

DESIGN AND FABRICATION OF BALL FEEDER MECHANISM AND BODY
FOR TENNIS BALL MACHINE

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“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive)”

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This technical report is submitted in accordance with the requirements of the
Bachelor of Mechanical Engineering (Automotive)

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DECLARATION

“I hereby declare that the work in this report is my own except for the summaries and quotations which have been duly acknowledge.”

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Author:

Date:

DEDICATION

I want to dedicate this report to my lovely parent,
My lecture, supervisor and friends.

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ABSTRACT

Tennis is the one of the popular sport in the world. In Malaysia, this sport become more popular and grows up rapidly. The lack number of coach cause the people not have a chance to learn and play tennis with the right technique. Apart from using the service of coach, a person can learn and play tennis using tennis ball machine. The problem is the tennis ball machines in the market are selling at high price. To overcome this problem, new tennis ball machine is needed to develop and the cost is lower. In the tennis ball machine, they have ball feeder mechanism. Feeder mechanism is the process that transfer the ball from the ball storage to launcher at one time interval. The project is needed to design and fabricate the ball feeder mechanism and body for tennis ball machine. Beside the ball feeder mechanism and body design, the project is contributed to develop complete tennis ball machine. The specification is determined and the component use like roller, motor, angle bar, plastic or recycle material and power supply like battery. The concept design had been develop from the other design concept. The mathematical analysis of the design mechanism will be carried out. Fabrication is carried out to develop the mechanism and tennis ball machine. Tennis ball machine will do the testing to test the functionality of the mechanism tennis ball machine. The ball feeder mechanism and body for tennis ball machine and also overall tennis ball machine is completely develop.

ABSTRAK

Tenis merupakan salah satu sukan yang popular di dunia. Di Malaysia, sukan ini semakin menjadi popular dan berkembang dengan cepat. Kekurangan bilangan jurulatih menyebabkan orang ramai tidak berpeluang untuk mempelajari dan bermain tenis dengan teknik yang betul. Selain menggunakan khidmat jurulatih, seseorang itu boleh mempelajari dan bermain tenis dengan menggunakan mesin bola tenis. Permasalahannya ialah mesin bola tenis dijual pada harga yang tinggi di pasaran. Bagi mengatasi masalah tersebut, mesin bola tenis baru perlu dihasilkan dengan harga yang berpatutan. Terdapat satu mekanisma iaitu mekanisma kemasukan bola tenis. Mekanisma ni berfungsi bagi menghantar atau memindahkan bola tenis daripada tempat penyimpanan ke tempat pelancaran bola pada satu selang masa yang ditetapkan. Projek ini adalah untuk rekabentuk dan fabrikasi mekanisma kemasukan bola dan badan mesin bola tenis. Projek ini dihasilkan bagi membina satu mesin bola tenis yang lengkap. Spesifikasi rekaan telah ditetapkan dan komponen yang digunakan seperti motor, roda, sesiku bar, plastik atau bahan kitar semula dan sumber tenaga seperti bateri. Konsep rekaan telah di reka melalui perbandingan dengan beberapa konsep rekaan yang lain. Analisis matematik terhadap rekaan akan dilakukan. Fabrikasi akan dilakukan untuk membina mekanisma dan mesin bola tenis. Ujian akan dilakukan untuk menguji kefungsiannya mesin bola tenis. Mekanisma kemasukan bola tenis, badan mesin bola tenis dan secara keseluruhannya mesin bola tenis berjaya di laksanakan.

TABLE OF CONTENT

CHAPTER	TITLE	PAGES
	SUPERVISOR DECLARATION	i
	DECLARATION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENT	viii
	LIST OF TABLE	x
	LIST OF FIGURE	xi
	LIST OF SYMBOLS	xiii
	LIST OF APPENDIX	xiv
CHAPTER 1	INTRODUCTION	1
	1.1 OVERVIEW	1
	1.2 PROBLEM STATEMENT	2
	1.3 OBJECTIVE	3
	1.4 SCOPE	3
	1.5 PROJECT OVERVIEW	3
CHAPTER 2	LITERATURE REVIEW	4
	2.1 MECHANISMOF TENNIS BALL MACHINE	4
	2.2 BALL FEEDER MECHANISM	5
	2.2. ENGINEERING DESIGN	7
	2.4 COMPUTER AIDED DESIGN	9

