the next step which is the machining process of 3D printing machine known as Creality Ender 3-Pro.

3.7.2 3D Printing Process

Lastly, after complete the generation of the g-code and setup the parameter of the product on the Ultimaker Cura software, finalize your process by simulation to generate the time estimation and material estimation. After the completion of the simulation, save the coding generated by the software to the removable disk and transfer it to the 3D printing machine, Creality Ender-3 Pro to proceed with 3D printing process. UNIVERSITITEKNIKAL MALAYSIA MELAKA

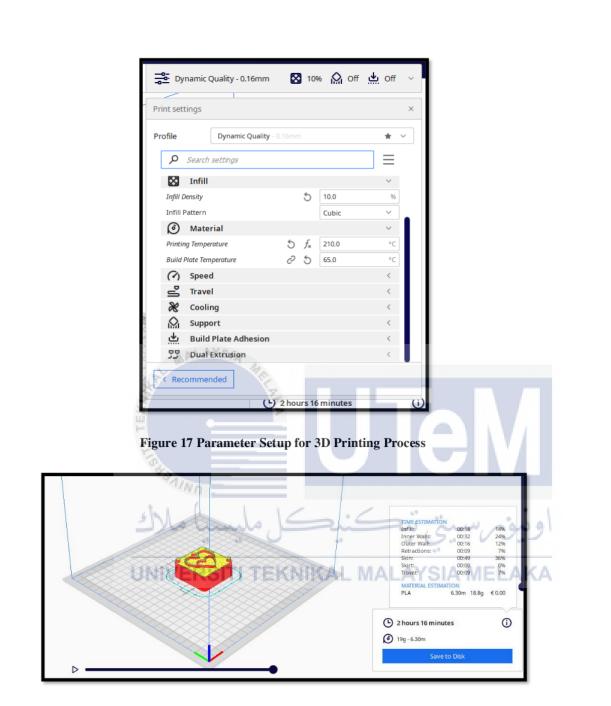


Figure 18 Simulation Process of 3D Printing

3.7.3 3D Printing Machine Setup



Figure 19 Creality Ender-3 Pro

Here are a number of features that make the Creality Ender-3 3d printer one of the most popular machines currently on the market. It has a build volume of 220 x 220 x 250mm, a BuildTak-like heated build plate, power recovery mode, and a tight filament pathway that makes it easier to print with flexible materials. Creality Ender-3 3D Printer is partially assembled and competed by Creality itself. It can work continuously for 200 hours without pressure Creality Ender-3 3D Printer allows it to resume printing after power-off or lapse occurs and with thermal runaway protection itself. Patented technology, V-Slot+precision pulley, running more smoothly, more wear-resistant. Effectively reduce noise. MK8 extrusion mechanism is used, a brand-new patented infrastructure that effectively reduces the risk of plugging and poor spillage and can print almost all filaments on the market. CNC machining of the Y-rail mounting groove to make sure precise positioning and keep the solid frame with the high-precision printing quality.



Table 4 Standard Operational Procedure (SOP) on 3D Printer





WHEN YOU FINISH:

1. Take out the printed model from the bed.

*If your print is still adhered to the build plate after cooling, you can use a spatula toremove the print.



2. Clean up filament residues on the nozzle and bed.





RESULT AND DISCUSSION

4.1 Introduction

4.2

This chapter presents the results and analysis on the design and development of gold bracelet stamping die. The prototype design has been formed through the steps that have been taken as described in Chapter 3. The topics to be discussed in this chapter such as Failure Mode and Effect Analysis (FMEA), design defect, prototype defect, software effectiveness and many more. The gold bracelet stamping die prototype analysis have been made to make sure there are no hindrance in the making of the real gold bracelet stamping die.

