

PROJEK SARJANA MUDA

**AN APPLICATION OF 3D MODELING AND SIMULATION ANALYSIS IN
THE DEVELOPMENT OF CONSUMER PRODUCT DESIGN
(FOLDING BIICYCLE)**

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KUDUS

„Saya/Kami* akui bahawa telah membaca
karya ini dan pada pandangan saya/kami* karya ini
adalah memadai dari segi skop dan kualiti untuk tujuan penganugerahan
Ijazah Sarjana Muda Kejuruteraan Mekanikal (Rekabentuk dan Inovasi)

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** Potong yang mana tidak berkenaan*

AN APPLICATION OF 3D MODELING AND SIMULATION ANALYSIS IN THE
DEVELOPMENT OF CONSUMER PRODUCT DESIGN (FOLDING BIYCYCLE)

ABDUL AZIM BIN ROSLAN

Laporan ini dikemukakan sebagai
memenuhi sebahagian daripada syarat penganugerahan
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“Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya telah jelaskan sumbernya”

Tandatangan:.....

Nama Penulis:.....

Tarikh:.....

To my beloved mum and family...

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Ahamdulillah...

Thank God, after a four month of doing research and study, finally this report is done successfully. I wanted to share this moment and giving a big thank to my supervisor for PSM, Mr Syahibudil Ikhwan for giving me lots of advice and always guiding me until I'm finishing this report. To my mother and family, thank you for always understanding me due to pressure and time constrain that I faced during this critical time.

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ABSTRACT

Every product produce in the world should have product development process. The process includes certain study about the customer needs, engineering requirement, Product Design Specification (PDS), Computer Aided Design (CAD) and also Finite Element Analysis (FEA). In this project, it is stress on the process of product development, starting from generate idea until analyze the design using CAE software. It is stated as one of main objective for this research to conduct and demonstrate a 3D modeling & simulation analysis in advance design software. It is also to produce innovative & creative design works in developing consumer product design. Subject matter for this project should be consumer product where the product is Folding Bicycle. Folding Bicycle is quite rare among Malaysian user, but the product is widely used in modern country such as Singapore, Japan, Europe and United States. There is potential market in Malaysia for this kind of product since there no bicycle manufacturer produce in Malaysia.

At the first stage of product development, the customer needs should be taken as important consideration. The data will be translated into engineering requirement to generate the PDS. The concept design will be based on these criteria as to fulfill the engineering requirement. The final concept design will be selected by using concept scoring matrix. The process developments continue with detail design using CAD software which is CATIA V5. The design structure needs to analyze to ensure whether the design is strong enough to support the load. The minimum Factor of Safety (FoS) for this product is 2 based on industry standard as specified by engineering requirement. It is important for each product produce by manufacturer to be identify as safe product where the FoS should passes the minimum value.

ABSTRAK

Setiap produk yang dihasilkan di dalam dunia ini akan melalui satu proses yang dinamakan sebagai process pembangunan produk. Proses ini melibatkan kajian mengenai kehendak pelanggan, spesifikasi kejuruteraan, Spesifikasi Reka bentuk Produk, Lukisan Berbantu Komputer, dan juga Analisa Berbantu Komputer. Projek ini menekankan process pembangunan produk, bermula daripada pembangunan idea sehinggalah kepada analisa reka bentuk menggunakan perisian Analisa Berbantu Komputer. Seperti mana yang telah dinyatakan didalam objektif projek ini, kajian yang mendalam akan dilakukan terhadap pembangunan lukisan tiga dimensi dan kajian simulasi menggunakan perisian kejuruteraan. Projek ini juga dilakukan untuk menghasilkan produk pengguna yang mempunyai nilai reka bentuk yang kreatif dan inovatif. Basikal lipat merupakan pilihan produk pengguna untuk dibangunkan didalam projek ini. Penggunaan basikal lipat agak meluas di negara maju seperti Singapura, Jepun, Eropah dan juga Amerika Syarikat tetapi tidak dinegara ini. Kajian mendapati terdapat potensi pasaran terhadap produk ini yang masih belum diterokai dimana tiada syarikat pembuat basikal di Malaysia yang menghasilkan produk ini.

Pada fasa awal pembangunan produk ini, kehendak pelanggan diambil kira sebagai satu keperluan yang penting. Data yang didapati akan ditukar kepada spesifikasi teknikal untuk menghasilkan sejumlah konsep awal produk. Konsep yang dijana akan berdasarkan spesifikasi teknikal yang ditetapkan. Apabila konsep terakhir dipilih, konsep itu akan dimajukan ke dalam lukisan berbantu komputer. Selepas itu, untuk memastikan kekukuhan struktur reka bentuk, kajian analisa akan dijalankan terhadap lukisan dengan menggunakan perisian analisa berbantu komputer. Nilai yang didapati melalui analisa tersebut mestilah melepasi Nisbah Kejuruteraan iaitu 2. Nilai ini mengikut spesifikasi yang telah ditetapkan oleh pihak industri.

