DESIGN AND DEVELOPMENT OF DRILL BIT SHARPENING JIG FOR THE BENCH GRINDER

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DESIGN AND DEVELOPMENT OF DRILL BIT SHARPENING JIG FOR BENCH GRINDER

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Report submitted in partial fulfillment of the requirements
for the award of the degree of
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ABSTRACT

This thesis deals with design and development of the drill bit sharpening jigs for bench grinder. The objective of this thesis is to design the drill bit sharpener jig that enhance the better outcome rather than manual sharpening operation. The thesis follows with the development of the drill bit sharpening jig that can be attached to the bench grinder . The structural three-dimensional solid modeling of drill bit sharpening jig was developed using the computer-aided drawing software which is CATIA V5R21. The strategy of validation of the model design was developed. The generative part structural analysis was then performed using simulation in CATIA V5R21 to detect the Von Mises distribution.The design and suitable material will be validated. The fabrication of the jig may undergoes in various machining process such as milling , turning , electrical discharge wirecut and grinding . The assembled part shall be tested on the bench grinder. Besides , several dull drill bits will be sharpen using the jig. These assessment results are significant to improve the component design at the early developing stage.Further analysis will be conducted by testing the drilling process on the workpiece.The resharpen drill bits and the new drill bits will results on the difference surface roughness.Thus, the surface roughness analysis is performed to distinguish hole surface roughness outcomes for both drill bits.The results shows the difference of surface roughness between both hole surface is small and insignificant.Thus, it means that the outcomes is relatively same.The jig can also significantly reduce the cost and time to market, and improve product reliability and customer confidence.

ABSTRAK

Tesis ini berkaitan dengan reka bentuk dan pembangunan bit gerudi mengasah jig untuk pencanai meja. Objektif laporan ini adalah untuk mereka bentuk sharpener jig gerudi bit yang meningkatkan hasil yang lebih baik daripada operasi mengasah manual. tesis berikut dengan pembangunan jig mengasah gerudi bit yang boleh dilampirkan kepada pengisar bangku simpanan. Struktur pemodelan pepejal tiga dimensi gerudi mengasah jig telah dibangunkan menggunakan perisian lukisan berbantukan komputer yang CATIA V5R21. Strategi pengesahan reka bentuk model itu dibangunkan. Bahagian generatif analisis struktur ketika itu dilakukan dengan menggunakan simulasi dalam CATIA V5R21 untuk mengesan reka sebaran Von Mises.Kemudian,lakaran dan bahan yang sesuai akan disahkan. Fabrikasi jig boleh menjalani pelbagai proses pemesinan seperti pengilangan, menukarkan, wirecut pelepasan elektrik dan pengisaran. Bahagian yang dipasang hendaklah diuji pada pengisar bangku simpanan. Selain itu, beberapa bit gerudi membosankan akan mengasah menggunakan jig. Hasil penilaian adalah penting untuk meningkatkan reka bentuk komponen pada awal membangunkan analisis stage.Further akan dijalankan dengan menguji proses penggerudian pada workpiece.The resharpen bit gerudi dan bit gerudi baru akan keputusan pada roughness.Thus permukaan perbezaan, yang analisis kekasaran permukaan dilakukan untuk membezakan hasil kekasaran permukaan lubang untuk kedua-dua keputusan bits.The gerudi menunjukkan perbezaan kekasaran permukaan antara kedua-dua permukaan lubang kecil dan insignificant.Thus, ia bermakna bahawa hasil adalah jig agak same.The juga boleh mengurangkan kos dan masa ke pasaran, dan meningkatkan kebolehpercayaan produk dan keyakinan pelanggan.

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LIST OF SYMBOLS

ω	Natural frequency
ε	Total strain, Bandwidth parameter
r_y	Raw rating of concept *j* for the *i*th criterion
w_i	Weighting for *i*th criterion
S_j	Total score for concept *j*
RM	Ringgit Malaysia

LIST OF ABBREVIATIONS

AA	Aluminum alloy
Al	Aluminum
ASTM	American Society for Testing and Materials
CAD	Computer-aided drafting
CAE	Computer-aided engineering
DOF	Degree-of-freedom
DTP	Discretized turning point FE Finite element
FEA	Finite Element Analysis
FFT	Fast Fourier transform
FRF	Frequency response function
MBD	Multibody dynamics
PDF	Probability density function

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In manufacturing industry,the mass production with the high productivity targets the lowering in cost and interchangeability to promote easy assembly.As to increase the manufacturing rate and improving the inspection process,the supporting devices are necessary.

Jigs are the special purpose tools that used to ease processing like machining ,assembling and inspection operations.Jigs provide an average of manufacturing interchangeable parts since they set up the tolerances between work and the cutting tool.

Jigs are used on most of the machining processes drilling, reaming, tapping, milling and grinding.There are many advantages using the jigs in the production.Jigs eliminate the individual processing, making, positioning and lessen the inspection.This reduces the production time and improve the efficiency and productivity.

1.2 PROJECT BACKGROUND

Drill biit sharpening jig known have tended to be complex, expensive difficult to adjust, or inexpensive and incapable of precision sharpening of drills, thus hindering the desired cutting lip surface**.**

Basically,the operator needs to have a jig to ensure the exact and consistent cutting of the drill bits whether the operator has a high or low skill on the manual drill bits sharpening.During manual grinding,the operator tends to use the bare hand without the aid of other apparatus.Thus, it will lead to vibration during the process of grinding and may affect the microstructure of the drill bits,the surface finish as well as the operator own safety.Besides, the usage of the jig can avoid the excessive residual stress and vibration comes from the grinding process.

Thus,as to avoid the loading stress on the jigs,the material selection must be correctly done.This is because the material should be suitable to to prevent the residual stress on the drill bits and the jig itself.Besides the measurement for available attachment place for the bench grinder must be considered so that it fits well.

1.3 PROBLEM STATEMENT

In recent years,the sharpening of the drill bits has become significant.A dull drill bits shall lesser the performance of the drillling process and subsequently lower the tool life.Thus,these project is to study the behavior of drilll bits during grinding process and enhance the safety of equipment, structures, and lead time to sharpen the drill bits.

For instance,the unevenly emergence of swarf,oversize or rough hole,drill point appears to wobble and make drill press shakes are some of the problem encountered during drilling using the defected drill bits.This may cause by the off-centre point angle, unequal cutting lip length or angles (Edgar, 2013).Resharpen the drill should fix the problem by following the right steps and procedure.

Besides, the squeaking and slow penetration of the drill bits frequently produced.These are due to the dull cutting edge and the insufficient lip clearance behind one lip (Edgar,2013)

During sharpening of drill bits, the a high quality clamp is not only holds the workpieces firmly together but the jig also must also be able to retain its position steadily in order to produce a smooth outcomes

Thus, a jig is fabricated to solve this problem with better specification.the jig must be able to hold the drill bits and made of the high stiffness material as to absorb the shock and vibration during the process

1.4 PROJECT OBJECTIVES

The aim of this project is to design and fabricate the drill bits sharpener that promote better outcome rather than manual drill bits sharpening process that may vary due to the skill of the operator.Besides,the objective of the project is also fabricate the jig that can attached at the bench grinder.

1.5 PROJECT SCOPES

The scopes of the project are :-

i. Design and fabricate jig for the various diameter of the drill bits
ii. Design and fabricate the jig that attachable to the bench grinder
iii. Fabricate jig using suitable material

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

During literature review chapter, will continue to discuss about the literature review of jigs design for sharpening the drill bits.Since the drill bit is used widely in the industry,there is a lot of research about the jigs design as the room of improvement.Besides,this chapter will also explain of the basic principle of the related jigs and the components in the jigs. The importance,advantages and the disadvantages of the jigs will be further discussed too in this chapter.

2.2 INTRODUCTION OF JIGS AND ELEMENTS OF JIGS

In machining,some process is very easy to setup and carried on for instance milling with the aid of the clamps.However for some processes,the machining needs to use extra device to help the process to guide the tool.The device stated as the process to be done perfectly is called jigs which can guide the tool and promote holding feature.

The jigs build up from various element which is body, locating devices ,clamping devices and the tool guide. (Krishnan, 2000.)

2.21 JIG BODY

The jig body is usually produced of cast iron using casting process or by welding that combine each mild steel part together. In order to relieve stresses, the body will then be heat treated. Body is considered the main feature of the jig. Its main purpose is to support and house the job.

2.2.2 LOCATING DEVICES

The function of the locatng device is to locate a workpiece on jigs. The shank pin is driven into the body of jig or fixture or being press fitted. The locating pin radius usually bigger than the shank to overcome it being pressurized into the jig or fixture body due to the weight of the work piece or cutting forces .There are examples of pins which is locating pins,support locating pins and jack pins.

2.2.3 CLAMPING DEVICES

The clamping devices functions as to exert pressure to the workpiece and hold it in position for the machining processes.There are several clamping devices are commonly used in industry such as clamping screw,hook bolt clamp,bridge clamp,heel clamp,latch clamp, and C-clamp. The essential features of the good clamp is :-

(a) The clamp must hold the workpiece rigidly.

(b) The clamping pressure will not harm or damage the clamped units.

(c) The clamping pressure should be sufficient to prevent the operating pressure applied on the workpiece as both pressure act on the workpiece in opposite directions.

(d) The clamping device should free from te vibration during the process.

(e) Easy to operate and maintenance,providing the user friendly feature.

2.3 DESIGN CONSIDERATION IN FABRICATION OF JIGS

There are many factors that dependant to design the jigs. These factors are simulated and experimented in order to obtain design inputs for jigs and fixtures. The list of such factors is mentioned below :

(a) Study of the size and shapes of the workpiece and finished component

(b) Type and capacity of the machine, its extent of automation.

(c) The locating devices provision in the machine.

(d) The already clamping setup patterns in the machine.

(e) The accuracy of the available indexing devices.

(f) Evaluation of variability in the performance results of the machine.

(g) Rigidity and of the machine tool under consideration.

(h) Study of ejecting devices, safety devices, etc.

(i) Required level of the accuracy in the work and quality to be produced.

2.4 IMPORTANCE OF JIGS

In industry,the jigs are undeniably vital for enhancing the performance and the lead time.These tool is most required to smooth and ease the operator in order to settle down their works.Subsequently, the holding or clamping features in jigs shall also help the operator in production lines besides lower the unconformities in the product.Thus, this will increase the productivity and minimize the manufacturing lead time.

2.4.1 BENEFITS OF USING JIGS

The application of jigs in the production offers the benefits that may cater the demands of the customers and the workers.The advantages are :-

(i) Interchangebility

Jigs can ease the mass production with high degree of accuracy and constant quality in manufacturing

(ii) Productivity

Jigs develop the productivity by discarding the individual marking, positioning and often checking. The operation time is also reduced due to increase in speed, feed and depth of cut because of high clamping rigidity.

(iii) Skill reduction

Jigs aid workers by its flexibility that requires no skillful setting of work on tool.Thus, the adaptation of jigs in production shall makes possible to employ unskilled or semi skilled machine operator in order to save labour cost.

(iv) Cost reduction

Jigs increase the production output rate and lessen the scrap.Besides,it also enhance the setting time due to its easy assembly feature thus directed to the savings in time and costs per capita.

2.5 INTRODUCTION OF DRILL BIT SHARPENING JIGS

Basically,the drill bits is sharpen manually with the bare hand in previous time.The output during the process is not constant and need the skillful worker as the process can be done.However,as the time changes,the researchers design and invent the jigs in order to ease the sharpening process. This invention relates to the sharpening of drill bits, and more particularly to a jig for supporting and moving a drill bit relative to a grinding wheel to effect precise sharpening of the bit.The another functions of the sharpening jigs is to produce precisely centered tip and a properly relieved clearance angle behind the cutting edges of the bit.The jigs must be economical to be manufacture and has a simplified design(Ausbie,1968).

2.6 MATERIAL SELECTION

There are a wide range of materials from where jigs and fixtures could be made, to resist tear and wear, the materials are often tempered and hardened. Also, phosphor bronze and other non-ferrous metals, as well as composites, and nylons for wear reduction of the mating parts, and damage prevention to the manufacturing part is also used. Some of the materials are discussed below:

2.6.1 Phosphor Bronze

Phosphor bronze is used in the production of jigs and fixtures for processes that involve making of interchangeable nuts in clamping systems like vices, and also inoperated feedings that require screws. As the manufacturing of screws is very expensive and also wastes a lot of time, the reduction of their tear and wear is often achieved by using replaceable bronze mating nuts made with phosphor bronze.

The alloys typically contain up to 10% tin and up to 0.35% phosphorus. They have excellent cold workability, that is, they can be cold rolled to thin sheet, and despite their relatively high strength, they can readily be shaped into connector components by bending. Being copper alloys, they have adequate electrical conductivity. Their fatigue strengths are high enough to make them suitable for applications where repetitive actions stress the components, as in fasteners, electrical connectors, springs, electrical switches and similar products.

