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TRANSFORMATIONAL CHAIR DESIGN ANALOGOUS TO MALAYSIA'S RAFFLESIA PLANT CELLULAR STRUCTURE

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ABSTRACT

The purpose of this paper is to provide a review of literature on Rafflesia cellular structure endemic to Malaysia Identity that is suitable to be applied in chair transformation design process which can help individual developing their understanding in plant analogy design. It is a critical and comprehensive review of a range of recently published literature sources (until May 2014) addressing various issues related to the transformation process design theory, Rafflesia Azlanii, and chair design. The sources are sorted into sections: morphological identification of Rafflesia, design for transformation and the analogy between R.A and chair. The paper provides insights about the characteristic and growth principle of R.A structure and form endemic to Malaysia resources; transformation process design theory that may influence the analogy between R.A cellular structure and chair design as a Malaysia identity product; and its benefits and guidelines to students/educators/designers of using R.A cellular structure as an analogy in developing chair design. It is hoped that the analysis, as captured in this paper, will highlight the different transformation process design theory in chair development. The paper will be of interest to researchers in the areas of tropical plant analogy design, enable learning environments, in general. Further, this paper demonstrates how the analysis of academic literature sources has been combined with commentaries and opinions on the journals and articles to develop this literature review. The finding is a very useful source of information and impartial advice which may be commercialized and influence learning and teaching strategies in higher and further education – specifically institutions that are considering the use of R.A cellular structure in chair design. This paper fulfils an identified information/resources of transformation design theory, design analogy of R.A cellular structure in chair design needs and offers practical help to students/educators/designers starting out a plant structure analogy design direction.

Key Words: chair design for transformation; form/structure analogue design; design analogy; Malaysia Identity design.

INTRODUCTION

Motivation. This section will address the following research questions:

- What is *design through transformation* and how transformation facilitates chair design?
- How is *analogue* defined? What are the advantages and disadvantages of an analogue chair design?
- What are the benefits of creating a new R.A plant structure/form analogue chair and how can we achieve it?

Research Question No.1 and 2 sought to address the design through transformation approaches to draw an analogy between R.A plant structure/form and chair design. The latter research question provides insights about the characteristic and growth principle of R.A structure/form endemic to Malaysia resources; transformation process design theory that may influence the analogy between R.A cellular structure/form and chair design as a Malaysia identity product; also its benefits and guidelines to students/educators/designers of using R.A cellular structure as an analogy that facilitates the development of chair design.

Limitation. This paper will be particularly informative regarding the review of the literature pertains to the studies. Here, the background of a fundamental study of transformational principles will be discussed and sum up into relevant facts as an elucidation of the literature towards the scope of study. It also shed a light on the current issues regarding the studies. Incidentally, the researcher could not find any related studies on chair design analogous to Rafflesia Plant Cellular that are done both locally in Malaysia or abroad neither journals nor theses which could help the researcher to review the literature of transformational chair design analogous to Rafflesia Plant Cellular in Malaysia. Therefore, the review on literature will be derived from a number of documents which were very germane to the study such as international journals, newspapers and articles from the engineering studies.

DESIGN FOR TRANSFORMATION

Transformation in Context. Transformation is defined as turning something into something else completely or to alter or convert it into much better or more appealing state, this is supported by the Collins Cobuild Advanced Learner's English Dictionary carried out by Sinclair (2006). Another line of thought on transformation by Jason Weaver (2010) demonstrates that transformation is the act of converting state of something to improve value and quality or adding on new function. The strength of transformation providing a foundation for developing design-by-analogy to inspire greater, different, and an eclectic collection of problem-solving in design. It is clear that transformation can facilitate chair design into another level.

Thus, transformation fulfills a system to help improving chair functionality and usability by compromising between design and transformation theory.

Transformation Design Theory To understand the role of Transformation Design Theory, this section provides a discussion of several possibilities by the potential fomulated in the theory.