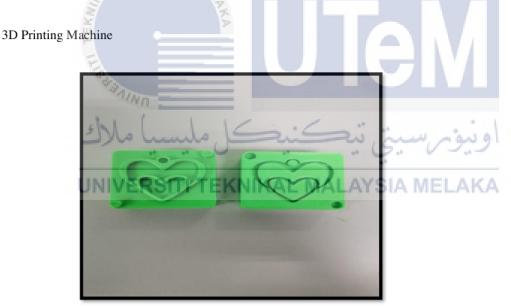


Figure 20 Upper and Lower Die



Figure 21 Test Print

4.3 Failure Mode and Effect Analysis (FMEA) on Gold Bracelet Stamping Die

This kind of analysis is used to find all possible design defects in a systematic way. It also looks for flaws in the machining and assembly processes. Failures are graded on the severity of their consequences, the frequency with which they occur, and how easily they may be discovered. The purpose of the analysis is to remove or reduce failures, starting with the most critical.

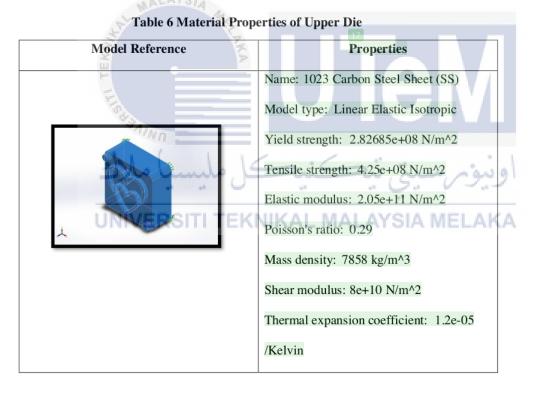
4.3.1 Upper Die Simulation

Solidworks Simulation was used to create the simulation. The Upper Die is treated as though it were made of solid metal. The current setting has been configured to be the default. As indicated in Chapter 3, the material for the Upper Shoe is 1023 Carbon Steel Sheet (SS). Table 5 contains additional model information, such as the pre-simulation.

Table 5 Upper Die Volumetric Properties

UPPER	DIE
32 TREATED AS	VOLUMETRIC PROPERTIES
Solid Body	Mass:0.0500393 kg
	Volume:6.36794e-06 m^3
	Density:7858 kg/m^3
	Weight:0.490385 N

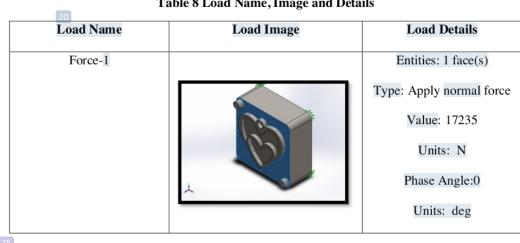
There are various details that need to be documented as simulation preparatory material attributes because the material is set to 1023 Carbon Steel Sheet (SS). Model type, yield and tensile strength, mass density, and other data are listed in Table 6.



The value was set to the average of mechanical stamping press pressure for the load and fixtures. Because the upper die shoe surface will shift with the lower die shoe, pressure was applied to the top of the upper die shoe surface. Because the geometry does not move, the fixed geometry was established at the bottom surface of the top die shoe. Tables 7 and 8 contain all of the load and fixture information.

	ame	Fixture Image	Fixture Details
Fixed-	I NALM	NA A	Entities: 1 face(s) Type: Fixed Geometry
esultant Force	s S	N. C.	
Components	X	Ŷ	Z Resultant
Reaction	0.00457573	-0.00650537	17234.9 17234.9
Force (N)	Paga Alino		
			4 ⁹
	UNIVERS	63	AL MALAYSIA MELAP

Table 7 Resultant Force, Fixture Name, Image and Details



Von Mises Stress, Resultant Displacement, and Equivalent Strain are three results that can be produced from the simulation. The von Mises Stress is a criterion for determining if the Upper Die made of 1023 Carbon Steel Sheet (SS) will yield or fracture. The phrase "equivalent strain" is used to define the state of strain in solids at the Upper Die level. Tables 9, 10 and 11 show the results of von Mises Stress, Resultant Displacement, and Equivalent Strain.