CHAPTER 3	METHODOLOGY	10
3.1	INTRODUCTION	10
3.2	PROJECT DEVELOPMNT PROCESS	11
3.2.1	Identifying The Problem	12
3.2.2	Technical Specification	12
3.2.3	Concept Design	15
3.2.4	Fabrication	18
CHAPTER 4	RESULT AND ANALYSIS	22
4.1	INTRODUCTION	22
4.2	BODY FOR TENNIS BALL MACHINE	22
4.2.1	Fabrication	22
4.3	BALL FEEDER MECHANISM	26
4.3.1	Ball Container	26
4.3.2	Rotating Plate	29
4.3.3	Ball Path	31
4.3.4	Tennis Ball Machine	34
CHAPTER 5	DISCUSSION	39
CHAPTER 6	CONCLUSION	42
6.1	Conclusion	42
6.2	Recommendation	43
REFERENCES		44
BIBLIOGRAPHY		45
APPENDIX		46-49

LIST OF TABLE

No	Title	Pages
2.3	The Different Between Pneumatic and Mecahnical Tennis Ball Launcher .(Source : Wojcicki et al. 2011)	4-5
3.2.3	Pugh Selection Method	16

LIST OF FIGURE

No	Title	Pages
2.2(a)	Ball Specification (Source : International Tennis Federation (2012))	6
2.2(b)	The Ball Feeder Mechanism (Source : Kenneth M.Hodges (1980))	6
2.3(a)	Engineering Design Process (Source : George E.Dieter and Linda Schmidt (2009))	7
2.3(b)	Pugh Concept Method (Source : Ann Hopkins (2012))	8
2.4	The Example of Drawing Product Using Catia Software (Source : idexsolutions)	9
3.2	The Flow Chart for PSM 1 and PSM 2	11
3.2.2(a)	Motor	13
3.2.2(b)	Tachometer	13
3.2.2(c)	The Roller	14
3.2.2(d)	The Angle Bar with Hole	14
3.2.2(e)	The Metal Sheet	15
3.2.3(a)	Concept Design A	16
3.2.3(B)	Concept Design B	17
3.2.3(c)	Concept Design C	17
3.2.4(a)	Body Frame	18
3.2.4(b)	Ball Container Using Plastic Bottle	19
3.2.4(c)	Rotating Plate Concept Design A	19
3.2.4(d)	Rotating Plate Concept Design B	20
3.2.4(e)	Rotating Plate Mechanism	20
3.2.4(f)	Ball Path by Metal Sheet	21

4.2.1(a) Angle Bar	23
4.2.1(b) Body Frame Using Catia	23
4.2.1(c) Marking Process	24
4.2.1(d) High Speed Cutting Machine	24
4.2.1(e) Joining Process Using Screw and Nut	25
4.2.1(f) Body Frame	25
4.3.1(a) Plastic Bottle	26
4.3.1(b) Ball Container After Modified	27
4.3.1(c) Ball Container Using Catia	27
4.3.1(d) Ball Container Attached To The Body Frame	28
4.3.2(a) Rotating Plate Using Catia	29
4.3.2(b) Rotating Plate With Motor	30
4.3.2(c) Rotating Plate At Body Frame	30
4.3.3(a) Ball Path Using Catia	31
4.3.3(b) Cutting Process by Shearing Machine	32
4.3.3(c) Bending Process by Bending Machine	32
4.3.3(d) Ball Path at Body Frame	33
4.3.3(e) Stand Holder to Hold Ball Path	33
4.3.4(a) Tennis Ball Machine	34
4.3.4(b) Tennis Ball Machine	34
4.3.4(c) Tennis Ball Machine	35
4.3.4(d) Tennis Ball Machine	35
4.3.4(e) Tennis Ball Machine	36
4.3.4(f) Projectile Motion of A Tennis Ball	36

LIST OF SYMBOLS

d	=	diameter
m	=	meter
°	=	degree angle
θ	=	angle
kg	=	kilogram
g	=	gram
N	=	newton

LIST OF APPENDIX

No.	Title	Pages
A	Flow Chart	46
B	Gantt Chart	47
C	List of Materials and Cost production	48
D	Rendering of Tennis Ball Machine	49

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Tennis ball machine is one of the device or mechanism of the machine that use by the people to training and playing tennis. Nowadays tennis becomes one of the famous sports in the world and the amount of people that want to involve in this kind of sport is increasingly over the time. Generally, tennis ball machine is the machine that launches the ball tennis using the man power. In specific, tennis ball machine consists of ball storage mechanism, feeder mechanism, serving mechanism, control circuit and body frame of the tennis ball machine. (Source : Liang,H et al 2012).