Transformer. Preliminary observations by Jason Weaver (2010) showed that transformation makes things truly portable. These products that transform are now called *transformer* in this paper. An example by Salom (2012) clearly exhibits the portability of a transformable furniture as shown in Fig.1.0. This foldable chair was designed for easy storage and accessibility, with a smart and elegant look of a flat packed wood. Hence, it has becoming a highly flexible hybrid of chair and transformer which supported by Jason Weaver (2010) that flexibility and convenience were achieved when the furniture is transformable.



Figure 1.00 The Leo Salom "Folding Chair"

Thus we can see that transformation design theory works well with the furniture piece in order to enhance its features and make it a value-added home piece. Apart from its original function (a surface to be seated), this theory has given the chair a new function with its portable characteristic.

Transformation Principles. Having established by Atif Qureshi (2006) , the principles of product flexibility has four general approaches to achieving flexibility, however Vikramjit Singh (2009) and Jason Weaver (2010) have another angle on transformation principles. The comparison of both principles are presented in table 1. Both principles are of equal importance , however Atif Qureshi (2006) had defined the flexibily principles based on flexible fuel cell in his studies, therefore the researcher attempts to adopt the transformation principles which more specifically on product transformer in order for the researcher to study an appropriate transformation process.

Table 1 Comparison of Principles

Principles of Product Flexibility	Transformation Principles
Modularity Approach	Expand/collapse
Spatial Approach	Expose/cover
Interface Decoupling Approach	Fuse/Divide
Adjustability Approach	

The following examples adopted from Vikramjit Singh (2009) bring out different sets of mechanical transformation derived from the transformation principles. Consequently, these principles aid to the transformer chair as raised in the Research Question No.1.