2.6.2 Die Steels

The three variants of die steel – high chromium (12 %), high carbon (1.5 to 2.3%), and cold working steels are applied in the production of jigs and fixtures for the making of thread forming rolls, as well
as cutting of press tools. When alloyed with vanadium and molybdenum for it to retain toughness at very high temperature, die steels are applied in the fabrication of jigs and fixtures that are used in high temperature work processes which include extrusion, forging, and

casting processes.

2.6.3 High Speed Steels

Based on the standard requirement,the mixture of the high speed steel material consist of tungsten (11.75%), molybdenum (1.8%) for the toughness of the cutting strength,vanadium (0.8%) that offers the retention of the hardness at elevated temperature and impact resistance,chromium (3.5%) for enhancement in hardenabiity and wear resistance.The tempered HSS may applied in the production of the jigs for reaming, boring ,drilling and cutting operation.Heat treatment on HSS can be done to produce HSS with hardness to 62 HRC.

High-speed tool steels are used for most of the common types of cutting tools including single-point lathe tools, drills, reamers, taps, milling cutters, end mills, hobs, saws, and broaches(Bayer,1989).

Requirement	Standard	Intermediate
Chemical requirements		
Minimum alloy content by major elements		
Carbon	0.65	0.70
Chromium	3.50	3.25
Vanadium	0.80	0.80
Tungsten + 1.8% molybdenum	11.75	6.50
Minimum total alloy content based on tungsten equivalents (⅓ Cr + 6.2 V + W+ 1.8 Mo)		
Grades containing less than 5% cobalt	22.50	13.00
Grades containing 5% or more cobalt	21.00	12.00
Hardening response requirements		
Ability to be austenitized, and tempered at a temperature not less than 510 °C (950 °F) with a fine-grain structure (Snyder-Graff grain size 8 min) to	63 HRC	62 HRC

Table 2.1:Requirements for high-speed tool steels per ASTM

2.6.4 Carbon Steels

When tempered with oil, carbon steels are applied in the making of some jig and fixture parts which are exposed to tear and wear like the locators and jig bushes.Basically,the carbon steels strength and hardness parameter will increase due to the increase in carbon content about 0.01 to 1.5% in the alloy and subsequently will reduce the ductility and the malleability of the alloy.

Generally,there are 3 types of plain carbon steel and they are low carbon steel, medium carbon steel, high carbon steel, each of them differs in the amount of carbon they contain.

Material	Density 103 kgm-3 Thermal	Thermal conductivity Jm-1K-1 s-1	Thermal expansion 10-6K-1	Young's modulus GNm-2	Tensile strength MNm-2	% elongation
0.2% C Steel	7.86	50	11.7	210	350	30
0.4% C Steel	7.85	48	11.3	210	600	20
0.8% C Steel	7.84	46	10.8	210	800	5

Table 2.2:Properties of Carbon Steel

Source: Material Science And Engineering, 4th Edition, V.Raghavan, p. 396

2.6.5 Mild steels

Mild steel which contain about 0.2% to 2.1% of carbon are very cheap and because of their easy availability are often the choicest material for the making of jigs of fixtures.

Advantages of the mild steel :-

a) Cheap
b) Wide variety availablewith different properties
c) High stiffness
d) Magnetic
e) Easy to machine amd weld

However,it also has a disadvantages at poor corrosion resistance

2.7 PREVIOUS RESEARCH JIG DESIGN

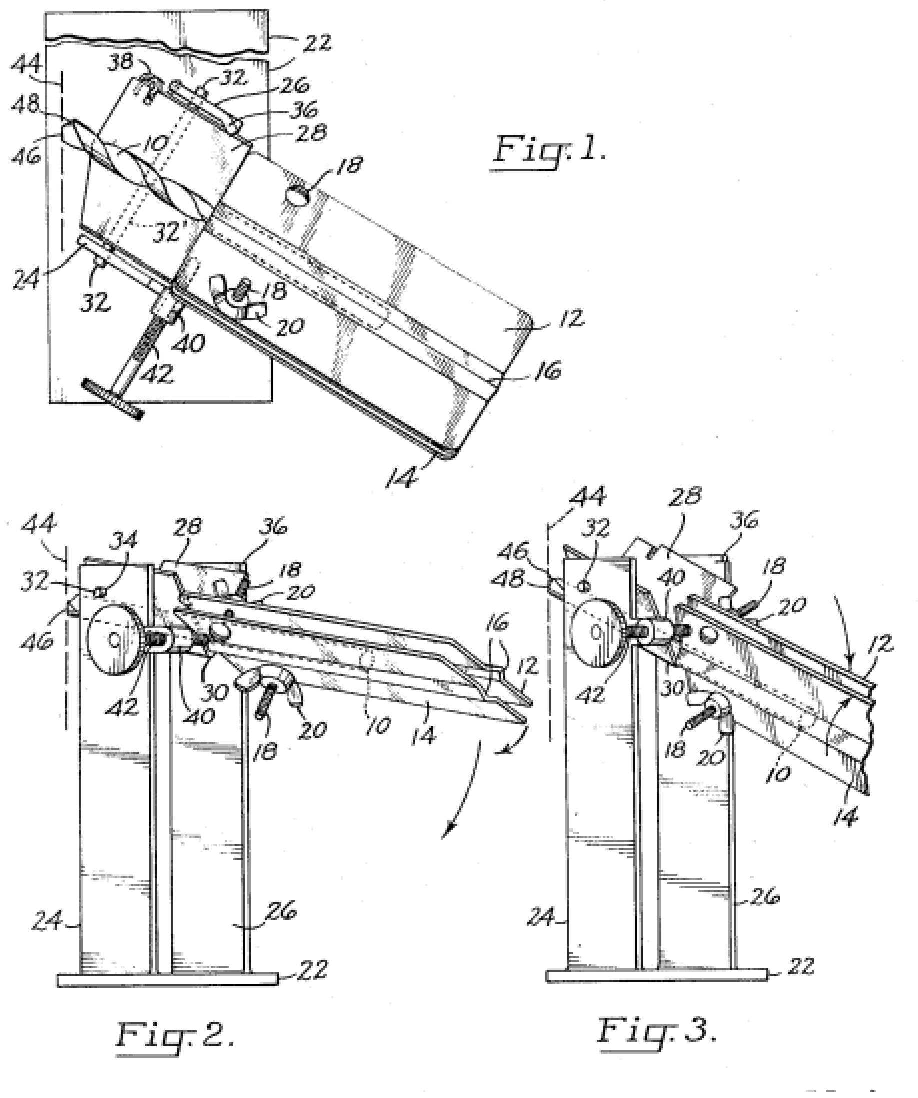


Figure 2.7.1: Drill bits sharpening jigs (York, 1965)

Ausbie A. York (1965) has studied about the Drill Bit Sharpening Jig .The documentation relates to the sharpening of drill bits, and more particularly to a jig for supporting and moving a drill bit relative to a grinding wheel to effect precise sharpening of the bit.Besides, the fabrication of the drill bit jig is to produce a sharpened drill bit having a precisely centered tip and a properly relieved clearance angle behind the cutting edges of the bit.In addition, the design promotes the simplified construction for economical manufacture.The design compromises an upstanding base member adapted to be mounted adjacent a grinding wheel, a drill bit support member having guide means for supporting a drill bit parallel to the axis of said guide means, pivot means interengaging the base member and bit support member for pivoting the latter relative to the base member on an axis substantially normal to the axis of said guide means, a drill bit holder independent of the base member and support member.

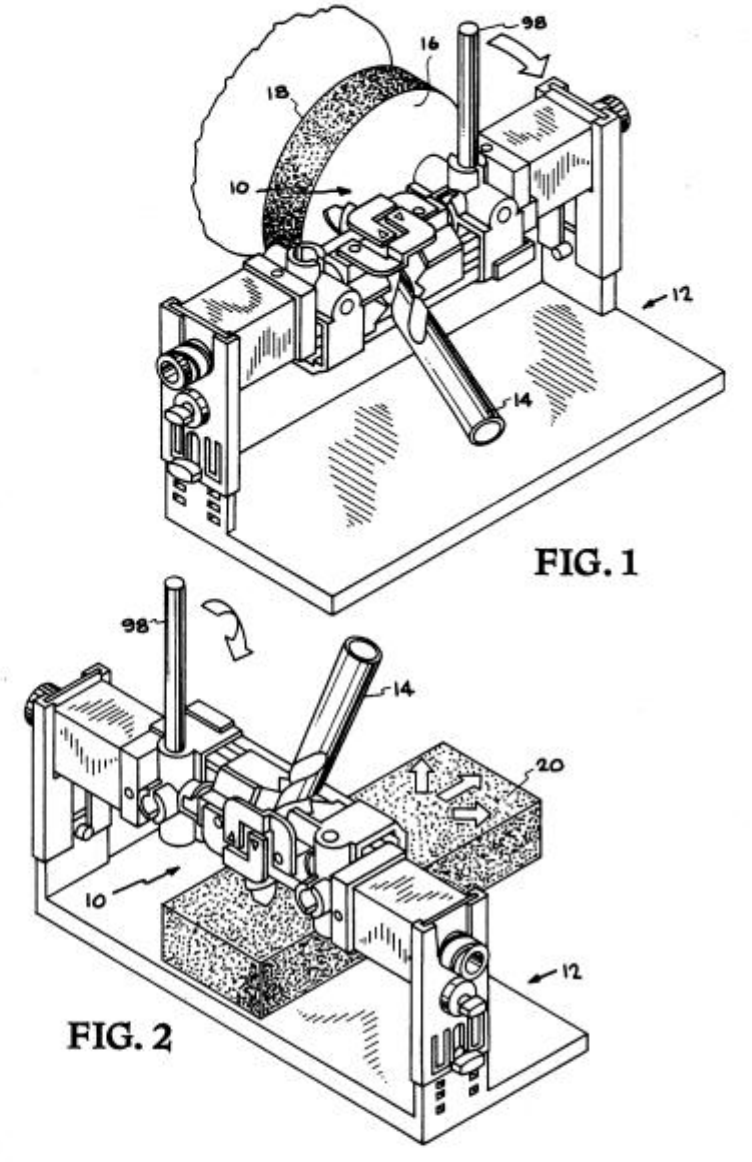


Figure 2.7.2: Universal Device for Sharpening Drill Bits (Chantalat,1989)

Vinit P. Chantalat (1989) has developed the Universal Device for Sharpening Drill Bits.The device is able to sharpen drill bits on the flat surface of an electric grinding wheel or on a flat surfaced sharpening stone.This device also can accommodate various sizes of drill bits, the vise type holder having a slotted and angled set of jaws for positioning the drill bit at the correct grinding angle to the grinding surface.Besides,this documentation also provides tha formula for the calculation of the relief angle and prootursion length. This is critical since operators resharpening drill bits by hand tend to remove material inefficiently, have a tendency to overgrind or under grind the drill-bit material, and tend to quickly overheat the drill-bit material, resulting in loss of temper and sharpness (Chantalat,1989).

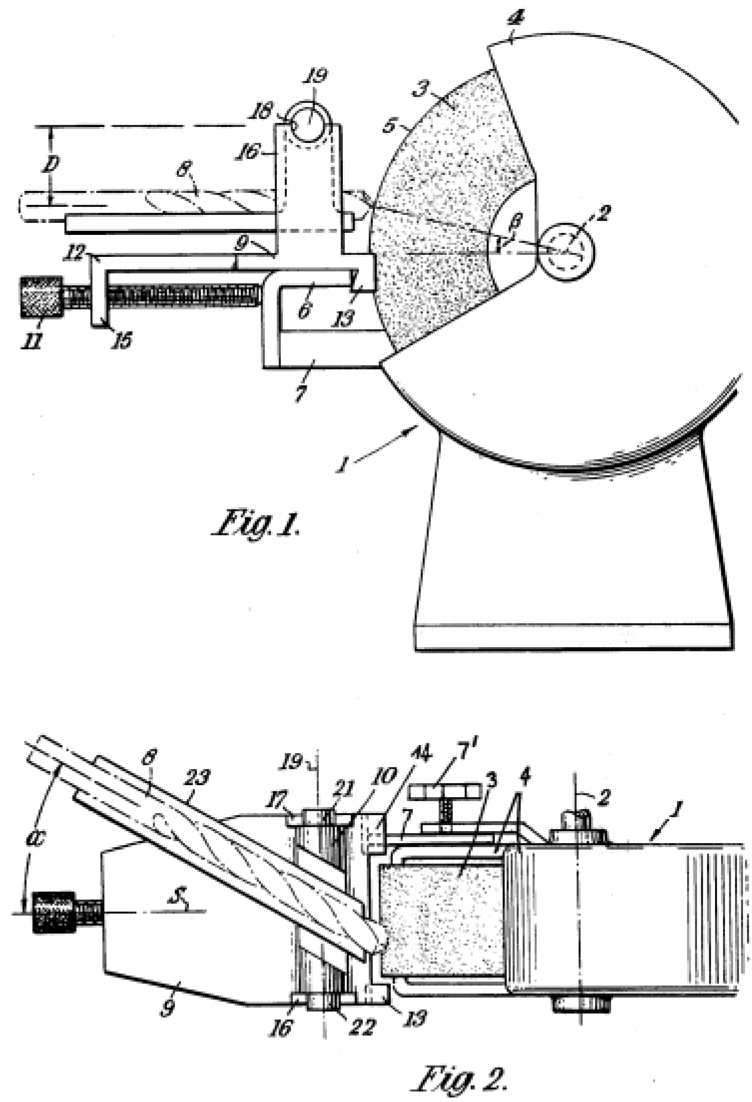


Figure 2.7.3: Device for grinding the spiral drill (Wolff & Kiesacker, 1979)

Robert Wolff and Im Kiesacker(1979) has studied of the device for grinding the spiral drill.The device promotes regrinding and sharpening of spiral drills used by a home or do-it-yourself amateur in conjunction with a conventional grinding machine mounted on a table and having a rotating grinding wheel or disk exposed on a horizontal shaft.The device also may be attached as an additional device to a grinding machine, especially to a so-called adapter wheel stand for home machine tools and which makes possible a very precise sharpening of used drills with the simplest possible handling.The device is simpler rather than the Chantalat version.