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Table 8 Load Name, Image and Details

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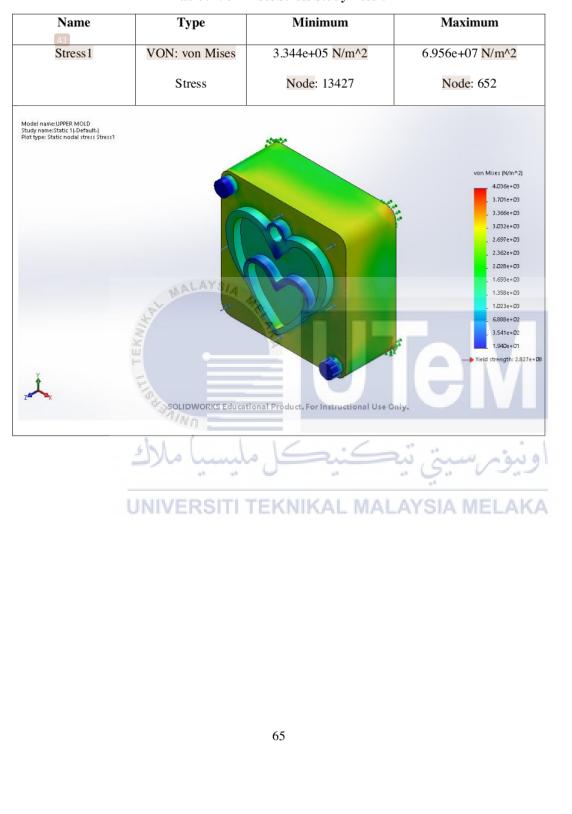