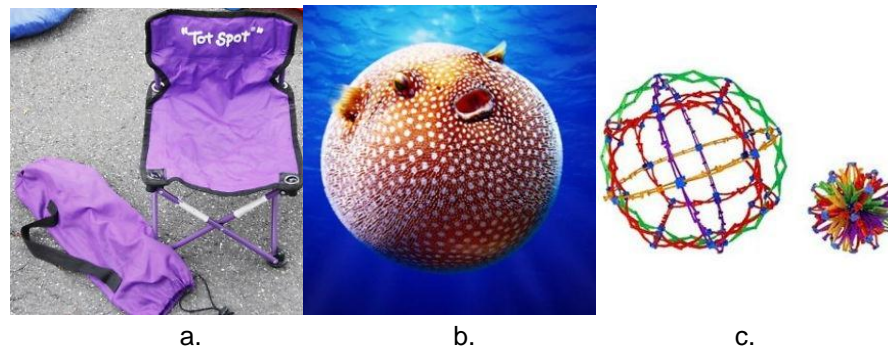


Figure 1.10 Examples of expand/collapse

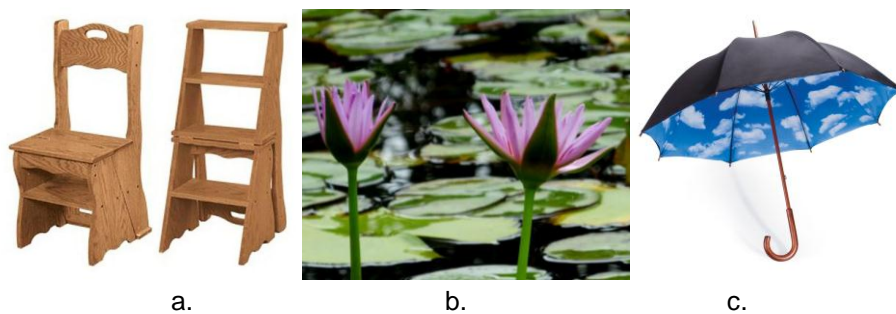


Figure 1.20 Examples of expose/cover

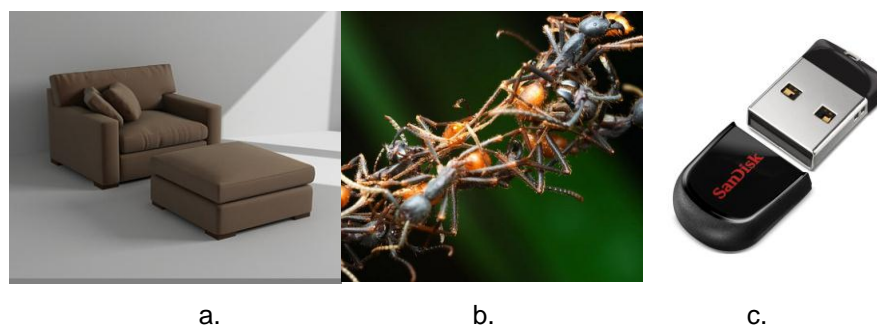


Figure 1.30 Examples of fuse/divide

From the above , it has clearly defined the meaning of the transformation principle with particular exemplar from chairs, natural analogies and products. Table 2 shows explain the principles more specifically.

Table 2 Transformation Principles and Its Meaning

Transformation Principles Example	Expand/Collapse	Expose/Cover	Fuse/Divide
a.	Portable Fishing Chair Fishing Chair expands for sitting purpose, collapses for storage.	Ladder Chair Ladder Chair transforming in ladder by exposing its structure.	Sofa It divides for foot resting purpose.
b.	Puffer Fish Puffer's natural defences, inflate its stomach to make the hungry predator feels unpalatable.	Water Lily Water Lily's opens to expose its petals and vice versa.	Army Ants Army Ants join their bodies to form a bridge.
c.	Hoberman Transforming Sphere It expands in diameter with a magical motion and vice versa.	Umbrella It exposes to protect against rain or sunlight.	USB Flash Drive It divides itself to connect to another device.

It is evident that chair design grows over a period of time and becoming more advanced, complete , or severe , would develop and develop fast with the potential of transformation theory.

Innovations in Design through Transformation. In recent years, there has been an increasing amount of literature on transformation design principles in mechanical design. Lately, innovations in design through transformation based on the fundamental study of transformation principles have identified the significance of new and original designed products with enhanced function. Vikramjit Singh (2009) coined this type of creation as transformer, in which transforming the product into separate arrangement or distinct condition however he argued that the present design theory lacks a thorough methodology for the potential transformable product. Therefore, Vikramjit Singh (2009) had carried out studies identifying the analogies in existing nature, patents, and products in different settings and circumstances based on their roles in general transformations to support his hypothesis as the element of innovative design process. This has shed a light on the importance of transformational chair design in which the researcher attempts to establish the mechanical transformation process design theory and R.A cellular structure analogue in Malaysia chair design. Therefore, this study is no more than an overture to an understanding of transformation design principles in mechanical design in which it could be applied in chair design.

Another way of viewing this, Takeo Igarashi (1999) highlights the transformation process in his editing operation study, he showed that there is a causal relationship between software editing and transformation. Simple primitives like pyramid or cylinder can be converted to a more innovative form through the transformation process or by

manipulating the primitive with a combination of a variety primitives. Alternatively, he mentioned that a few editing techniques would make transformation easier, for instance, bending, elongation, distortion, rotation, scaling and more.

Notably, besides transformation theory, Takeo's idea had shed a new light in developing chair design which contributing to Research Question No.1. The researcher believes it is necessary to discover new ideas by combining Vikramjit, Jason and Takeo's idea, beneficial in which raises their reliance towards innovation in design through transformation.

Why Transformer Product. Numerous studies in design for transformation have attempted to demonstrate the advantages of its application over the ordinary ones. As we can see, Brandon Walther (2007) draws our attention to *a specific physical configuration in which a system performs a function* where Vikramjit Singh (2009) considers *the art of creating new product, system, or process is an innovation* based on their understandings on transformer. Similarly, Jason Weaver (2010) also pointed out that transformation theory makes a product value-added. Building on from their ideas, the researcher intends to use her research to take their points further by combining both qualities and features in them. The strength of such an approach would be leading the chair design trend in the near future. These future improvements will contribute to new problem-solving in creating new design embodied all the essence from the transformational solutions. This section will next consider the benefits of transformer.

Transformer is called a multi primary-function product, according to Vikramjit Singh (2009) the existing products in the market are still primary-function product. For instance a common bicycle's primary function is to transport people from one place to another , eventhough it can also be used as a hanger to drape towels or blackets without reconfigure its structure. One of the classical transformer products as shown in Fig. 1.40 , on the other hand , falls into the category of multi primary-function products where this USB flash drive transformed into a leopard display toy adopted from Rubin (2014).