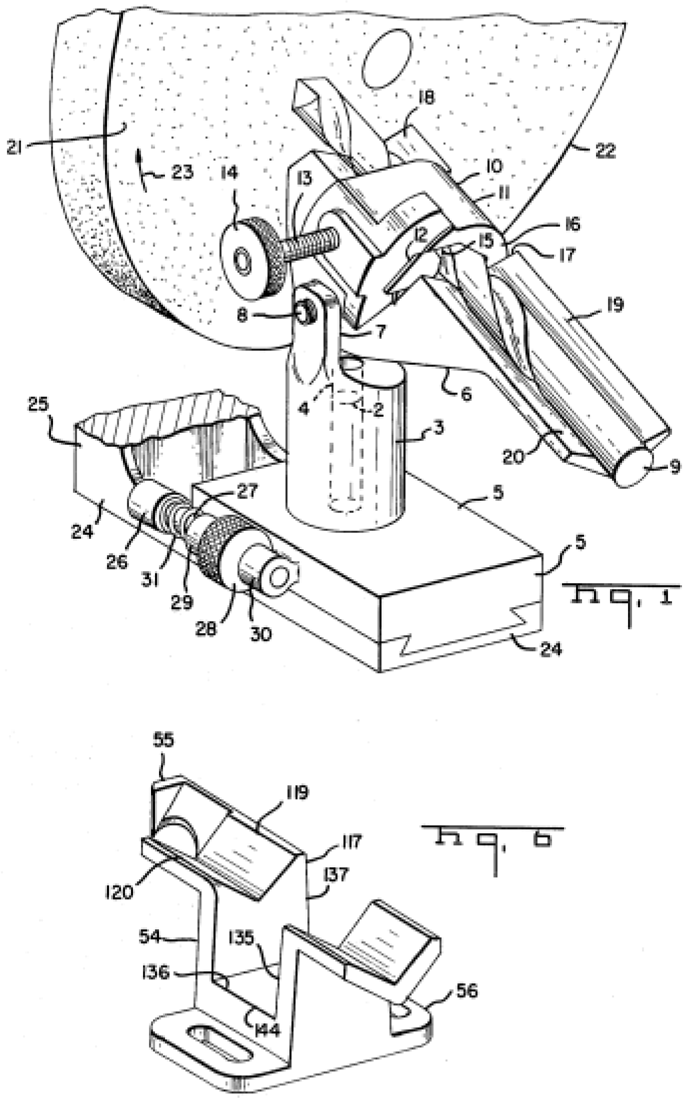


Figure 2.7.4: Drill grinding ficture (Clarke, 1977)

Edmond C. Clarke (1977)has developed a drill grinding fixture.The design of the particular jig provides a drill grinding fixture which is sturdy, inexpensive to produce, requiring minimal complex machining, embodying only a few simple parts, simply and rapidly operable and easily set up for each drill to be sharpened.The jig also useable with a wide range of grinders of common construction, and so arranged that operators having minimal skill can quickly and surely sharpen drills with cutting lips accurately ground to the proper shape, and, particularly, with identical cutting lips and the bit end being perfectly symmetrical.

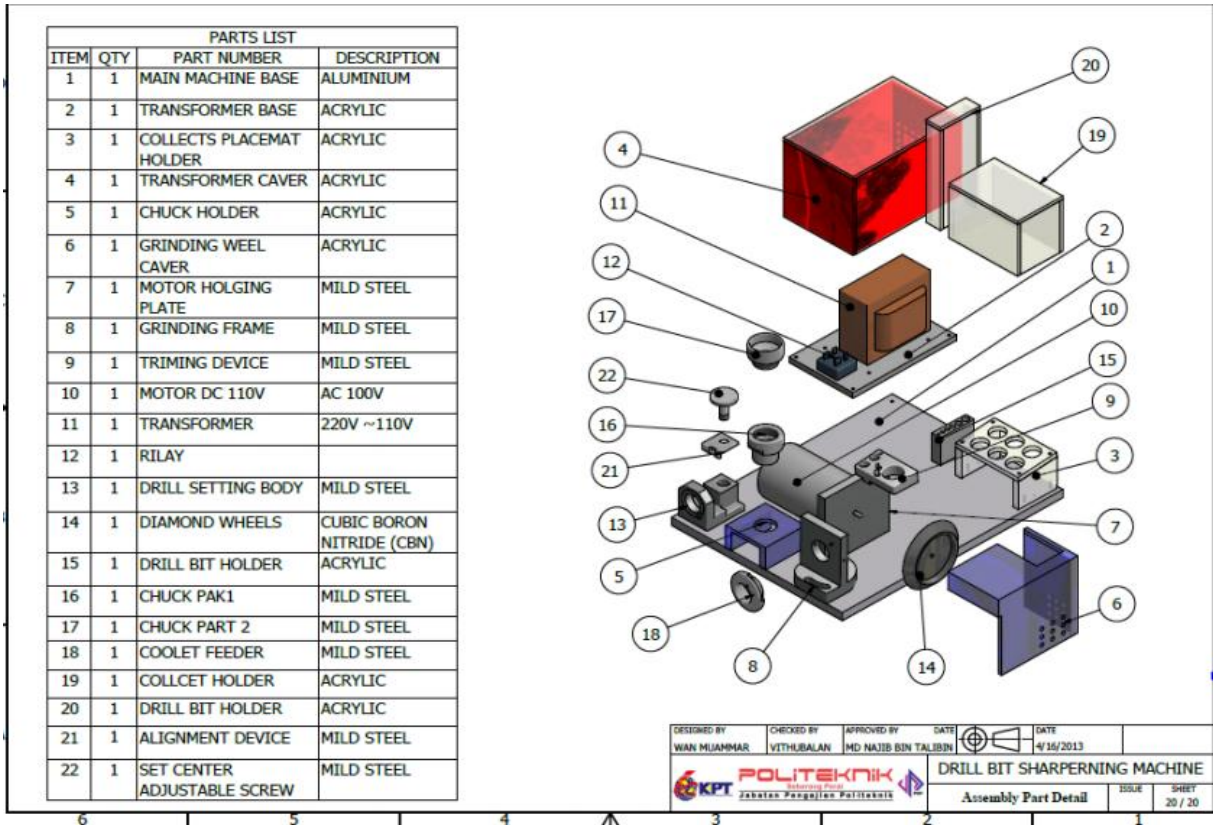


Figure 2.7.6: The Drill Bits Sharpening Device (Talibin, 2014)

Mohd Najib bin Talibin (2014) has fabricated the drill bit sharpening device.This device is a built in grinder insides it with Tormek attachment. The journal is particularly more to the best drilling angles for different material to be drilled such as normal drilling on wood (angle 118 degrees) ,high carbon steels (angle 150 degrees),alloy or stainless steel (angle 125 degrees),cast iron and aluminium (angle 90 degrees).

Julian Edgar has published an article titled Sharpening Drill Bits on Jan,2013.The article discussed about the consultation of problem, causes and solution related of the drill bits.Besides,the standard point angle also discussed which is about 118 degree with 59 degree from axis,the clearance angle about 12-15 degree.This article also stressed of sharpened drill bit should have equal cutting angles, equal length cutting edges and equal angle lip clearances (Edgar, 2013).

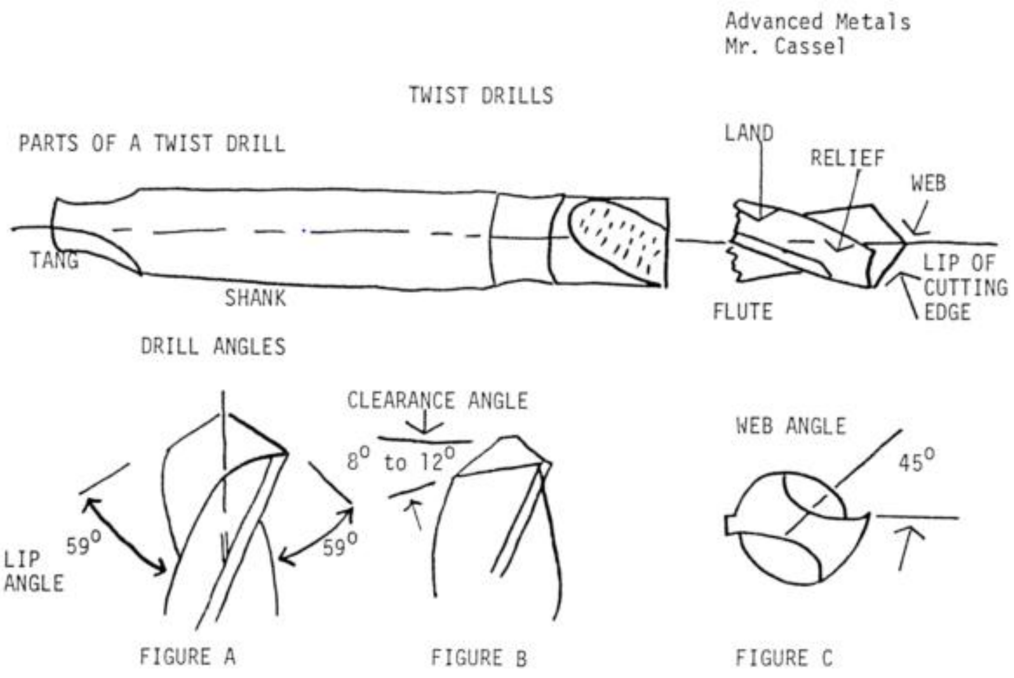


Figure 2.7.7:Figures of lip angle, clearance angle and web angle (Chasel, n.d.)

M. Chassel also has visualised the lip angle, clearance angle and the web angle in his writtings.Both angles must be considered in order to grind the drill bits.Besides mentioning about the figure, he also commends of the situation when the lip clearance angle is out of the limit that may results of broken of the drill bits (Chassel, n.d.)

PREVIOUS RESEARCH OF MATERIAL

Alan M. Bayer and Bruce A. Becherer, Teledyne Vasco has written a book which is ATSM Handbook in 1989.In volume 6:Machining,the properties of the high speed steel is discussed.Besides, the requirement for high speed tool per ATSM and further composition of the high speed steel also available in this handbook. High speed steels possess a high-alloy content, has sufficient carbon content to achieve 64 HRC in term of hardening,uniform hardness from center to the surface, and posses the carbide particle that promotes the wear resistance of hardened HSS (Bayer, Becherer, & Vasco, 1989).

Omkar Phatak has authored an article entitled Mild Steel Properties in December, 2012. The article is discussing of mild steel structure properties.The mild steel has ferromagnetic properties,an alloy of iron, consisting of 0.2% to 2.1% of carbon, as a hardening agent.The hardening agent prevents dislocations from occurring inside the iron crystals and stop the lattice layers from sliding past each other making it ductile and hard (Phatak, 2010).

Effect of Zinc on Strength and Electrical Conductivity in Phosphor Bronze C51000

Alloy	Fe	P	Sn	Zn	Cu	Electrical Conductivity %IACS	Tensile Strength Ksi (MPa)	Yield Strength Ksi (MPa)
	2.2	0.06	1.8		Bal	33	99 (682)	96 (662)
	2.2	0.06	1.8	5	Bal	29	99 (682)	94 (648)
	2.2	0.06	1.8	10	Bal	25	108 (745)	101 (696)
C51000		0.033	4.27		Bal	17	102 (703)	96 (662)
All properties were measured with the alloy in a spring temper after a 70% reduction in thickness by cold working.								

Figure2.7.5: Effect of Zinc on Strength and Electrical Conductivity in Phosphor Bronze C5100 (Greetham, 2001)

Geoff Greetham has published a newsletter entitled Phosphor Bronze: Teaching an Old Dog New Trick, Copper Applications in Metallurgy of Copper & Copper Alloys in 2001.The newsletter includes the development of the phosphor bronze.The properties of phosphor bronze typically contain up to 10% tin and up to 0.35% phosphorus, relatively high strength and high fatigue strength. This includes the findings of the benefit of adding zinc is that it helps reduce grain size in its own right since it appears to enable more of the iron to appear as fine particles.