Table 9 Von Mises Stress Study Result

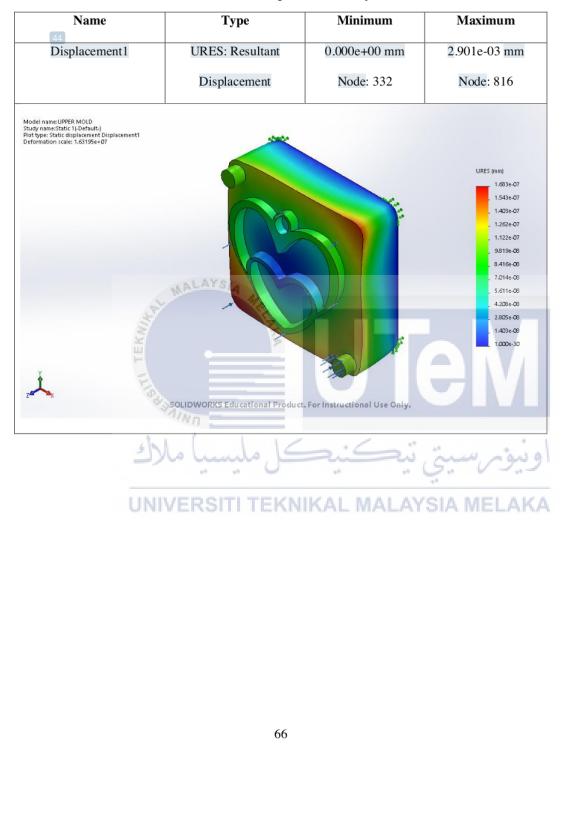


Table 10 Resultant Displacement Study Result

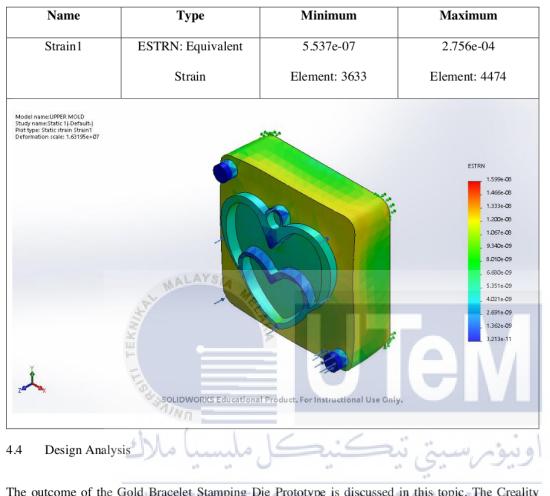
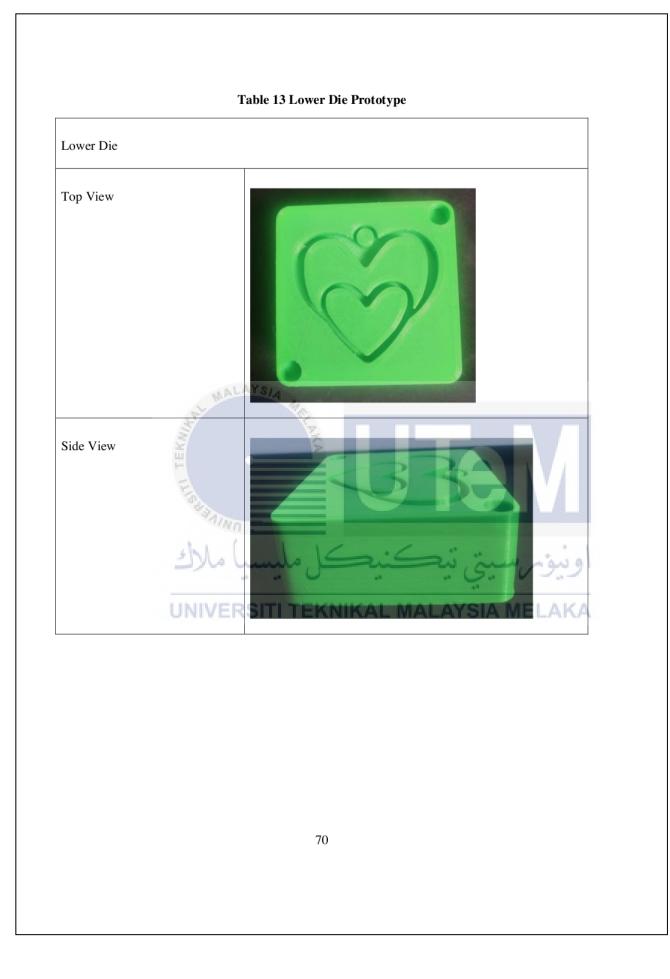


Table 11 Equivalent Strain Study Result

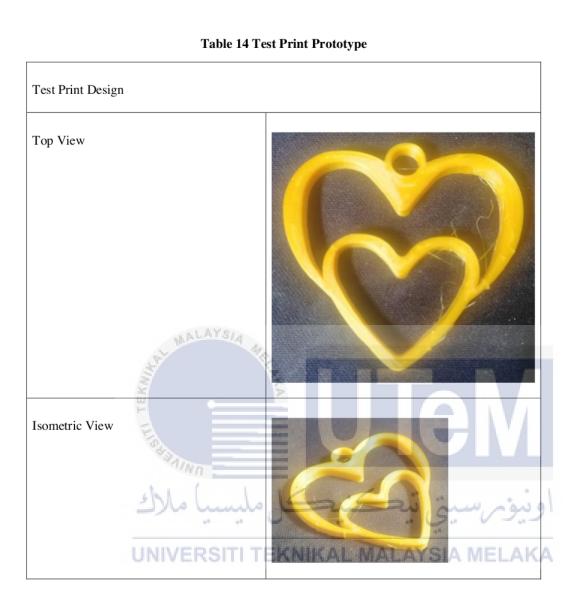
The outcome of the Gold Bracelet Stamping-Die Prototype is discussed in this topic. The Creality Enders-3 3D-Printing machine was used to create the prototype. The prototype creation process can take up to 4 hours. It has both an upper and lower die in its construction. Table 12, Table 13, and Table 14 illustrate the Gold Bracelet Stamping Die prototype.