Figure 1.40 Transformer USB Flash Drive

Brandon Walther (2007) stated that the benefits of transformer comes form their possibility of changing/ converting themselves into a different configuration and enhance new performance , all within a one system. He also mentioned that, transformer is a product with refined simplicity, fidelity and consistency. In another major study by Vikramjit Singh (2009) who found that transformers are more user-friendly compared with a single primary-function product. Yet, there are more advantages to be discussed as listed below :

- A transformer performs better functions between states that might seem impossible for a single primary-function product.
- Manufacturing cost and sales price are reduced compared with the costs of a set of single primary-function product.
- A transformer comes in a lighter weight due to its compacted design.
- It facilitates new design solution for products that serve a wide variety of functions.
- It cuts down complexity and deployment time for many designs.

Although transformers may have many good points, it also has some drawbacks. Vikramjit Singh (2009) points out that transformation does, however may take longer initial time to develop a successful transformer due to its complexity. In addition, the compact design of a transformer might cause the conflict in function which will increase the weight, size and et cetera. Last but not least, a transformer frequently shares its component with two different functional parts which may or may not be compatible at times. Thus we can see that, there are pros and cons in transformer, yet, it is clear that transformer products have noticeable potential in Malaysia market and great promise in facilitating chair design.

MORPHOLOGICAL IDENTIFICATION OF RAFFLESIA

Introduction. There is a large volume of published studies describing morphological identification of the world's largest flower. *Rafflesia* differs notably from size, species, Danilo S. Balete (2010) prominently raised warts on the perigone lobes and diaphragm, the small anthers, the toroid annulus, the pleated, laminar and interconnected processes, also the cup-shaped disk ornamented with dense pubescence on the abaxial surface, in the anther sulci and corona extending to the basal third of the disk exterior. In order to gain better understanding of the morphology, the next section provides a general discussion of *Rafflesia* taxonomic.

Taxonomy. Taxonomy is defined as the naming process and classifying things such as plants and living creatures into common and distinct features, size and et cetera within a system. In September 2010, Danilo S. Balete (2010) has examined *Rafflesia Verrucosa* using scientific methods, he claims that *Rafflesia Verrucosa* is an endophtic, which is a plant living within another plant, or we called it parasite. *Rafflesia*'s taxonomy falls into a few parts – mature buds, perigone tube, flower, cupule, bract and perigone lobe (Fig. 1.5).