Tennis ball machine already exist a long time ago with different type of mechanism, size, level and price. The more advanced of the tennis ball machine will provide more advanced level training in tennis. Mostly, the tennis ball machine uses storage battery for power supply. The battery is used to spin the roller, control the supply or feeder mechanism and control all others mechanism in the tennis ball machine. In the market today, there have two type of tennis ball machine.

First is pneumatic tennis ball machine. The pneumatic means the machine uses air compressor or pressure to launcher the ball. Second is mechanical tennis ball machine. (Source : Wojcicki.K et al. 2011) The mechanical means the machine used roller that spin to launcher the ball. Mostly, the user used the mechanical tennis ball machine because this type of tennis ball machine provide more advanced machine

comparing the pneumatic tennis ball machine. The pneumatic tennis ball machine is suitable for the beginners in the tennis profession. (Source : Wojcicki.K et al. 2011) The basic principle for this machine to operate is from the ball storage. The ball storage is where the ball is kept and placed before it's ready to launch. Before the ball is launched, it will go through the supply or feeder mechanism. The feeder mechanism is the mechanism that passes the ball at certain time intervals from the ball storage to the launcher mechanism. The launcher will launch the tennis ball at certain velocity to the user. This tennis ball machine will help the people or player that want to practice or improve their skill in playing tennis without using other partner or coach.

1.2 PROBLEM STATEMENTS

In Malaysia, tennis sport begins to grow rapidly and get serious attention by the public especially tennis players. Therefore, a coach is needed to train and teach how to play tennis properly. Unfortunately, the coach that can train and teach to play tennis is smaller. It makes the people or the beginner that want to play tennis lack of suitable opportunities to practice without proper training partners. In this case, apart from using the service of a coach, a person can practice in playing tennis by using a tennis ball machine.

The problem is the existing tennis ball machine is mostly selling at a high price because the tennis ball machine is imported from the outside. This factor also can be an obstacle to the people that want to involve in this sport seriously. Therefore, to overcome this problem, a new tennis ball machine needs to be developed and produced. A tennis ball machine produced must be low in cost. In order to reduce the production cost, the use of local products and recycled material is used. The mechanism used like feeder mechanism and thrower mechanism is operating by using a minimum source of energy like electricity consumption. Using a mechanical system without using a lot of energy is considered for the new tennis ball machine.

1.3 OBJECTIVES

The objectives of this project are to design the prototype of feeder mechanism and body for tennis ball machine. Furthermore, fabricate the feeder mechanism and body for tennis ball machine. The next objective is to produce a tennis ball machine with low cost.

1.4 SCOPE

The scope of this project is to study and analysis the mechanism of ball feeder for tennis ball machine. Furthermore, design and fabricate the prototype of ball feeder mechanism and the body for tennis ball machine. The other scope in this project is use the design software such as CATIA V520 and other software in order to design and analyzing a ball feeder mechanism and the body of tennis ball machine

1.5 PROJECT OVERVIEW

The project is start by generate idea for the concept of ball feeder mechanism and the design of the body of tennis ball machine. The idea and concept must according to the objective of the project. The type of this tennis ball machine is mechanical ball machine that used two rollers to launch the ball. Selected material is chosen to produce the tennis ball machine. The cost material to make this project must reasonable, lower and not to high. The feeder mechanism is including the ball container, rotating plate and the ball path. The body for tennis ball machine is made up from light material to reduce the weight of the body. The all part or mechanism is fabricated to produce complete tennis ball machine. Lastly, testing is carried out to see the mechanism of tennis ball machine can be functioning orderly.

CHAPTER 2

LITERATURE REVIEW

2.1 MECHANISM OF TENNIS BALL MACHINE

In the market today, there have many type of the tennis ball machine. The variety of the tennis ball machine includes the type of mechanism, price, and design of the body frame of the tennis ball machine. The main difference between tennis ball machines are the number of controlled parameters and possible range of their adjusting. (Source : Wojcicki.K et al. 2011). Generally, the tennis ball launcher can be divided into two groups mechanism. First is the pneumatic tennis ball launcher. The machine is using compressed air as a mechanism to launch the ball. Second is the mechanical tennis ball launcher. The machine is using rotating rollers or wheels to launch the ball. They have many different between pneumatic ball launcher and mechanical ball launcher. Table 2.1 shows the different between pneumatic tennis ball launcher and mechanical tennis ball launcher.