4.4.1 Prototype Defect

4.4.1.1 Circle Inaccuracies

The circle inaccuracies defect occurs when the heated bed and printing nozzle of a 3D-printing machine move lateral to the X, Y, and Z axes to print the prototype. Making the circle tolerance about 0.5 mm is one of the preventive measure to avoid the defect. Even if it isn't the optimal option, it will offer the

prototype design the best shape. Figure 22 shows an example of a circular inaccuracies fault inside the red circle.

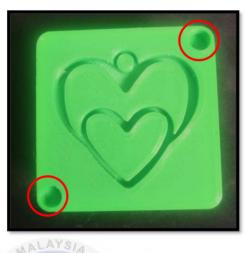


Figure 22 Circle Inaccuracies Defect Example

4.4.1.2 Layer Shifting and Splitting

When the prototype model is not produced at a good printing parameter, layer shifting and splitting occur. Because the print profile is only set to Standard Quality, the model may split. The model's durability is also influenced by the wall thickness and infill density. The wall thickness is set to 0.8 mm, and the wall line count is set to 2. The infill density is set to 10%, and the infill pattern is designated as cubic. A greater number of wall thickness and infill density may produce in a very good Gold Bracelet Stamping Die Prototype, preventing the model from splitting, but it will take longer to print, use more material, and cost more overall. Figure 23 and 24 depict the fracture of the Gold Bracelet Stamping Die.



4.4.1.3 Model Stringing or Oozing

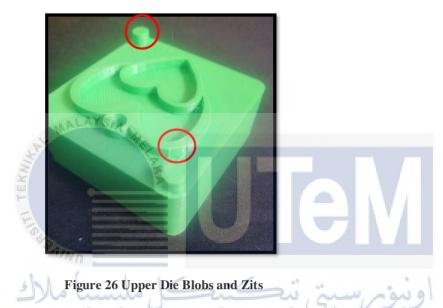
When the printing extruder moves between different sections of the print section, it causes model stringing or oozing. When the filament flowing out the nozzle while the extruder is being transferred to a new region of printing, a lot of hairs and strings are left behind. Despite the fact that the retraction command was enabled during the extruder's travel, causing the filament to be pulled backwards into the nozzle, stringing or oozing still occurs due to the small size of model printing. Furthermore, the distance between one printing part and the next is too tiny. Figure 25 depicts the Test Print model stringing or leaking.



Figure 25 Test Print Stringing or Oozing

4.4.1.4 Blobs and Zits

The blobs and zits are a minor mark on the prototype model's exterior shell surface. The extruder must frequently stop and resume extruding as it moves around the construction platform. The extruder had to begin printing the outer shell at that precise location on the prototype model, then return once the entire shell had been printed, leaving a little imprint on the surface. Figure 26 depicts the Gold Bracelet Stamping Die model blobs and zits.



4.4.1.5 Dimensional Inaccuracies

When the measured dimensions do not match the design intent, dimensional accuracy is required. Overextrusion, thermal shrinkage, and filament characteristic are all minor factors that might affect the precision of Gold Bracelet Stamping Die Prototype. The length on lower die shoe, where the purported dimensional accuracy is 50.00 mm but the printed portion is only 49.94 mm, are the most notable dimensional accuracy on the prototype model. Aside from that, the most noticeable dimensional accuracy is on the upper die length, which is meant to be printed on 50 mm but is only 49.74 mm. Figures 27 and 28 depict the dimensional precision of the Gold Bracelet Stamping Die.