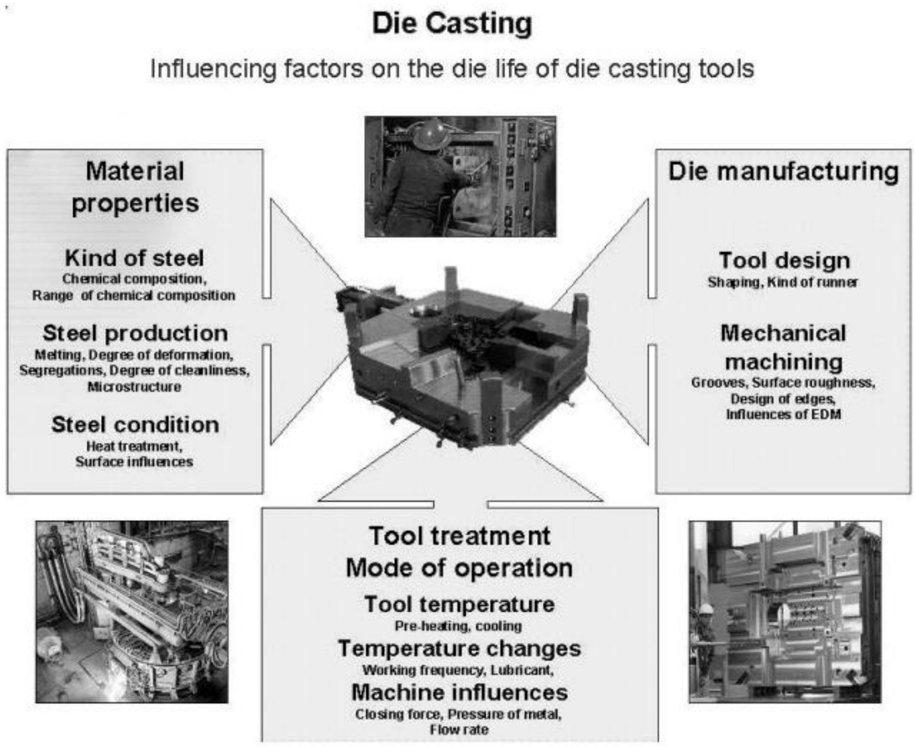


Figure2.7.6:Influencing factors on the die life of die casting tools

Source:(Fuchs, 2002)

K.D. Fuchs has authored a journal of hot work tool steels with improved properties dor die casting aplications in 2002. The study conducted involves in the to get a better die life in die casting it is necessary to look at the main reasons for damage,to reduce the heat checking effect by possess a good high-temperature strength, high-temperature toughness and thermal conductivity material.

Don Moulton is the sales manager for EDM Network, headquartered in Sugar Grove, Illinois. His experiences over the last quarter of a century include many facets of EDM including applications, management, marketing, sales, and over 15 years working directly for EDM manufactures while promoting EDM throughout the United States and Canada.His journal paper Wirecut “The Fundamentals” is discussing the process of wirecut,promoting the benefits of using the wirecuts and the application of the wirecut itself in the industries.

2.8 CONCLUSION

This chapter consist of the literature review of designing jigs and the important elements description in in the jigs.The design consideration and basic requirement of the element also provided in this chapter.Besides, this chapter is discussing of the benefits using the jigs and various sharpening drill bit jigs that being used as to ease the process.The material selection for the jigs also being stated in this literature review chapter.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will cover the details explanation of methodology that is being used to make this project complete and working well. Many resources or findings from this field mainly generated into journal for others to take advantages and improve as upcoming studies. The method is use to achieve the objective of the project that will accomplish a perfect result. In order to evaluate this project, the methodology generally follows the flow given by the supervisor.

3.2 METHODOLOGY OVERVIEW

The project begins with the particular title given from the supervisor.Both problem statement,objectives of the project, and project scopes is being discussed in the starting phase of the project. Then,the appointment with the supervisor may be arranged to discuss about the progress and guidance in order to make sure the process of the project preserved.

During the given time, the research on the project which is related to jigs will be conducted.The resources is available in the reference books, journal ,article ,patents and from the Internet. Each of the findings must be summarize to the table for the better observation. The findings will be continuous so that the project documentation can be improved as the times goes by.

After the enough resources is acquired, the design of the jigs can be set up. In this phase, Catia V5R21 software is used to sketch and draw the design.By compare and contrast the previous drill bit sharpening jig design ,the best design will be chosen.Besides, the selection of suitable material will be necessary.Analysis implementation on the materials also vital to confirm the best material for the project usage.The analysis can be done on the generative part stress analysis simulation in Catia V5R21 software.

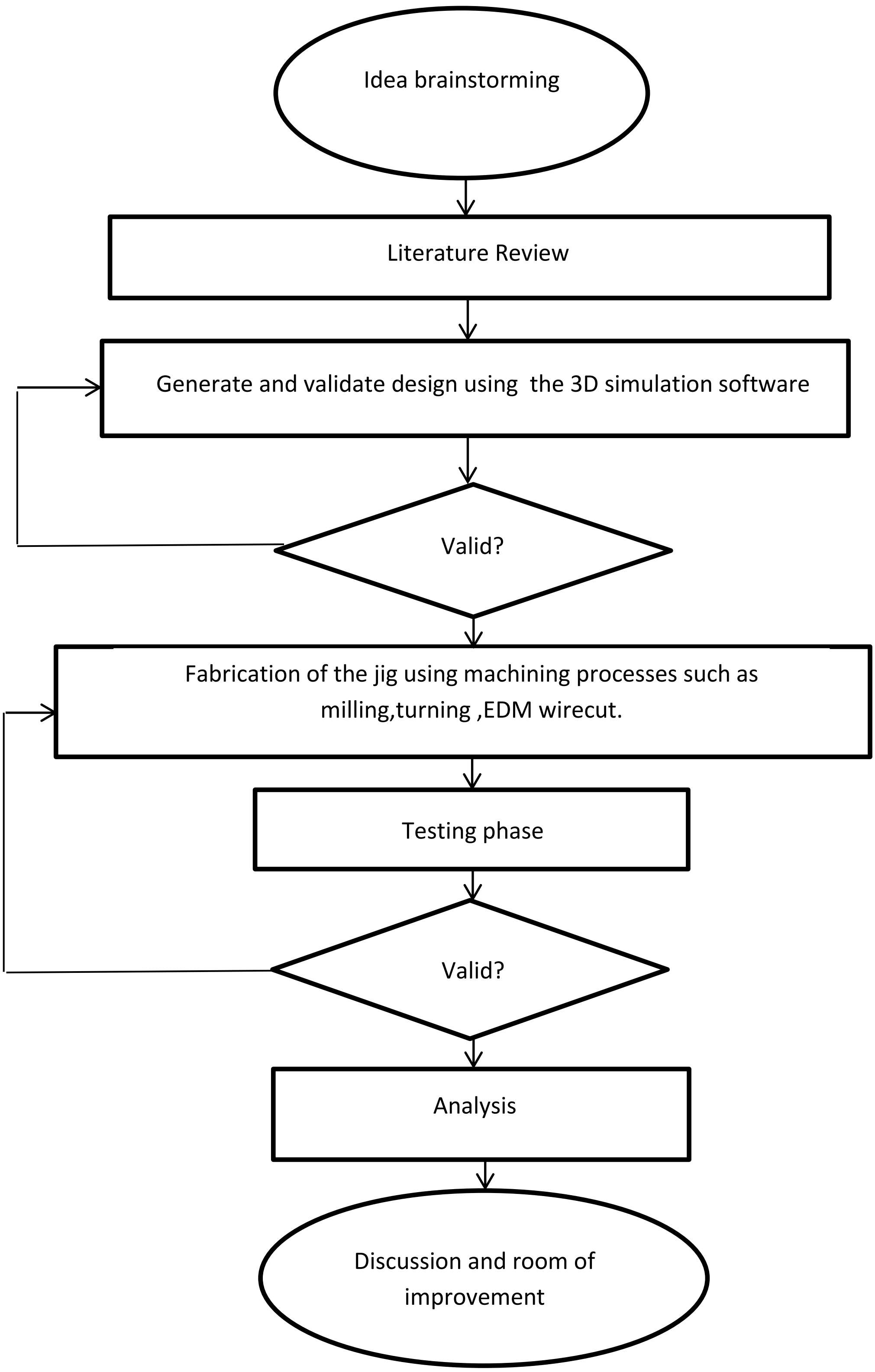


Figure 3.2.1: Flow chart for final year project progress

3.3 PRODUCT DRAWING USING CATIA SOFTWARE

The design of the jigs will be drawn in the three dimensional orientation using Catia V5R21 software.Each of the part dimension must be determined before the components are drawn.Both components wil be sketched and drawn different part design and will be assembled together at the end of the drawing phases (Dassault, 1994).

3.4 ANALYSIS USING CATIA-GENERATIVE PART STRUCTURAL ANALYSIS

The guide book:- CATIA - Generative Part Structural Analysis and Generative Assembly Structural Analysis Version 5 Release 3 has allows the users to quickly perform first order mechanical analysis for 3D parts.After selecting the .CatPart files,the design will be applied with the suitable material.The part design will be loaded in the Stress Analysis workbench.After that, follows the steps to create the restraints and force.Slider connection is necessary due to the interconnection between the parts in the jig.

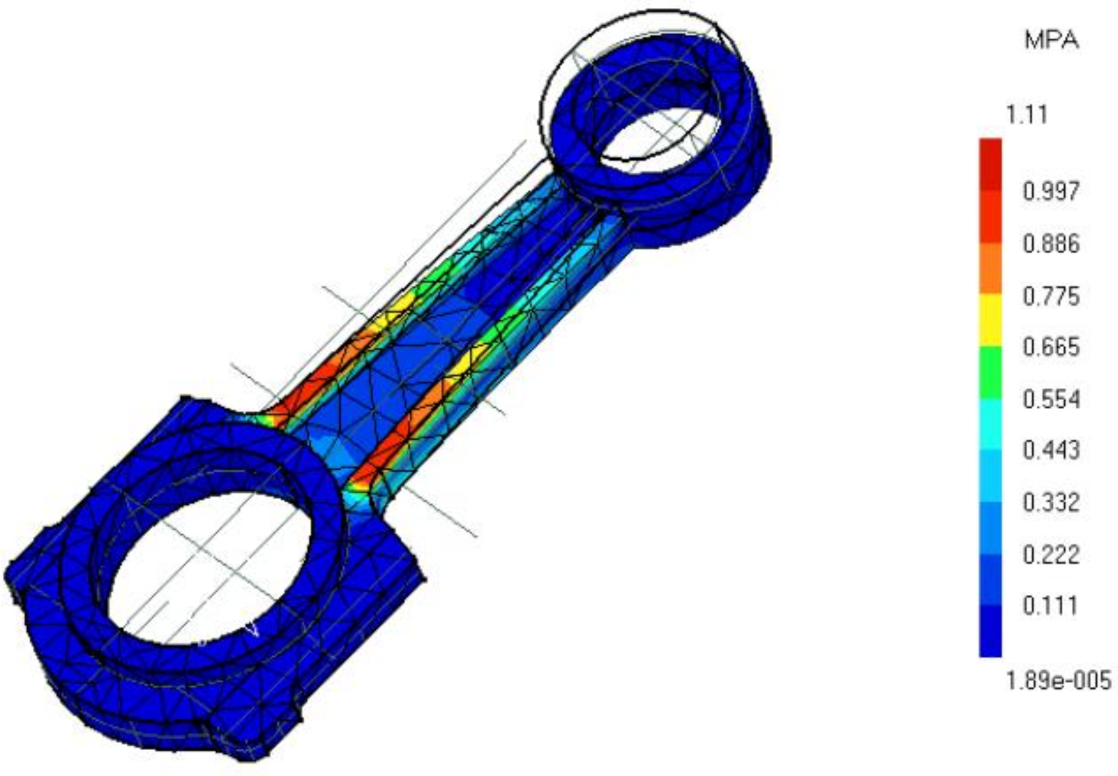


Figure 3.4.1:The Von Mises stress distribution in ISO value

Source:(Dassault, 1994)

3.6 PROCESSES

Milling process

The machining processes of cutting away material by feeding a workpiece past a rotating multiple tooth cutter. The cutting action of the many teeth around the milling cutter provides a fast method of machining. The machined surface may be flat,angular, or curved. The surface may also be milled to any combination of shapes. The machine for holding the workpiece, rotating the cutter, and feeding it is known as the milling machine.The milling process will hugely contribute in the development of the jig fabrication

Figure 3.6.1:Milling machine Makino KE55

Lathe process

The lathe or turning process is the material removal process by rotating the part as to remove the unwanted material. Turning is used to produce rotational, typically axi-symmetric, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners.

Figure 3.6.2:Lathe machine Romi C420

EDM wirecut

The EDM wirecut stands for electrical discharge machining wirecut which is using the wire as the subtitute of the tool which is used by the milling or the turning process.The wire with electric discharge sparks range of 1/1,000,000 seeconds or less.The wirecut process left no burr afterward the cutting process.Every discharge spark may erode tiny material that melted into vapour in the dielectric water.The clamping force is minimal thus prevent the damage on the surface otf the workpiece (Moulton, 1999).