Table 2.1 The Different Between Pneumatic and Mechanical Tennis Ball Launcher

Pneumatic launcher	Mechanical launcher
Used the air jet. The air is compressed with attached compressor and stored inside the chamber.	Used rotating rollers. The ball is shooting by pulling it between two counter rotating rollers.
The initial velocity of the ball depends on the output pressure of the compressor.	The initial velocity of the ball depends on the velocity of the rotating rollers.

Elevation and heading angles can be adjusted by setting the outlet tube.	Elevation and heading angles can be changed by turning the whole machine or launcher mechanism.
Allow one to practice basic stroke and cannot be used for advanced training.	Allow one to practice more advanced training.

.(Source : Wojcicki.K et al. 2011)

2.2 BALL FEEDER MECHANISM

Ball feeder mechanism in tennis ball machine is the one mechanism that supplied or transfers the tennis ball to the launcher mechanism. The feeder mechanism will make the tennis ball pass through the mechanism from the ball storage. A tennis ball server supplied by a motorized ball feeder comprised of a trough and rotating plate that feeds balls at one rate. (Source : Hodges K. M(1977)) For example one ball serves every three or four seconds. This is to make sure the ball pass through the ball launcher is easily and orderly manner without any problem such as the tennis ball is stuck from going the ball launcher.

In the feeder mechanism, sometimes it has a problem to the mechanism. The problem experienced with the ball jams in the ball runs from ball storage, as a result of stoppage at the feeder to the server. In tennis, all tennis balls are not same diameter and texture. (Source : Hodges K. M(1977)). The normal tennis ball have diameter range between 6.54cm to 6.86cm see figure 1. With the present invention, a rimmed plate receives tennis balls bulk in a rough and having at least one opening therein to form a pocket that selective for single ball trough and carries it upon and underlying will having a feed opening that drops the balls one at a time into the ball launcher. (Source : Hodges K. M(1977))

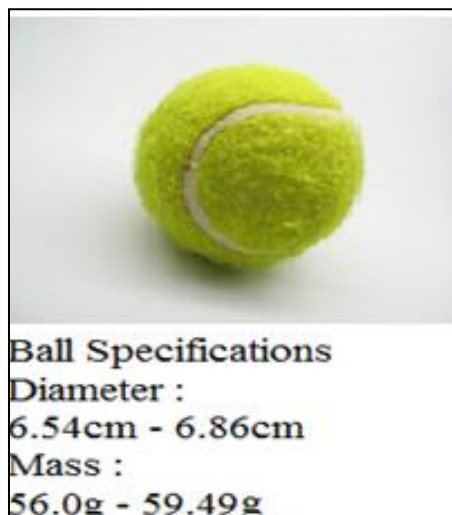


Figure 2.2(a): Ball Specification

(Source:International Tennis Federation (2012))