Figure 27 Dimensional Error on Lower Die



Figure 28 Dimensional Error on Upper Die

4.5 Software Analysis

The efficiency of using Ultimaker Cura software as an open source slicing application for 3D printers to create Gold Bar Stamping Die Prototype is discussed in this topic. The overall time, number of filaments used, and total length of filament used are utilized to determine whether the machine's prototype is satisfactory or not. All of the primary print settings may be configured in the software using Ultimaker Cura as a preparation step before creating the G-code.

The model for printing was the upper die shoe. The print profile for the first result was set to standard quality. The infill density has been set to 10%, and the infill pattern has been set to cubic. As a consequence, the entire print time is 24 minutes, and the filament used is 3 grams and 0.96 meters long. Figures 29 demonstrate the print settings and the result of standard quality printing.



_						
	Standard Quality - 0.2m	ım 🔀 10% 🕻	noff 🛓 off	~		
	Print settings		1	×		
	Profile Standard Qu	ality - 0.2mm	*	~		
			≡			
	Quality		<			
	Walls		< <			
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\leq	(?) Speed		<			
	< Recommended		₹ /			
The next profile of printing quality ensuing a different	result. The print s	neasure are d	ynamic qua e result of l	lity and supe Upper Die Pr		
Table 15	14 14 14 14 14 14 14 14 14 14 14 14 14 1	· ·		- · · ·		11
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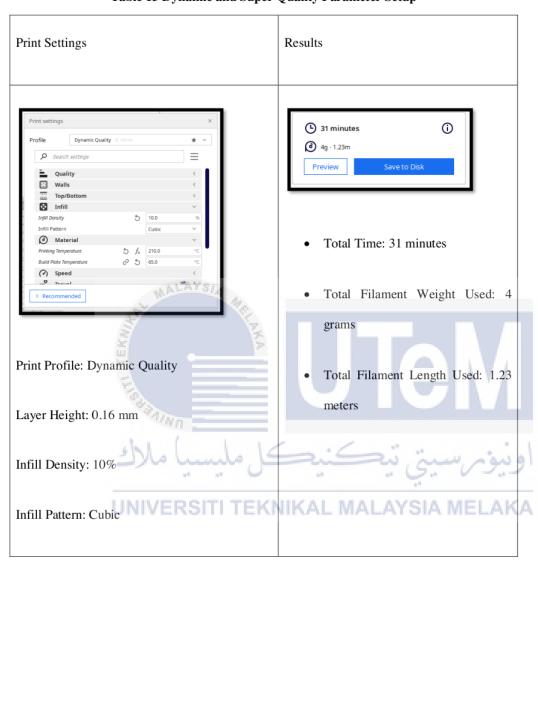


Table 15 Dynamic and Super Quality Parameter Setup

80

r Quality 0.12mm s	0.12] ≡ 	4g · 1.26m Preview Save to Disk
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	0.12		
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		<	Total Print Time: 49 minutes
		~	
	20.0	96	
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		~	• Total Filament Weight Used: 4
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ire O	60	°C	grams
	AY ST	1	• Total Filament Length Used: 1.20
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per Quality		×.	
per Quanty		>	
F	_		
10 51			
.12 mm			
232			
al	Vn .		
0.01	1		
0%			
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Following the printing profile, there are a number of factors that will have a direct impact on the prototype model. Because a part with smaller areas requires a print profile with slower production rates to preserve the piece's quality, the shape and thickness of the component have a direct impact on printing parameters like speeds and layer thicknesses. The higher the printing quality, the longer the total printing time. The ideal printing quality for printing the Gold Bracelet Stamping Die is Dynamic Quality, because the parameter is adjusted correctly and the total time consumed is not excessive.