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CHAPTER 1

INTRODUCTION

1.1 Background



Figure 1.1: One of early invented bicycle

(source: wikipedia, 2009)

Bicycles were introduced in the 19th century and now number about one billion worldwide, twice as many as automobiles. They are the principal means of transportation in many regions. They also provide a popular form of recreation, and have been adapted for such uses as children's toys, adult fitness, military and police applications, courier services, and competitive sports.

The basic shape and configuration of a typical bicycle has changed little since the first chain-driven model was developed around 1885. Many details have been improved, especially since the advent of modern materials and computer-aided design. These have allowed for a proliferation of specialized designs for particular types of cycling.



Figure 1.2: Modern Bicycle

(Source: Wikipedia, 2006)

The invention of the bicycle has had an enormous impact on society, both in terms of culture and of advancing modern industrial usage. Several components that eventually played a key role in the development of the automobile were originally invented for the bicycle such as ball bearings, pneumatic tires, chain-driven sprockets, spoke-tensioned wheels and others.

Bicycles can be categorized in different ways depends on the function and numbers of the rider. In this report, I will focus on the folding bicycles where one of the types of the bicycles is. A folding bicycle is a type of bicycle that incorporates hinges or joints in the frame that permit it to be broken down into a more compact size. Folding bikes can be taken on public transport and into apartment buildings or workplaces where conventional bicycles are not allowed. This facilitates mixed-mode commuting, because a folding bike can be carried on any available transport, and ridden when there is none. Folding bikes are also easier to transport in a car.

Folding bicycles typically cost more than non-folding bicycles of comparable quality, because they have more parts to allow folding. This results in a more complicated design, which is more complex to manufacture. There is also a smaller

market for this type of bike. As an alternative to folding, some models achieve similar results by separating into two or more parts. These are sometimes grouped in the same category as folding bicycles but are also referred to as break-away, disassemble, or separable bicycles.



Figure 1.3: Folding Bicycle

(Source: Wikipedia, 2005)

1.2 Consumer Product

A consumer product is generally any tangible personal property for sale and that is used for personal, family, or household for non-business purposes. The determination whether consumer product is a good product requires a factual finding based on a case-by-case basis.

1.3 Why Folding Bicycles?

i. Portable

Foldable bikes offer flexibility and ease of commuting via train/bus and bike as they can be carried free on public transport. It is also great as training bikes for cyclists travelling abroad and are super easy to pack as they simply fold into a travel bag.

ii. Space

We can save space if using folding bicycles where we did not need any big space to keep the bicycles. We also can keep the bicycles inside our house as we were provided a special bag for the bicycles.

iii. Green Bicycles

As we know, this bicycles offer a healthy, green method of transport and potential cost savings versus a car when used with public transport for longer journeys.

1.4 Objectives:

- i. To conduct & demonstrate a 3D modeling & simulation analysis in advance design software.
- ii. To produce innovative & creative design works in developing consumer product design.

1.5 Scope:

- i. To conduct a literature study on advance design software in local industry.
- ii. Design & develop conceptual modeling of consumer product according to engineering design specifications.
- iii. To conduct simulation Finish Element Analysis (FEA).

1.6 Case Study:

- i. In urban area, lots of workers going to work using public transportation like buses and commuters. Although they use this transportation, they still need to walk around 5-10 minutes to go to the commuter's station or bus stop.
- ii. On family vacation or *balik kampung* season, usually they need to bring along their bicycles especially for families that have children who love to ride bicycles around.
- iii. In university area, the distance between faculties to other faculties is not too far but still tiring if the student or lecturer only walks to go to the other classes in other faculties.

CHAPTER 2

LITERATURE REVIEW

2.1 Folding Bicycles

2.1.1 What is Folding Bicycles?



Figure 2.1: Folding bicycle before & after folded
(Source: Wikipedia, 2008)

A folding bicycle is a type of bicycle that incorporates hinges or joints in the frame that permit it to be broken down into a more compact size. Most 'folders' have 20 inch (51 cm) diameter wheels, or less. Folding bikes can be taken on public transport and into apartment buildings or workplaces where conventional bicycles are not allowed. This facilitates mixed-mode commuting, because a folding bike can be carried on any available transport, and ridden when there is none. Folding bikes are also easier to transport in a car.