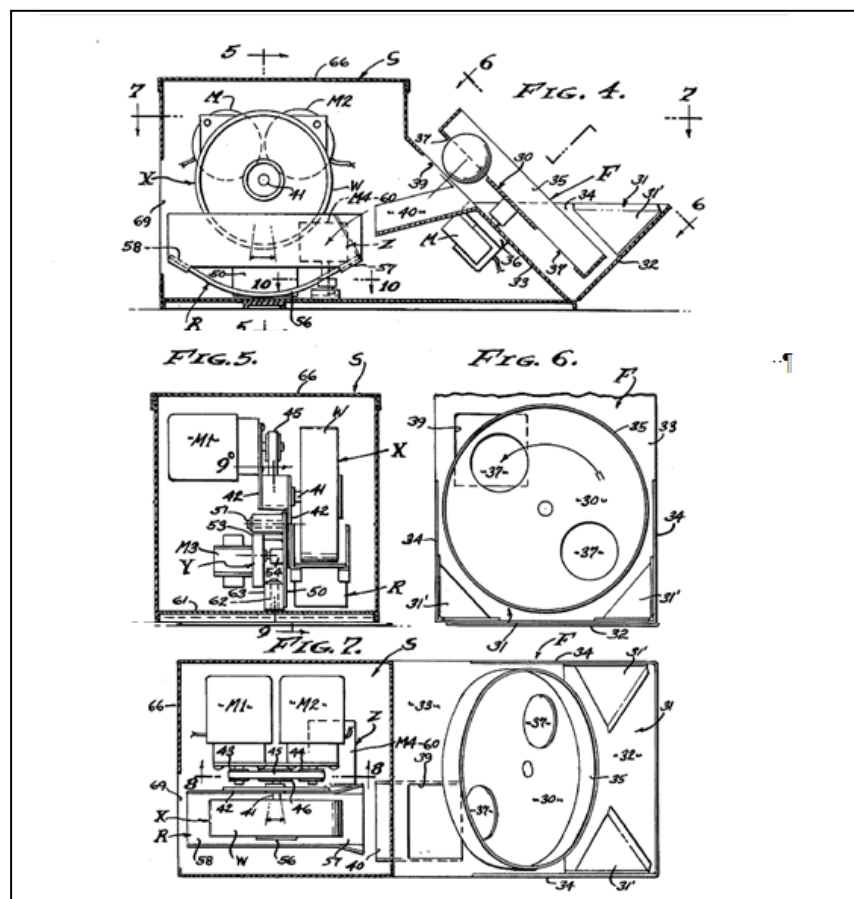


Figure 2.2(b) : The Ball Feeder Mechanism

(Source : Hodges K. M(1977))

2.3 ENGINEERING DESIGN

In engineering design consist of engineering design process. This design process can be used to achieve several different outcomes. Any project or work that needs to design and produce something must follow the engineering design process. The design process should be conducted so as to develop quality, cost competitive products in the shortest time possible. (Source : Dieter G. E and Schmidt L.C (2009)). In engineering design, they have several types of design which are original design, Adaptive design, Redesign, Selection design and Industrial design. Engineering design process consist eight steps of design activities. (Source : Dieter G. E and Schmidt L.C (2009)). Figure 2.3 shows the engineering design process.

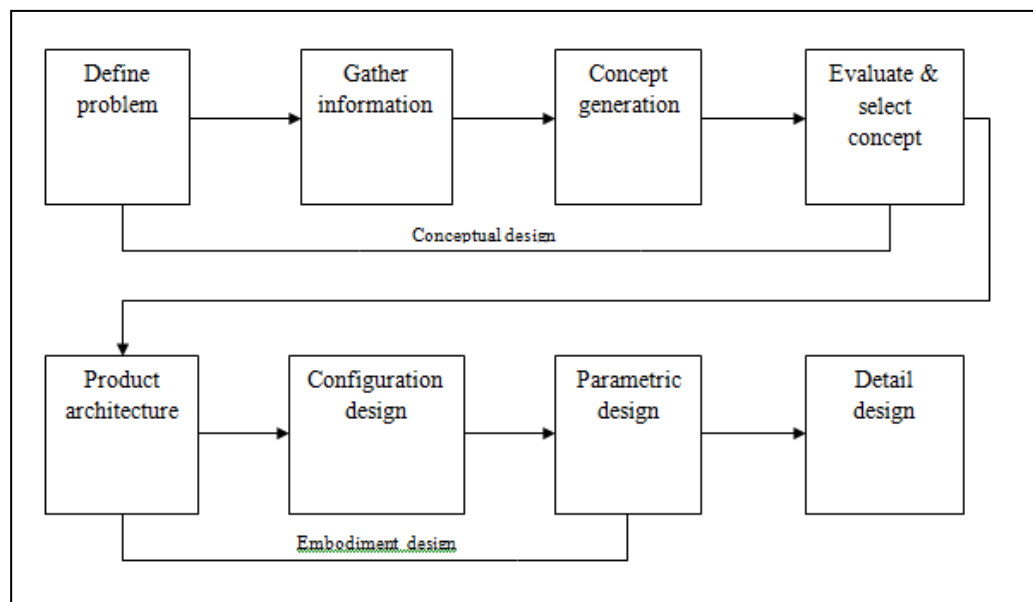


Figure 2.3(a) Engineering Design Process

(Source : Dieter G. E and Schmidt L.C (2009)).

Product development begins by determining the needs that the product must achieved. In the engineering design process, problem definition is the first and most important steps in developing the product. The problem statements will the information about the product and how to develop the product based on the problem statement. The information get will be analyze and evaluate in order to design and select the concept generation. In engineering process, they have five evaluation

methods for selection concept design. First is Comparison Based on Absolute Criteria. Second is Pugh Concept Selection Method. Third is Measurement Scales. Fourth is Weighted Decision Matrix and fifth is Analytic Hierarchy Process (AHP). (Source : Dieter G. E and Schmidt L.C (2009)).

