



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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## **INTEGRATING BIOMIMETIC INTO PRODUCT DEVELOPMENT**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering  
Manufacturing Design (Hons.)

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## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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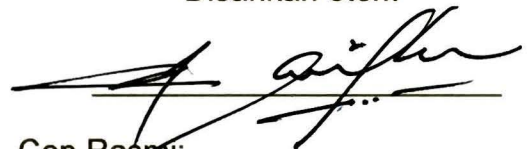
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## APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory is as follow:



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## **ABSTRAK**

Projek ini bertujuan untuk mencari satu cara yang sesuai untuk menggabungkan biomimetik ke dalam pembangunan produk. Ini adalah disebabkan pereka cuma mengetahui pencapaian individu dalam penggunaan biomimetic yang tertentu. Selain itu, maklumat tentang biomimetik adalah berselerak dan tidak sistematik. Hasil daripada masalah ini, satu program untuk membantu dalam menentukan reka bentuk biomimetik telah dibangunkan dengan menggunakan program pengaturcaraan asas iaitu Microsoft Office Access. Oleh itu, informasi untuk proses reka bentuk yang menggunakan biomimetik dan contoh-contoh visual telah dicari. Dengan menggunakan contoh-contoh visual biomimetik, program ini akan menyediakan pilihan ciri-ciri mengenai biomimetik untuk dipilih oleh pengguna dan pengguna juga boleh menambah maklumat ke dalam program ini. Selepas itu, satu kajian soal selidik akan dijalankan terhadap 35 responden. Daripada keputusan soal selidik, kebanyakan responden berpuas hati dengan program ini dan didapati cadangan supaya lebih banyak informasi biomimetik ditambahkan dan penambahbaikan susun atur program ini.



## **ABSTRACT**

Although biomimetic is a good source of ideas for designs, it is not widely used. This is due to lack of systematic process for engineers to find biological analogies related to the design problems and the transferring knowledge of biological designs to engineering problems. Besides that, the information is scattered as some design engineer are aware of some individual achievements of biomimetic, also in some cases are just based on incidental observations and reports. The objective of this project is to find a suitable strategy to integrate biomimetic into product development, collecting scattered information about biomimetic and upload the information into Microsoft Office Access to create a database program. The information of biomimetic features are input into table, query, form and report in order to build relationship among these objects. There are a few testing and refinement of the database. Later, a questionnaire survey is carried out on 35 respondents to test the functionality and satisfaction of the respondents. From the survey result, the majority of the respondents are satisfied with the database program. However, there are comments about the layout and user-interface needs to be improved. Besides that, more biomimetic features and information about biomimetic need to be added and uploaded into the database.

## **DEDICATION**

Dedicated to my supervisor, honourable lecturers, helpful friends and my beloved family who has given me support throughout this final year. Thanks for the memories that we had in UTeM throughout these years.

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## **LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE**

ARIZ	- Algorithm of Inventive Problem Solving
BID	- Bio-inspired design
BIKON	- Bionics Competence Network
BIONIS	- Biomimetics Network for Industrial Sustainability
DANE	- Design by Analogy to Nature Engine
ESA	- European Space Agency
R&D	- Research and Development
TRIZ	- Theory of Inventive Problem Solving
IPs	- Inventive Principles

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# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Biomimicry or Biomimetic is the study of structure and function in biological systems as models for the design, engineering of materials and machines in order to solve complex human problems. According to Speck T. and Speck O. (2008), biomimetic come from the Greek words bios meaning life and mimesis meaning imitation. Sometimes a closely related term bionics which means combined from biology and technics is also used. Besides that, there are alternative terms to 'bionic' or 'biomimetic', these are 'biologically inspired' or 'bio-inspired'.

In recent years, many engineering design has been inspired by nature. Nature's design can generate a new idea and can solve engineering design problems. On the other hand, biomimetic can create opportunities to generate new materials, processes and devices. According to Vattam et al. (2010), the increased need for biologically inspired design is caused by two factor, these are the need for sustainable development and the perception that nature's design can create opportunities for innovation. Biologically inspired design is to implement the functions, mechanisms and principles from biological systems.

This project will gather the information of living organism's structure and function which serves as a model in biomimetic. Biological systems are assembled, categorized



and arranged systematically in a database. It will help designer to improve their creativity and generate ideas which will create opportunities for more innovative products. On the other hand, it will be a systematic process of using biomimetic to solve an existing or technical problem. By using this system, designers are exposed to systematic evaluation rather than based on incidental observations or report which is faster and easier.

## **1.2 Problem Statement**

Most of the designers use concepts to design and solve design problems. This situation happens because the information of Biomimetic is scattered. Some designers are aware of some individual achievements of Biomimetic, also in some cases are just based on incidental observations and reports. By uploading data to this programme, designers are exposed to systematic evaluation and visual examples.

Other than that, designers are lack of creativity and innovative, sometimes it is hard to solve design problems. The visual examples provided will give idea to improve creativity and thus producing innovative and new products. Besides that, it takes time to search for solutions which will increase product's life-cycle. It is not competitive as the product is slow to market. It is easy to use the programme and they can easily make decision.