Folding bicycles typically cost more than non-folding bicycles of comparable quality, because they have more parts to allow folding. This results in a more complicated design, which is more complex to manufacture. There is also a smaller market for this type of bike. As an alternative to folding, some models achieve similar results by separating into two or more parts. These are sometimes grouped in the same category as folding bicycles but are also referred to as break-away, disassemble, or separable bicycles.

2.1.2 Folding Bicycle Design

2.1.2.1 Size



Figure 2.2: Comparison size between normal & folding bicycles

(Source: <http://www.absoluteastronomy.com>, 2006)

Basically, the designs of folding bicycles are almost similar to the usual bicycle. Folding bicycles generally come with a wider range of adjustments than conventional bikes for accommodating different riders, because the frames are usually only made in one size. Seat posts and handlebar stems on folders extend as much as four times higher than conventional bikes. For even greater range of adjustment, longer after-market posts and stems are available. While folding bicycles are usually smaller in overall size than conventional bicycles, the distances between center of bottom bracket, the top of the saddle and the handlebars, the primary factors in determining whether a bicycle fits its rider, are usually similar to that of conventional bikes. There are few types of design of folding bicycles that usually have a similar pattern. Based on my research during interviewing the seller of folding bicycle, he also stated that the sizes of folding bicycles are almost the same with the normal bicycle (Interview, 2009).

a. Frame Size

Normally, the frame size is the distance between the top of the seat tube and the axis around which the cranks rotate, measured along the seat tube. Frame sizes generally run from 19" to 25" in increments of 1".

To find a good frame size for a rider, have the person stand in bare feet on an uncarpeted floor. Measure the vertical distance from the floor to the head of the femur (see drawing). Subtract 13.75".

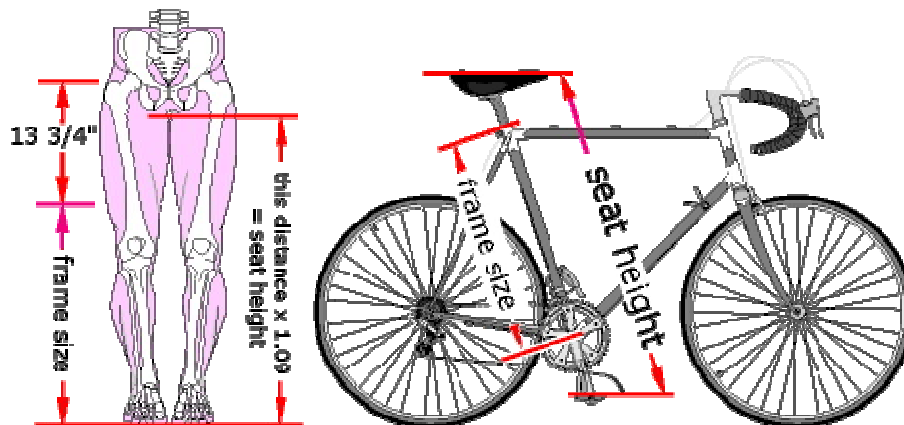


Figure 2.3: Frame size

(Source: <http://www.sizes.com/>, 2004)

Adjusting saddle height is the second step in fitting a bike to a rider. With the rider standing in bare feet on an uncarpeted floor, measure the vertical distance from floor to crotch. Rotate the pedals so that the cranks are parallel to the seat tube. Adjust the height of the saddle until the distance from the top of the bottom pedal to the top of the saddle is equal to the rider's crotch height times 1.09 which a factor developed by Vaughn Thomas (1967) at Loughborough University, England.

b. Saddle Adjustment

The adjustment of the saddle serves to enable the muscles to work optimally in the longitudinal reach. As there is only one optimal longitudinal reach, there is only one optimal saddle height. Most of the methods used at present to determine the correct saddle height are far from optimal. We will briefly discuss a few of these measuring methods.

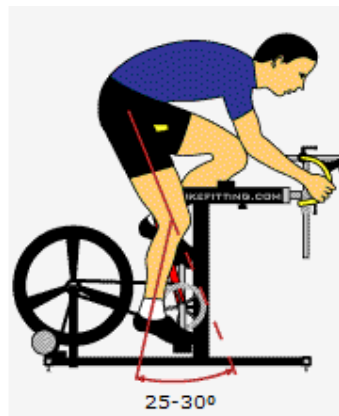


Figure 2.4: Position of Leg

First there is the so-called heel-method. The heel of the shoe is placed on the pedal and the saddle is adjusted at such a height that the leg is stretched while the pelvis is still in horizontal position. So far no evidence, empirical nor scientific, has been found to justify this measuring method. More importantly, this method does not take into account the fact that the modern cycling or racing shoe has a heel jump. In reality this means that, as a rule, with this method the saddle is adjusted too low.