Figure 3.6.3: Example of wirecut process

Source:(Custompart.net, 2000)

3.5 CONCLUSION

In this methodology chapter, the project process and flowchart is discussed from the beginning phase to the end of the project.Besides, the design using Catia V5R21 software are evaluated. The best design and material selection also being evaluated in this phase.The analysis is conducted using the built-in function in Catia V5R21 software which is Generative Part structural analysis.The machining processes also being discussed in this chapter which is milling process, turning process and EDM wirecut process.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter describes several main section and organized from the previous section.This chapter also will be divided into three parts which is design phase,fabricate phase and analysis phase The detailed design has been generated and the analysis also has been done due to the design validation phase.The selection of the final design is due to the manufacturability,complexity cost and time.

The new design has a feature to control the outcome of 59 degree of point angle form every twist drill bits to be resharpen. Rather than the previous design , the new design also has reduce the cost of material, standard part usage , machining processes, weight and time to manufacture.

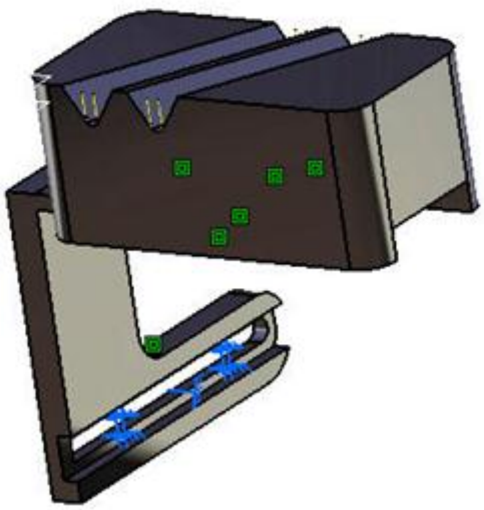


Figure 4.1:Design generated in CATIA software

4.2 DESIGNING PHASE

There are total of 4 designs that has been sketched and drawn on CATIA V5R21, which is 3 preliminary design and 1 cobined design.The selection of the design is determined by using the concept selection method (Ulrich K.T and Eppinger S.D,2005).The concept screening and scoring is important to select the best design to be develop

4.2.1 CONCEPT SCREENING

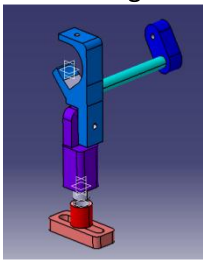
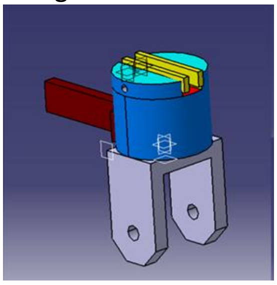
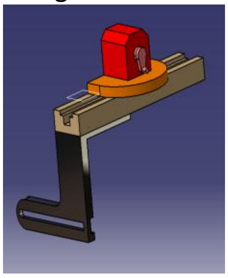
	Concept		
Selection Criteria	Design A 	Design B 	Design C 
Lightweight	+	-	0
Inventory Issue	+	0	+
Comfortable	-	+	+
Flexible	+	+	+
Ease at use	0	+	+
Complexity	-	0	-
Sum +'s	3	3	4
Sum 0's	1	2	1
Sum –'s	2	1	1
Net score	1	2	3
Rank	3	2	1
Continue	No	Yes	Yes

Table 4.2.1: Concept Screening of Drill Bit Sharpening Jig

From the activity concept screening, we can know the concept and design that can be generate from many ideas. For my design,the sharpening drill bit jig have 3 concepts but the acceptable concept after interviewer people only 2 concepts. We can know the relevant and acceptable concept with total net score and ranking it with number. Finally the concept that will continue the design is concept B and C. For combine is related to design concept B and C. For the design that must be combined we must create a new design for it for example concept BC. Then, we continued with concept scoring.

4.2.2 CONCEPT SCORING

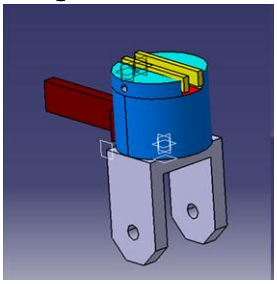
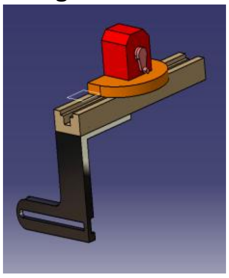
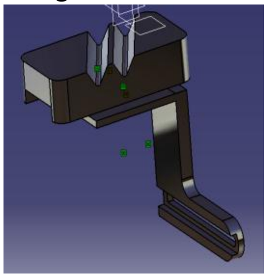
		Concept					
		Design B 		Design C 		Design BC Combine 	
Selection Criteria	Weight	Rating	Weight	Rating	Weight	Rating	Weight
Lightweight	20%	4	0.8	5	1	6	1.2
Inventory Issue	20%	4	0.8	4	0.8	6	1.2
Comfortable	10%	4	0.4	5	0.5	7	0.7
Flexible	10%	6	0.6	6	0.6	5	0.5
Ease at use	20%	7	1.4	7	1.4	7	1.4
Complexity	20%	3	0.6	4	0.8	6	1.2
Total Score	100%	4.6		5.1		6.2	
Rank		3		2		1	
Continue		No		No		Develop	

Table 4.2.2: Concept Scoring of Drill Bit Sharpening Jig

To rank the concept, the weighted scores is multiplied with the raw scores by the critical weight.The total scores for each design concept is the sum of the weighted scores

$$S_j = \sum r_y w_i$$

where

r_y =raw rating of concept *j* for the *i*th criterioncriterion

w_i =weighting for *i*th criterion

S_j =total score for concept *j*

The concept scoring is very important that we must develop final part that suitable and acceptable for people. The concept scoring will focus on the difference relative to concept screening. From the last concept, I have 3 concept that, B,C and BC. This is from the combination and improvement of the concept and from this part, we will calculate the total score of weighted score, ranking the concept and the highest score will rank no.1 and follow the others. Finally, the higher total score will be developed and for my drill bit sharpening jig, I agree that concept BC will be likely to result in a successful product.

4.2.3 FINITE ELEMENT ANALYSIS (FEA)

The Fininte Element Analysis (FEA) is applied to validate the jig virtually.FEA functions as to determine the possible part to be break, wear out due to the physical response such as heat , vibration , or stress.The jig design is analysed using the Generative Stress Analysis in Catia software.The distributive force on the surface of the jig is defined by the maximum stress applied on the weight balance. The obtained results is the maximum possible stress is 25N.The simulation is being done and shows that the jig is safe for normal working purpose since the jig will start to fail when the applied force is at 46N and above.

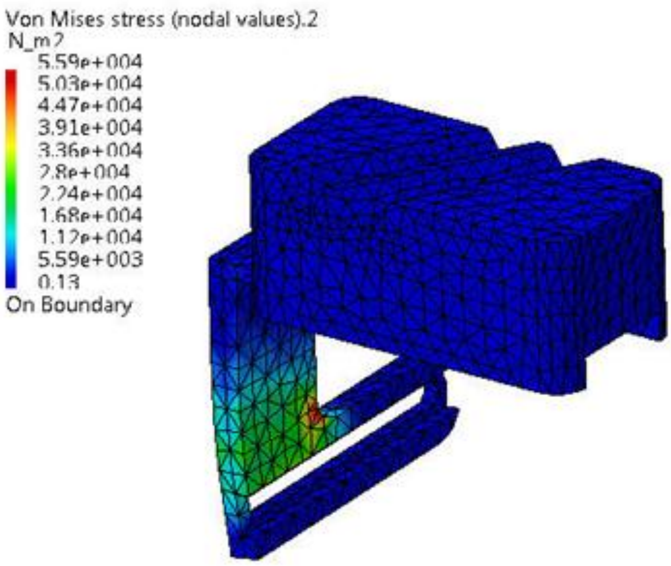


Figure 4.2.3: The Finite Element Analysis (FEA) in CATIA Generative Stress Analysis

4.3 FABRICATION PHASE

The jig has been fabricated using CNC milling machine (model Makino KE55).The time elapsed for machining process is 18.58 hour. The machining processes consider to has a spindle speed of 2700 rpm , feed rate 0.1mm/min , depth of cut 0.05 and using the 4 mm end mill to produce the slot profile on the jig body. The lower part is also removed by using milling machine rather than the EDM wirecut as the alternative method.In addition there are two 6.8mm hole drilled on each sides.Then the internal hole is being threaded using the tap drill size M8 x 1.25 to fit an adjust bolt through it.

Figure 4.3.1: Milling process using Makino KE55 milling machine

The adjust bolt is made using the CNC turning machine.The processes involve bushing ,knurling ,drilling and threading. The external thread is same size as the tap drill size for jig body internal hole, which is M8 x 1.25.

Figure 4.3.2: Manual tapping for the adjust bolt fitting thread

The jig has been tested due to several testing in the physical validation. The test considers several considerations which is :-

1. The jig able to be mounted on the bench grinder
2. The adjust bolt fits the internal hole o the jig body
3. The clamping force of the adjust bolt is sufficient
4. The resharpening process of twist drill bits must produce the point angle of 59/118 degrees

From the test phase,the jig is mounted to the bench grinder hand rest and it fits the bench grinder.The adjust bolt is also fits in the threaded hole.The clamping force is sufficient since the jig does not vibrate during the attachment.

Figure 4.3.3:The jig setup on bench grinder

The resharpening process has the outcomes of 59 degree of twist drill bits point angle.This validationcan be done by two method ;using the protractor or simply refer to the edge of the slot. Besides, the shape of the drill bit after being sharpened is observed

Figure 4.3.4:Drill bit surface (Before resharpening)

Figure 4.3.5:Drill bit surface (After resharpening)

Figure 4.3.6:The continuous chips formed

After that, the resharpen twist drill bits is tested on a workpiece to ensure that it possible to do the drilling process.During the drilling process,the uniform and continuous chipping can be observed and the no squeaking sound produced.

Figure 4.3.7:Drilling holes on the aluminium block

The testing phase is successful and continued to the analyze phase.The 8mm,10mm and 12mm hole diameter has been drilled using the resharpen and new drill bits;total 6 holesThe workpiece is cut down using the vertical bandsaw to ensure the stylus of surface roughness machine can touch the surface of the hole,Furthernore, the surface roughness analysis is taken 3 times for both holes and the average reading is calculated.

Figure 4.3.8: Surface Roughness Analysis

4.4 ANALYSIS PHASE

Hole diameter (mm)	Minimum Surface roughness (µm)	
	New	Resharpen
8mm	0.709	0.827
	0.802	0.713
	0.857	1.035
10mm	0.686	0.781
	0.824	0.703
	0.970	0.936
12mm	0.477	0.443
	0.669	0.560
	0.446	0.477

Table 4.4.1:Data from the surface roughness analysis

Hole diameter (mm)	Average Minimum Surface roughness (µm)	
8mm	0.789	0.858
10mm	0.827	0.807
12mm	0.531	0.493

Table 4.4.2: Average Minimum Surface roughness (µm) for both holes on the workpiece

Hole diameter(mm)	Difference(µm)
8mm	0.08
10mm	0.03
12mm	0.07

Table 4.4.3:The difference of surface roughness(µm)

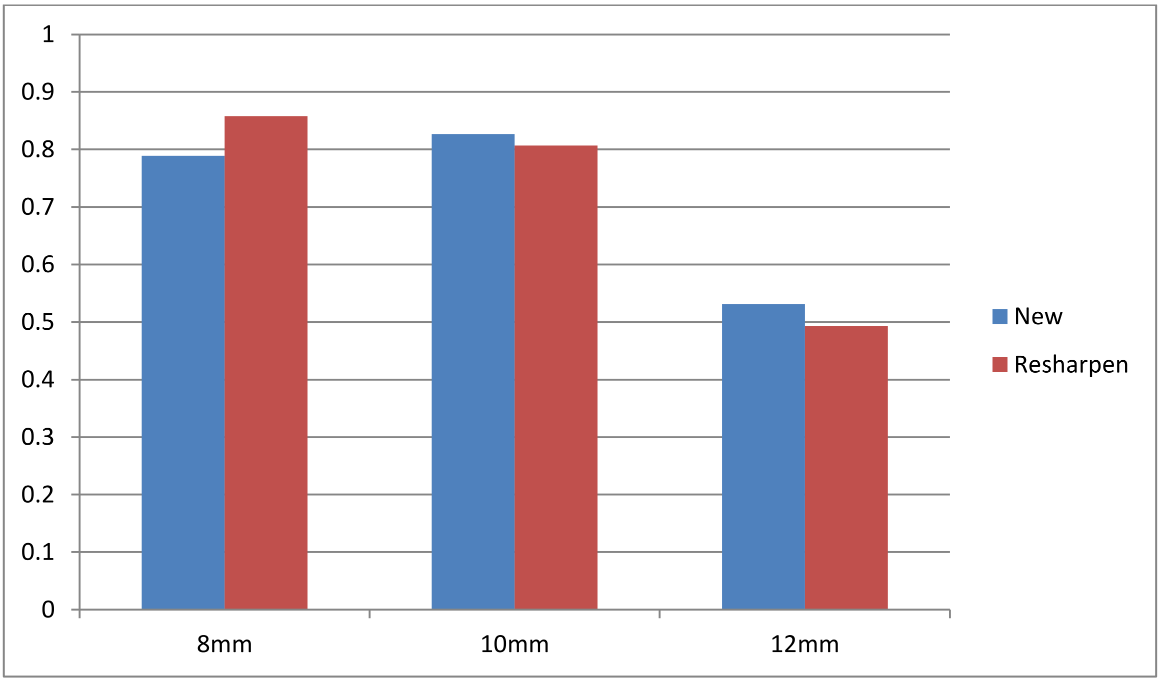


Figure 4.4.1:Graph of the differences of the hole surface roughness

The surface roughness differences has been made and the the differences is particularly small and insignificant.Thus , the drill bits is considered to produce the drilling performance approximately similar to the new one.