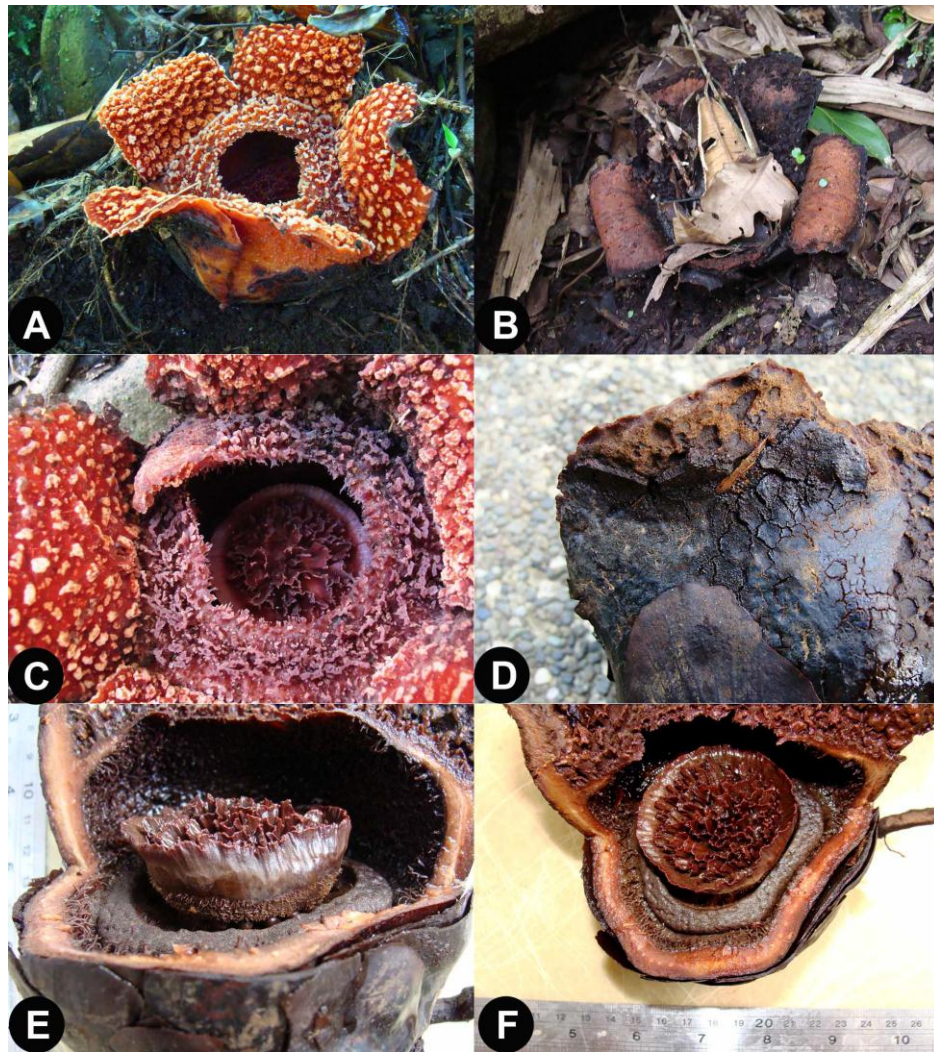


Figure 1.50 *Rafflesia Verrucosa's Taxonomy*

The taxonomy (Danilo S. Balete, 2010) explained as below :

- A. Newly-opened flower exhibiting its perigone lobes and diaphragm
- B. Senescent flower after fallen warts
- C. Prominent raised warts
- D. Perigone lobe and the flaking outermost tissue
- E. Internal components (acicular hairs , laminar, interconnected processes of the disk, and the shallowly rugose annulus)
- F. Top View (perigone tube interior : disk and its processes, and the annulus)

Rafflesia Genus. Recent studies clarifying the relative types of the world's largest holoparasitic flower. The current study by Julie F.Barcelona (2007) identifies various types of *Rafflesia* - *Rafflesia* Brown , *R. manillana* Teschem, *R. schadenbergiana* Gopp.ex Hieron, *R. speciosa*, *R.magnifica*, *R.baletei*, *R. lobata*, *Rafflesia* Banahaw. Likewise, Danilo S. Balete (2010) pinpoints 18 species of *Rafflesia* from Philipines (some have been brought out by Julie), *R. bengkulensis* from Sumatra, *R.azlanii* from Peninsular Malaysia, 5 species in Luzon which are *R.aurantia* Barcelonam, *R.baletei*,

R.leonardi, R. manillana and R. philippensis , two in Panay which are R. lobata and R. speciosa, R. manillana from Samar and R.speciosa from Negros, last but not least R. mira , R. verrucosa and R. schdenbergiana from Mindanao.

Rafflesia Studies. Prior studies by J.F. Barcelona (2009) have revealed the taxonomy, conservation status and ecology of *Rafflesia* endemic to Philippine, the character comparison between *Rafflesia* species in the Philippines are discussed in detail such as diaphragm aperture shape, disk processes disposition, ramenta size and shape, anther number and many more. On the other hand, Refaei J (2011) has conducted a research to isolate, identify and evaluate antimicrobial activity of *Rafflesia cantleyi* endemic holoparasite in Malaysia. His study has focused on the fungal DNA isolation, bioactivity microscopic morphology, molecular identification and et cetera. As well as a study by Davis (2008), he clarifies a remarkable *Rafflesia arnoldii* R.Br. from its diameters, patterns of floral size evolution, colour, texture and scent.