### **1.3 Aim**

This project is focus on providing visual example to designer for improving creativity. Besides that, to ensure the programme is easily understood and user friendly, the information is assembled, categorized and arranged in a systematic manner. This Biomimetic example is going to help designers to solve their design problems and improve their creativity.

### **1.4 Objective**

The objectives of the project are:

- a) To find a suitable strategy to incorporate Biomimetic features into product development.
- b) To gather all the scattered information concerning Biomimetic features applied in product designs.
- c) Uploading the data of Biomimetic features into MS Access to form a database programme.

### **1.5 Scope**

This project studies about integrating Biomimetic into product development. Information of product design which incorporate Biomimetic need to be gathered and arranged in a systematic manner. The information collected provides visual examples to designers for improving creativity. The information is used to develop a systematic database system by uploading into Microsoft Office Access. To ensure the database is

able to be used later, a few testing and editing will be carried out. Then, a questionnaire survey is carried out to 35 respondents in order to collect the feedback and comments from the respondents. Lastly, the results are analyzed and discussed.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Definition of Biomimetics**

Biomimetics is the study of the structure and function of biological systems as models for the design and engineering of materials and devices. The purpose of biomimetics is to solve complex human problem. According to Speck T. and Speck O. (2008) the term Biomimetics are derived from Greek words bios meaning life and mimesis meaning imitation. It means the contribution of ideas from biology which transfer and apply to technology. In other words, Biomimetics is based on the information from biological research then it is applied in engineering, design, chemistry, industrial, mechanical and other fields.

The other term Bionics is defined as the application of biologically inspired systems and methods to engineering and technology by (Colombo et al, 2008). Besides that, the term bionics combined from Biology and Technics is also used (Speck T. and Speck O, 2008). There are terms synonymous with Biomimetics which are biomimesis, biomimicry, bionics also known as bionical creativity engineering, technical biology, biognosis, biologically inspired and bio-inspired design (BID).

## **2.2 Introduction to Biomimetics**

In the study of nature, analysis of living organisms for models, behaviors, systems, morphologies, anatomies, components and processes is carried out. This will then uses analogical or metaphorical reasoning to imitate or gain creative inspiration from the biological models. Lastly, this will facilitates in generating sustainable and optimal solutions to solve human design problems.

## **2.3 Looking at Nature as Model, Measure, and Mentor**

In biomimetics or in other words biomimicry , the main source of knowledge is from nature. By looking at nature as model, mentor and measure (Eilouti, 2010). These are also known as Benyus' 3M definition of nature roles. The major roles of nature are summarized by Benyus' 3M framework that nature functions as a Model, a Measure and a Mentor. The first aspect is model. Biomimicry is a new science that studies biological models and then emulates the forms, processes, systems and strategies to solve human problems sustainably. These can be directly imitated or indirectly inspired by developing solutions.

For the second aspect is mentor. Biomimicry is a new way of viewing and valuing nature. This introduces an era based not only on what can be extracted from the natural world, but also what can be learnt. In this aspect, nature is used for evaluative purposes to compare man-made products for the standards and criteria. For the third aspect is measure. Biomimicry uses an ecological standard to judge the sustainability of the innovations nowadays. After 3.8 billion years of evolution, Nature has learned what works and what lasts. Nature serves as a source of learning which facilitates in design guidelines and processes.



## 2.4 History of Biomimetics

Biomimetics is not a new approach for human to solve their problem. Humans have been gaining inspiration from nature to solve complex and simple problems since their existence until now. Biomimetics has solved many engineering problems such as self-healing abilities, environmental exposure tolerance and resistance, hydrophobicity, self-assembly, and the conversion of solar energy. In recent years, the knowledge gained during the implementation of the theories inspired from nature will make biological systems more understandable. According to Vincent et al. (2006), human have looked to nature to acquire inspiration for more than 3000 years, since the Chinese first tried to make an artificial silk.

An early example of Biomimetics is the study of birds flying, started by Leonardo da Vinci (1452-1519). He has designed some flying machines but never made any. The Wright Brothers succeeded in flying the first heavier-than-air aircraft in 1903, which are inspired from observations of pigeons in flight. During the 1950s, Otto Schmitt, an American biophysicist and polymath created the word Biomimetics (Vincent et al, 2006). He acquires the Schmitt trigger by studying the nerves in squid. He is also trying to make a device that imitates the nerve propagation system. In 1960, another similar term Bionics was created by psychiatrist and engineer Jack E. Steele, it means the science of systems which have some function gain from nature (Vincent et al, 2006). In 1960, Bionics entered the Webster dictionary as a science regarding the mechanism of biological systems that are applied to solve engineering problems.

In 1969 the term biomimetics was used by Schmitt to title one of his papers. In 1974, the term Biomimetics entered Webster's Dictionary which stated the study of the formation, structure or function of materials such as enzymes or silk, mechanisms and processes such as protein synthesis or photosynthesis in the biological system to incorporate into products which imitates nature. In 1997, the term Biomimicry was used by a scientist and author Janine Benyus in the book Biomimicry: Innovation Inspired by Nature. According to Benyus (1997), Biomimicry means a science that researches the biological