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

As the conclusion, the best design has been choosed due to the durability, the low cost production and the material selection, The fabrication processes includes the processes such as milling,turning,drilling, and tapping. The jigs can performed same processes like the sharpening drill bits machines but with a lower cost,lighter,smaller in size and low maintenance.Besides , by using this jig , we can maximize the usage of the bench grinder rather than considering to buy a new sharpening drill bits machine which is more expensive.The product will be affordable for the users as well.

The Finite Element Analysis (FEA) shows that the jigs starts having a failure upon distributive force of 46N and above. The maximum distributive force that may be applied on the jig surface is 25N which is still normal for the working purpose.

The surface roughness analysis for the holes specimen shows minor difference between using the new drill bits and the resharpen drill bits.From the results of the experiment, the difference of the surface roughness analysis range from 0.02µm to 0.08µm.Since the differences is small and insignificant, the outcomes of drilling using the reshapen drill bits is approximately same to the new one.

In conclusion, the project outcome has achieved the project objectives which were the design and fabricate the drill bit sharpening jig and to compare the surface roughness holes of the drilling processes using the new drill bits and resharpen drill bits.

5.2 RECOMMENDATION

As the recommendation, there are several things that can be implermented to optimize the result and as to extend the scope of the experiment.:-

I. In order to optimize the manufacturability of the jig, the 59 degree slot section can be replace by using the aluminium sheet as the alternatives. The aluminium sheet can be shaped as the 59 degree slot profile using the press machines.

II. Instead of the surface roughness analysis of the hole produced using, the another analysis also can take place such as the length of the continuous chips produced

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APPENDIXES

APPENDIX A1

Generative Structural Stress Analysis

Analysis Von Mises

MESH:

Entity	Size
Nodes	2378
Elements	8785

ELEMENT TYPE:

Connectivity	Statistics
SPIDER	4 (0.05%)
TE4	8779 (99.93%)
NSBAR	2 (0.02%)

ELEMENT QUALITY:

Criterion	Good	Poor	Bad	Worst	Average
Stretch	8779 (100.00%)	0 (0.00%)	0 (0.00%)	0.331	0.641
Aspect Ratio	8382 (95.48%)	397 (4.52%)	0 (0.00%)	3.857	1.843

Materials.1

Material	Aluminium
Young's modulus	7e+010N_m2
Poisson's ratio	0.346
Density	2710kg_m3
Coefficient of thermal expansion	2.36e-005_Kdeg
Yield strength	9.5e+007N_m2

Static Case

Boundary Conditions

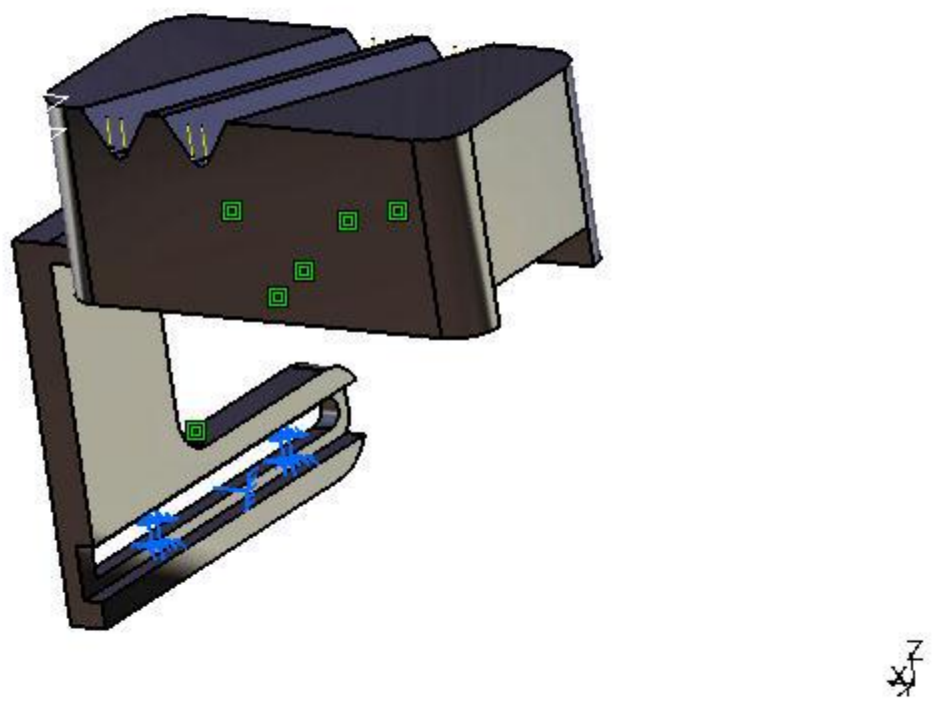


Figure 1

STRUCTURE Computation

Number of nodes : 2378

Number of elements : 8785

Number of D.O.F. : 7146

Number of Contact relations : 0

Number of Kinematic relations : 900

Number of coefficients : 3376

Linear tetrahedron : 8779

Translation rigid spider : 4

Rigid spider : 2

RESTRAINT Computation

Name: Restraints.1

Number of S.P.C : 309

LOAD Computation

Name: Loads.1

Applied load resultant :

Fx = 0 . 000e+000 N

Fy = 0 . 000e+000 N

Fz = -1 . 067e+000 N

Mx = -4 . 064e-002 Nxm

My = -8 . 415e-002 Nxm

Mz = 0 . 000e+000 Nxm

STIFFNESS Computation

Number of lines : 7146

Number of coefficients : 128430

Number of blocks : 1

Maximum number of coefficients per bloc : 128430

Total matrix size : 1 . 50 Mb

SINGULARITY Computation

Restraint: Restraints.1

Number of local singularities : 0

Number of singularities in translation : 0

Number of singularities in rotation : 0

Generated constraint type : MPC

CONSTRAINT Computation

Restraint: Restraints.1

Number of constraints : 1209

Number of coefficients : 0

Number of factorized constraints : 1130

Number of coefficients : 2515

Number of deferred constraints : 0

FACTORIZED Computation

Method : SPARSE

Number of factorized degrees : 6016

Number of supernodes : 840

Number of overhead indices : 40478

Number of coefficients : 734799

Maximum front width : 559

Maximum front size : 156520

Size of the factorized matrix (Mb) : 5 . 60607

Number of blocks : 1

Number of Mflops for factorization : 2 . 055e+002

Number of Mflops for solve : 2 . 969e+000

Minimum relative pivot : 8 . 033e-005

Minimum and maximum pivot

Value	Dof	Node	x (in)	y (in)	z (in)
1.1571e+008	Ty	886	-4.1997e+000	2.5498e+000	3.6144e+000
3.9699e+009	Tx	357	-5.6776e+000	0.0000e+000	2.6443e+000
3.5771e+004	Ry	2377	-2.6140e+000	1.4768e+000	2.3533e+000
3.5942e+006	Rx	2376	-2.0281e+000	5.0000e-001	1.7430e+000

Minimum pivot

Value	Dof	Node	x (in)	y (in)	z (in)
1.1669e+008	Ty	1342	-3.0552e+000	7.5023e-001	3.4691e+000
1.1786e+008	Ty	782	-6.4153e+000	1.5722e+000	3.7987e+000
1.2085e+008	Tz	1521	-1.5298e+000	3.5968e-001	2.7201e+000

1.2585e+008	Tz	1342	-3.0552e+000	7.5023e-001	3.4691e+000
1.4266e+008	Tz	1346	-3.4323e+000	5.2057e-001	3.6837e+000
1.4871e+008	Ty	2377	-2.6140e+000	1.4768e+000	2.3533e+000
1.5977e+008	Tz	212	-2.2875e+000	1.7219e+000	3.8038e+000
1.7304e+008	Ty	2374	2.9357e-001	1.7598e+000	1.7408e+000
1.7306e+008	Tx	2374	2.9357e-001	1.7598e+000	1.7408e+000

Value	Dof	Node	x (in)	y (in)	z (in)
4.7859e+004	Rz	2377	-2.6140e+000	1.4768e+000	2.3533e+000
2.7260e+005	Rx	2377	-2.6140e+000	1.4768e+000	2.3533e+000
3.5942e+006	Rx	2376	-2.0281e+000	5.0000e-001	1.7430e+000

Translational pivot distribution

Value	Percentage
10.E8 --> 10.E9	4.5476e+001
10.E9 --> 10.E10	5.4524e+001

Rotational pivot distribution

Value	Percentage

10.E4 --> 10.E5	5.0000e+001
10.E5 --> 10.E6	2.5000e+001
10.E6 --> 10.E7	2.5000e+001

DIRECT METHOD Computation

Name: Static Case Solution.1

Restraint: Restraints.1

Load: Loads.1

Strain Energy : 1.202e-007 J

Equilibrium

Components	Applied Forces	Reactions	Residual	Relative Magnitude Error
Fx (N)	0.0000e+000	-4.6573e-012	-4.6573e-012	1.7846e-012
Fy (N)	0.0000e+000	2.8864e-012	2.8864e-012	1.1060e-012
Fz (N)	-1.0668e+000	1.0668e+000	-2.7105e-012	1.0386e-012
Mx (Nxm)	-4.0644e-002	4.0644e-002	-4.0465e-013	9.5154e-013
My (Nxm)	-8.4147e-002	8.4147e-002	-5.7908e-013	1.3617e-012
Mz (Nxm)	0.0000e+000	-1.3867e-014	-1.3867e-014	3.2608e-014