Pugh concept selection method is the method that compares each concept relative to a reference or datum concept. The criterion determines whether the concept is better than, poorer than or same as the reference concept. They have eight steps in Pugh concept selection method. First step is choosing the criteria by which the concepts will be evaluated. The next step is formulating the decision matrix. Then, clarify the design concepts. Next is choosing the datum concept. Then, run the matrix. The next step is evaluating the ratings. Next is establishing a new datum and rerun the matrix and the last step is examine the selected concept for improvement opportunities. (Source : Dieter G. E and Schmidt L.C (2009)). Figure 2.3(b) show the pugh concept method.

Calculation of Best Concept

Selection Criteria PSFs From Optimisation Matrix	Baseline Concept	Alternative Concepts/Options					Weighted Normalised Importance
	B	1	2	3	4	Ideal	
Customer Matrix PSF 1		+	-	+	S	+	7
Customer Matrix PSF 2		+	+	+	+	+	5
Stakeholder Matrix PSF 1		+	S	S	+	+	9
Operations Matrix PSF 1		-	-	-	-	S	6
Excitement PSF 1		S	+	S	-	+	7
Total + Rating		21	12	12	14	28	
Total - Rating		6	13	6	13	0	
Overall Total		0	15	-1	6	1	28

Rating
 + = Better than baseline
 - = Worse than baseline
 S = Same as baseline

Source: Pugh (1981)

Figure 2.3(b) Pugh Concept Method

(Source : Ann Hopkins (2012))

2.4 COMPUTER AIDED DESIGN(CAD)

Computer Aided Design is tools in engineering design that had been develop for a long time ago. Computer Aided Design become more advanced over the time and become a critical enabling technology in product design since they help build virtual prototypes of complex products like automobiles, airplanes and electronic appliances. The CAD can make the design process become more flexible and easy to conduct. Furthermore, the CAD also can be used to do a simulation on the design product.

Today, CAD enabled design engineer select available materials from databases to realize desired product functionality. They have many types of CAD software in the market like CATIA (Computer Aided Three Dimensional Interactive Application), AutoCAD, BricsCAD, Solid Work, AutoDesk, ADAMS (Automatic Dynamic Analysis of Mechanical System) and other CAD software. All this kind of software will help the design process, design engineer to design the product and do simulation analysis on the product. Figure 2.4 show the drawing product using CATIA software.

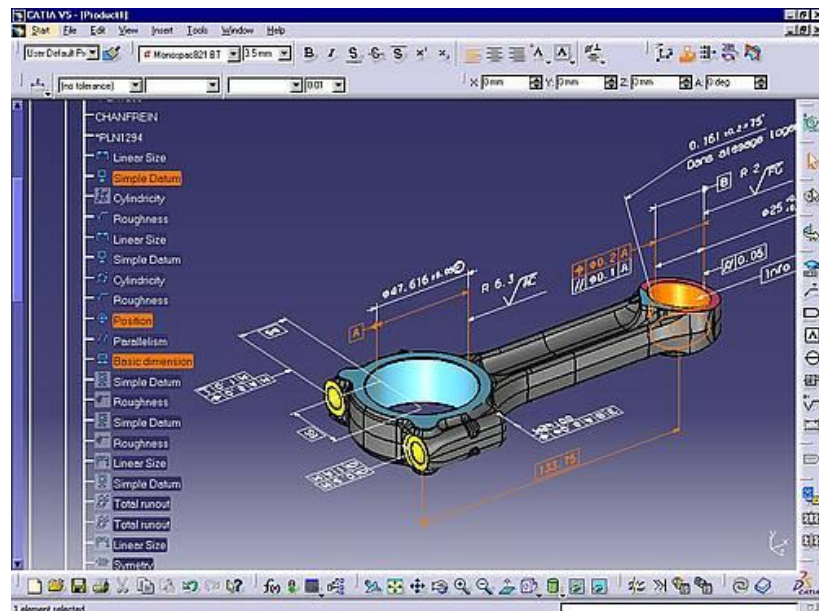


Figure 2.4 The Example of Drawing Product Using CATIA Software
(Source : http://www.idexsolutions.com/software_solutions/catia/v5/fta/)