4.6 Summary

This chapter discusses the outcomes of prototyping a gold bracelet stamping die. The discussed issue can help fulfil the project's goal of designing and developing gold bracelet stamping dies. The Failure Mode and Effect Analysis (FMEA) simulation is used to eliminate or reduce faults in gold bracelet stamping dies, starting with the most critical. The prototype was analyzed to verify that the project went off without a hitch. Defects such as circle inaccuracy, layer shifting, and model stringing have been discovered. All of the flaws have been addressed with solutions and enhancements.



49 CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

There are numerous courses available for designing and developing gold bracelet stamping dies. There have been proposed activities that have been categorized using various methodologies. A "Gold Bracelet" is a quantity of pure metallic gold in any shape created by jewelry manufacturer under standard production, tagging, and track circumstances. In response to the increased demand for gold bracelet, many manufacturers plan to offer a variety of stamping dies. The designer may experiment with a few distinct concepts to see how each media functions.

The processes for designing and developing gold bracelet stamping dies are presented in this project. Research design, design sketching, design drawing, prototype creation, and material selection are all part of the product development process. To guarantee that the project follows the process flow, it is divided into three sections: project planning, design, and prototype fabrication.

The project's major feature is design sketching. 'SolidWorks 2018' was the software version that was used. The base square, which is 25 mm, is the most important aspect of the design. It is critical to develop gold bracelet stamping dies as the primary foundation for upper and lower die shoes. The term "sketching" is also crucial in the development of a gold bracelet stamping die.

Slicing is a step in the machining process that occurs before the design is put through its paces. The slicing software was decided to be Ultimaker Cura. The g-code will be generated automatically if you use this software. After the g-code has been completed, it can be delivered to the printer for physical

item manufacturing. Setting the print settings to ensure a nice prototype is produced is a critical component of utilizing this software.

Machining is the first stage in creating a gold bracelet stamping die prototype. The method was carried out on a Creality Ender 3- Pro 3D printing machine. It has a 200-hour continuous working capacity. It allows printing to resume after a power interruption or lapse, as well as preventing thermal runaway. There are various concerns to be aware of when using this equipment, including a high-temperature printer nozzle that can inflict severe harm and hot filament flowing out of the nozzle.

Following thorough research, carbon tool steel was identified as the best material for gold bracelet stamping dies. Their hardness, resistance to wear and deformation, and ability to keep a cutting edge at high temperatures all contribute to their usefulness. Many of the properties of tool steel are determined by the presence of carbides in the matrix. This research was conducted on a production line in an industrial setting. Inspection of a large number of machined components is possible, which improves statistical correctness and dependability.

The gold bracelet stamping die design and development findings and analyses have been completed. The prototype design was built by following the procedures specified in Chapter 3. The Failure Mode and Effect Analysis (FMEA) is used to identify and eliminate problems, starting with the most critical. It's possible that the prototype creation process will take up to 2 hours. It is constructed with both an upper and lower die. Circle inaccuracies, layer shifting, model stringing, blobs and zits, and dimensional accuracy are among the prototype flaws discovered. It has been demonstrated that utilizing Ultimaker Cura software as an open source slicing application for 3D printers to create Gold Bracelet Stamping Die Prototype is effective. The best print settings have been given in order to ensure the production of a good gold bracelet stamping die prototype. Overall, the gold bracelet stamping die design and development project was a success. It has been proved that the proposed technology can be used to create a gold bracelet stamping die. The findings and analysis cover the entire process of making gold bracelet stamping dies. As a result, it lays the groundwork for the upcoming project.

5.2 Recommendations

The design and development of gold bracelet stamping dies could be improved in the future as follows:

- Conduct research into additional gold bracelet manufacturers in order to broaden the design of gold bracelet stamping dies.
- ii. Conduct further research into the development of gold bracelet stamping die in order to experiment with a wider range of manufacturing methods.
- iii. Switch to another piece of material to see whether there are any other ramifications to the error.
- iv. Develop a large number of gold bracelet stamping die prototypes in order to attract more manufacturers.

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APPENDICES



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