Static Case Solution.1 - Deformed mesh.2

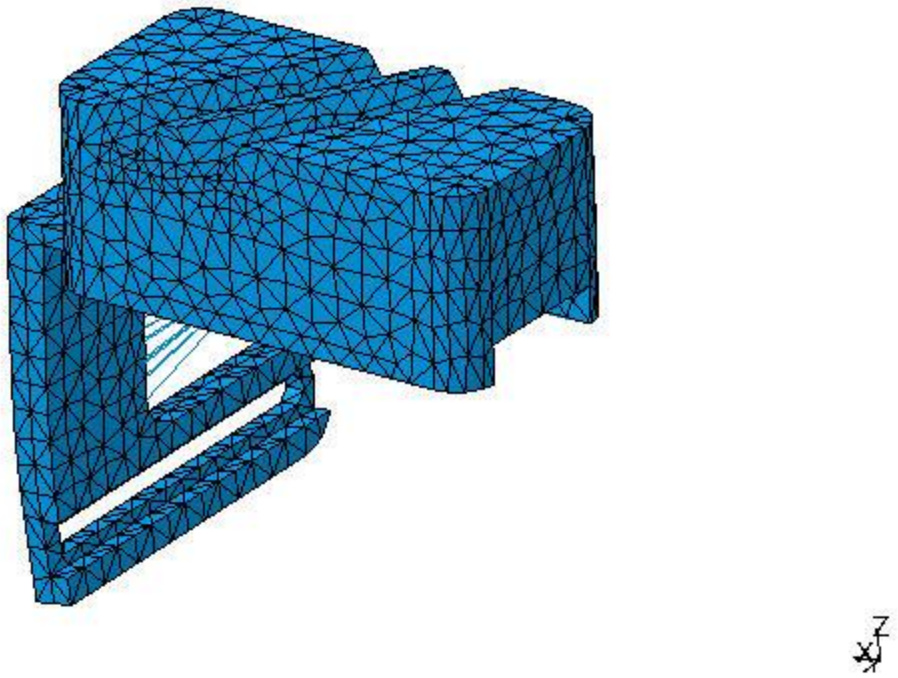


Figure 2

On deformed mesh ---- On boundary ---- Over all the model

Static Case Solution.1 - Von Mises stress (nodal values).2

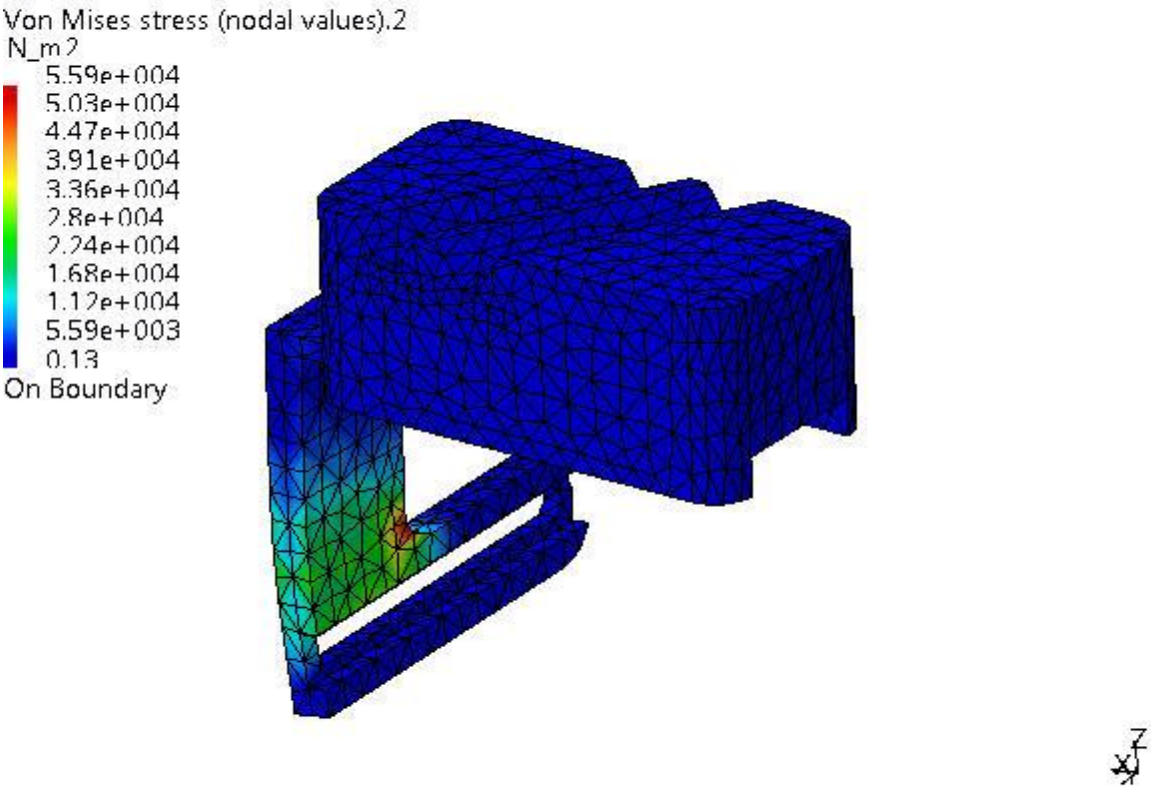


Figure 3

1D elements: : Components: : All

3D elements: : Components: : All

On deformed mesh ---- On boundary ---- Over all the model

Static Case Solution.1 - Von Mises stress (nodal values).1

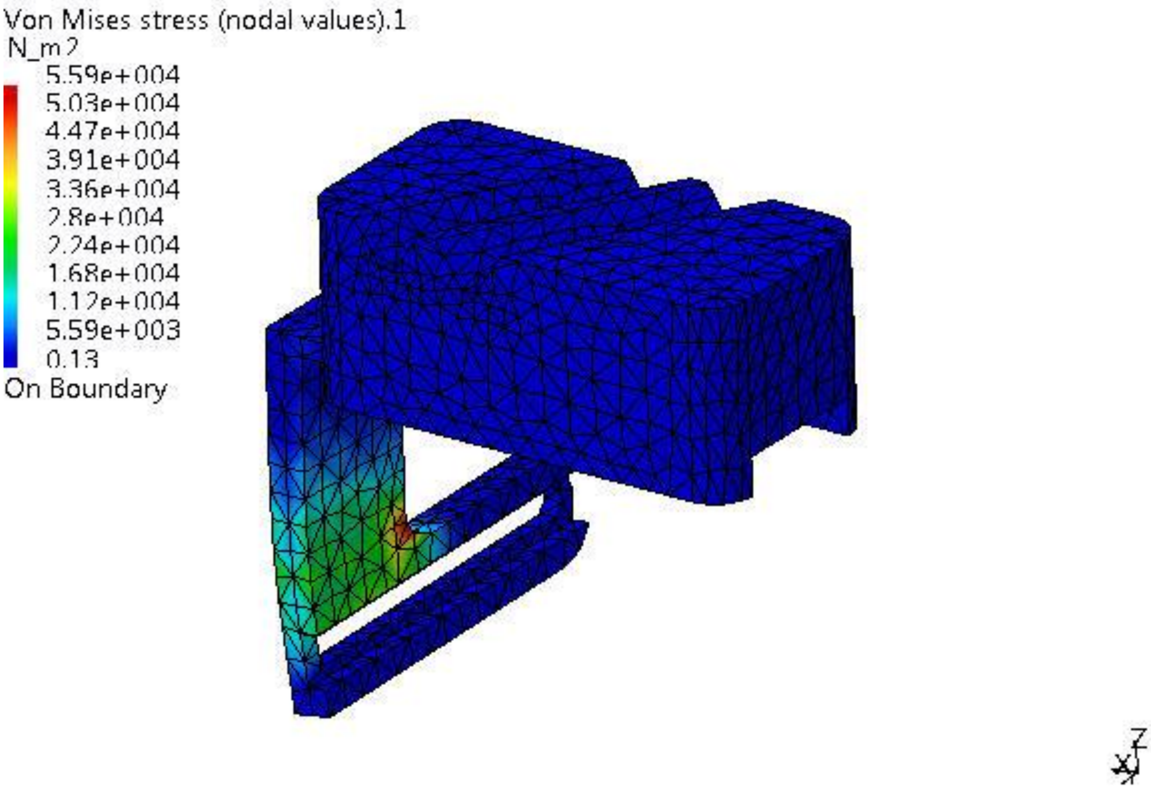


Figure 4

1D elements: : Components: : All

3D elements: : Components: : All

On deformed mesh ---- On boundary ---- Over all the model

Static Case Solution.1 - Deformed mesh.1

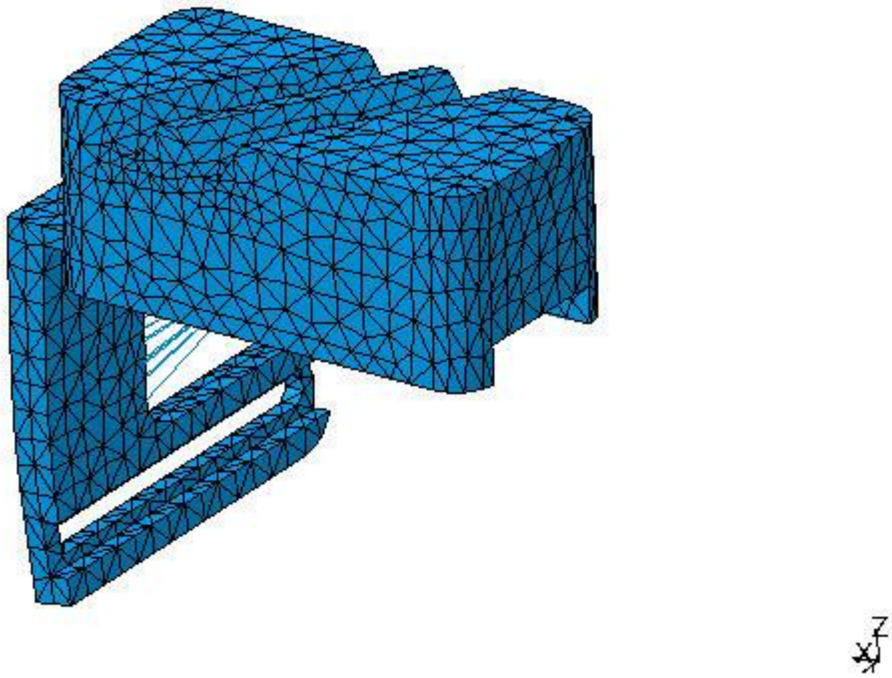


Figure 5

On deformed mesh ---- On boundary ---- Over all the model

Static Case Solution.1 - Translational displacement vector.1

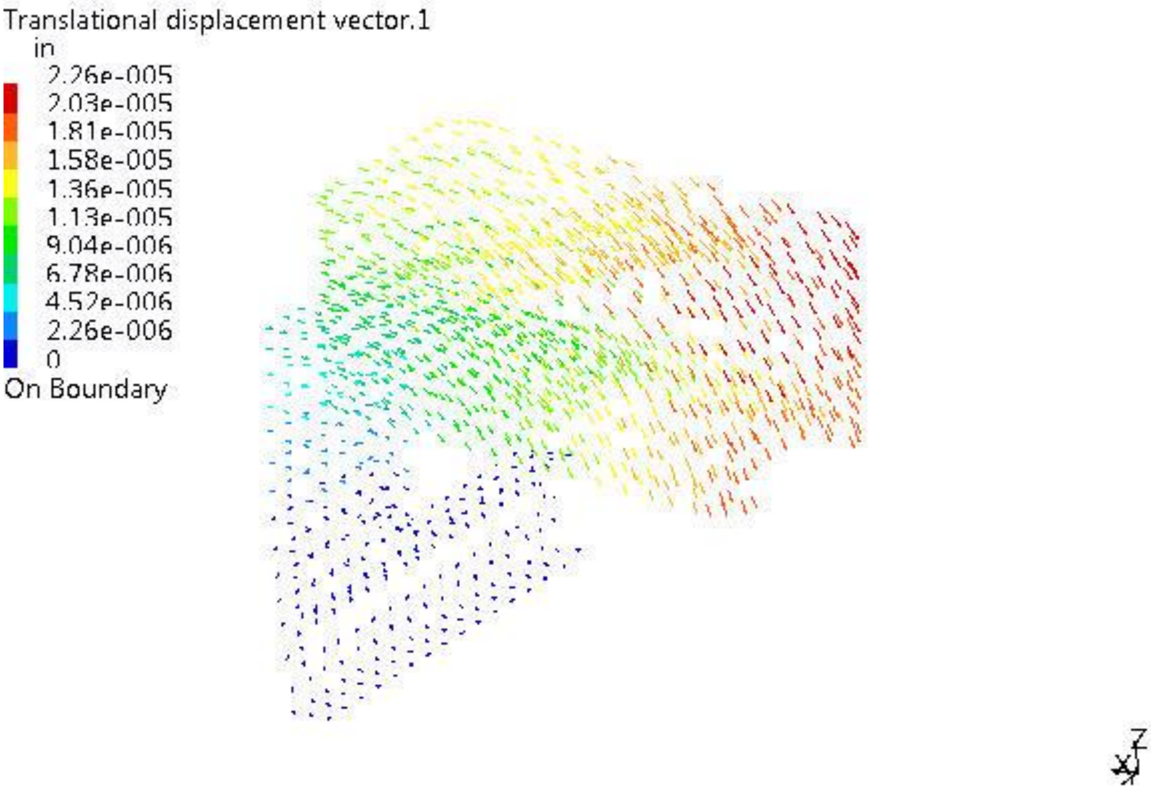


Figure 6

1D elements: : Components: : All

3D elements: : Components: : All

On deformed mesh ---- On boundary ---- Over all the model

Static Case Solution.1 - Stress principal tensor symbol.1

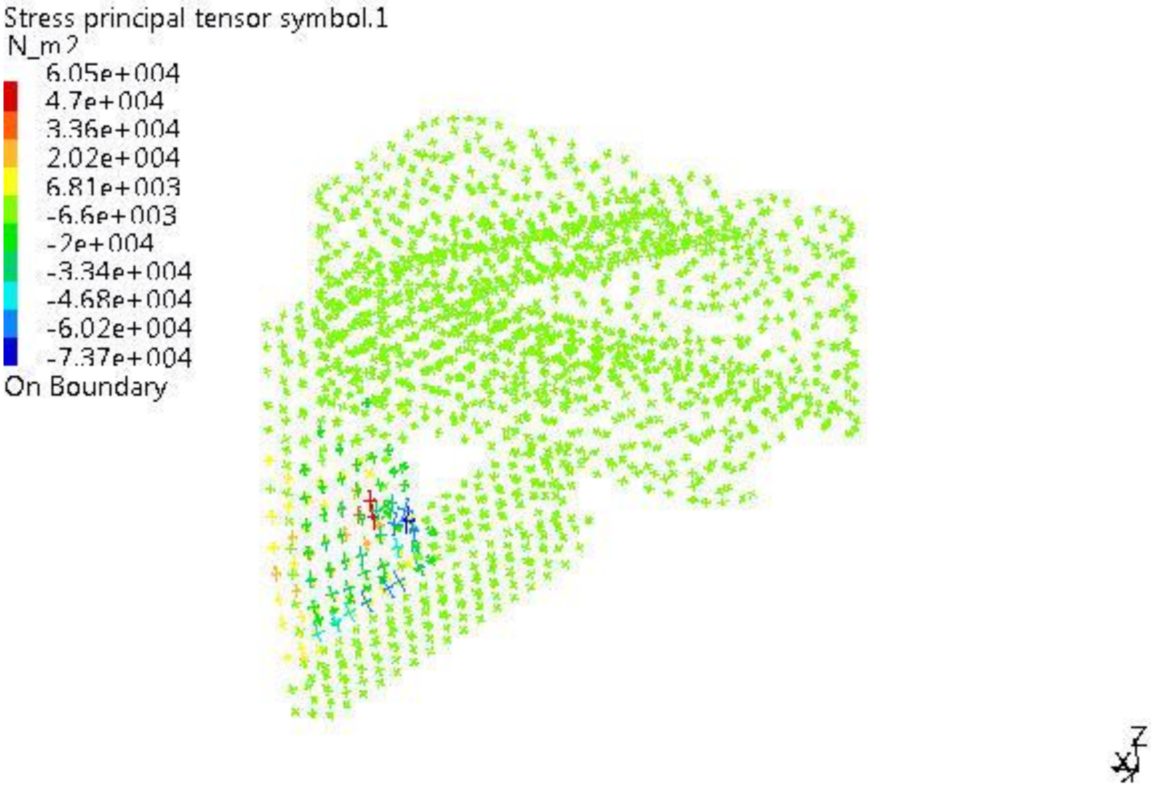


Figure 7

1D elements: : Components: : All

3D elements: : Components: : All

On deformed mesh ---- On boundary ---- Over all the model

Static Case Solution.1 - Estimated local error.1

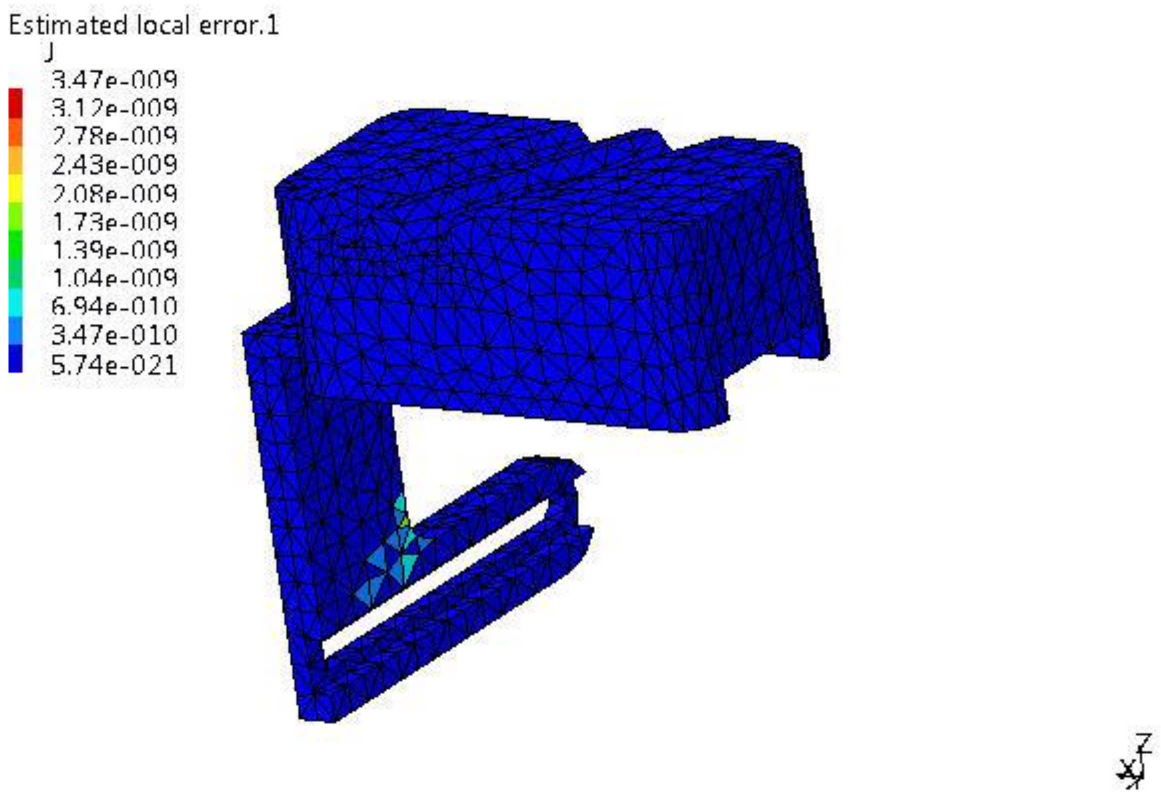


Figure 8

1D elements: : Components: : All

3D elements: : Components: : All

On all Elements ---- Over all the model

Global Sensors

Sensor Name	Sensor Value
Energy	1.202e-007J
Global Error Rate (%)	55.011753082

APPENDIX B1

Final Year Project 1 Gantt Chart

	Week1-3		Week4-6		Week 7		Week8		Week9-13		Week 14	
	P	A	P	A	P	A	P	A	P	A	P	A
Understanding the title	**W2**	**W2- W3**										
Literature Survey			**W6**	W5- W6								
Research of jig designs					**W7**	**W7**						
Research in methodology							**W8**	**W8**				
Budget Planning									**W9**	**W9 – W10**		
Final Presentation											**W11**	**W11**

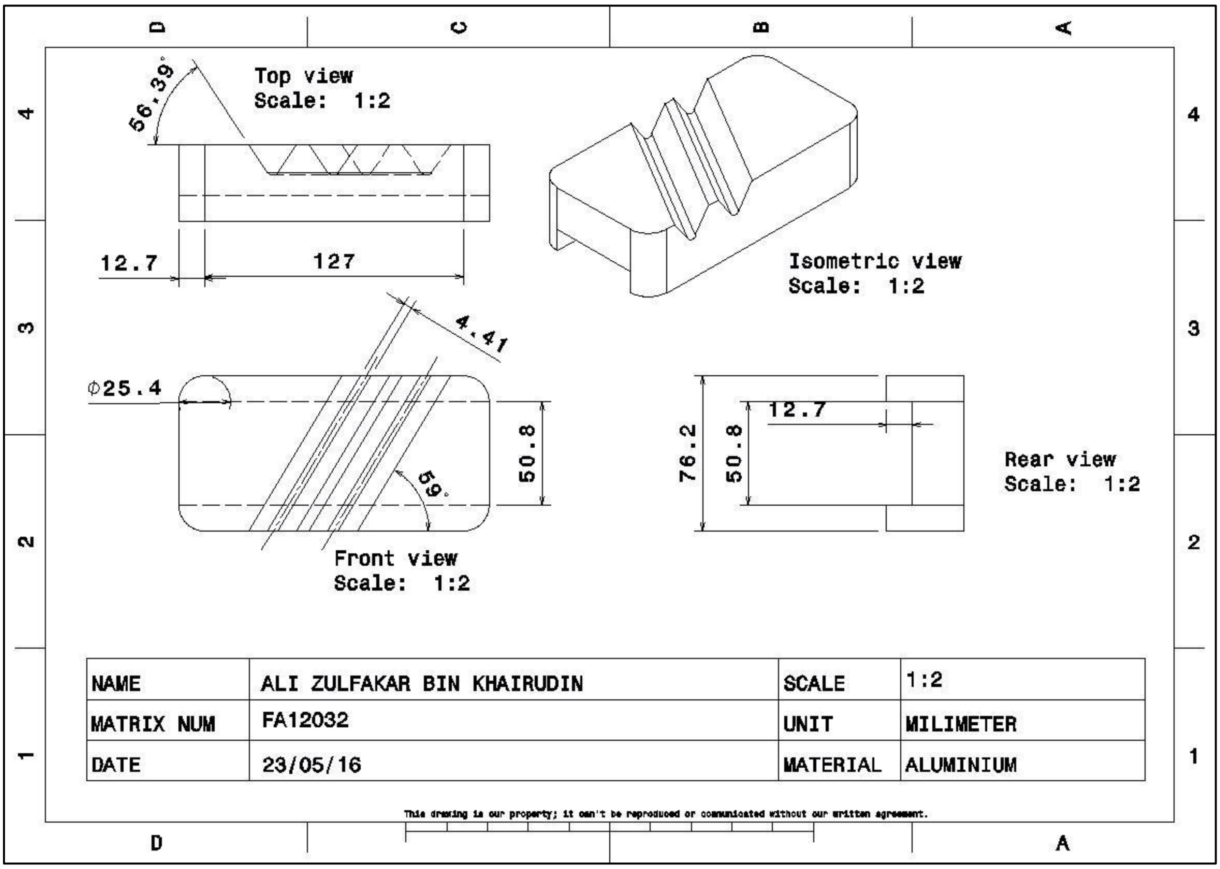
APPENDIX B2

Final Year Project 2 Gantt Chart

	Week1-3		Week4-6		Week 7		Week8		Week9-13		Week 14	
	P	A	P	A	P	A	P	A	P	A	P	A
Item arrival	**W2**	**W2**										
Simulation in CATIA			**W4**	**W4**								
Fabrication progress 1					**W7**	**W7**						
Fabrication Progress 2							**W8**	**W8**				
Testing									**W9**	**W9**		
Final Presentation									**W13**	**W13**		
Documentation									**W13**	**W13**	**W14**	**W14**

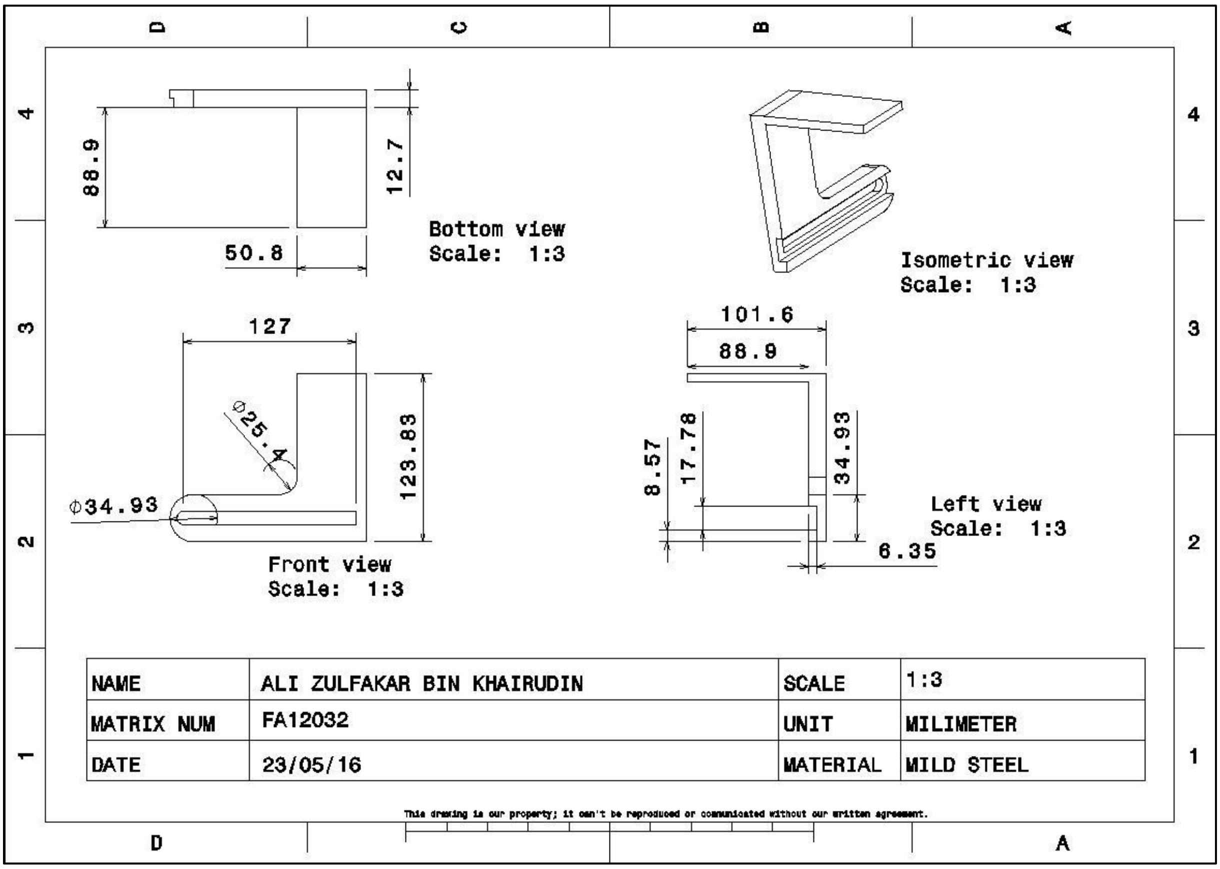
APPENDIX C1

Drafting for Jig Body



APPENDIX C2

Drafting for Bottom Clamp



APPENDIX D1

Bill of Material

No	Material	Dimension (cm)	Total	Approximate Price
1	Aluminium block	Rectangular Block (7 x 7 x5)	1	RM15
2	Standard part	-		RM 10
3	Miscellaneous (Drill Bits)	-	-	RM40
Total				RM75