R.A Analogue Chair and Its Advantages. From the above, several conclusions emerge from this analysis, first and foremost, the study of *Rafflesia* could have two aspects – morphological and molecular identification. Secondly, numerous studies in *Rafflesia* have been done in the Philippines, which revealed that there is a paucity of research undertaken for *Rafflesia azlanii* , an endemic *Rafflesia* in Malaysia. This is supported by Refaei J (2011), he claims that *Rafflesia* is a remarkable and uncommon, endemic plant in South East Asia which has not been previously studied. Hence, he has tried to discover the facts of *Rafflesia cantleyi* and its endophytic component.

In contrast to what has been said, the researcher finds the study for *Rafflesia azlanii* is of paramount importance, this is because, as far as the researcher's concern, there has not been much study done for this species. Therefore, in this study, the researcher attempts to identify the significance of morphological and molecular identification for *Rafflesia azlanii*, to help the creating a new R.A plant morphology analogue chair design, to discover the endophytic component and character of R.A in order to be on par with other countries in South East Asia.

This will also help the researcher to answer Research Question No.3 and it is believed that this primary study of R.A plant/structure analogue chair design would bring Malaysia furniture design to another level. The findings of the research would provide a strong footing for students/designers/researchers to develop their research in this area. This innovative idea of R.A analogue chair incorporating transformation design theory would be able to trigger new pragmatic approach which representing Malaysia identity.

DESIGN BY ANALOGY

Analogy in Context. There are sameness in certain way when you draw an analogy between two things, this is supported by the Collins Cobuild Advanced Learner's English Dictionary carried out by Sinclair (2006). As well as a statement carried out by Brandon Walther (2007), he defines analogy as "you consider two or more things and discover the similarity between them". It has been established that analogy is two

lookalike each other either by appearance or feature. Analogy facilitates design by mimicking something else. To further understand the role of analogy, J. S. Linsey (2006) observes that during the concept generation in fashion, analogies always play vital roles incorporating innovative ideas to maximize the production.

To summarise, analogy strongly affects design process especially during the idea generation phase, which in other words, the crucial phase in design. Analogy would be the new rule that to suggest new possibilities facilitating the transformation of the object's structure.

Chair Design by Analogy and its Advantages. The analogous concept has gradually expanded and the evidence from the web highlights that this idea has developed fast. One of the most notable chair design by analogy has won the home furniture design concept award in the International Red Dot Design Award as shown in Fig. 1.60. According to Taoyang (2009), this Breathing Chair analogous to Tofu has its unique feature that can support the weight and buffer the pressure when someone sitting on it. Its flat surface would transform into two arms like an arm chair when a person is sitting on it.



Figure 1.60 Breathing Chair by Yu-Ying Wu

Mushroom furniture has always been fantasized to be brought to the real-world design. Another example from Klarenbeek (2013), a Dutch designer whom has created a 3-D printed Fungus Chair which makes the dream-come-true from fairy tales. Erik allowed yellow oyster mushrooms (Fig. 1.70) to grow on his chair to make it more attractive. This new idea by analogy would be the fast-growing trend for a sustainable future.



Figure 1.70 Fungus Chair by Erik Klarenbeek

Next, one more example adopted from Noxmag, reported by Noelia (2014), the unique Durian Sofa Design (Fig. 1.80) is the leading furniture trend in the future. It is comfortable by its look and texture. Noelia also mentioned that the sofa design analogous to Durian improves the quality of life and becoming the long-lasting furniture style.



Figure 1.80 Durian Sofa

Last but not least, this is one of RCA student who executed chair structure analogous to bubble (Fig. 1.90). This chair is an experiment to develop new foamed chair structure using casting process (Noe, 2009). Gilbert designed “SuperFoam” with consideration of foam properties so it is flexible, adjustable and easy to deform.



Figure 1.90 SuperFoam Chair by Rich Gilbert

To recap, there are many advantages incorporating analogy in design, for instance, it improves sustainability, fast-growing trend, makes better quality of life, enhance the ergonomics and aesthetic value of the product. In addition, an analogous design could feature the properties of the subject being analogued. The benefits from design by analogy would make a comfortable sitting experience and reduce stress, this is supported by Wagner (2014) that an ergonomic chair would maximize back support and helps to keep good posture while sitting. Thus, an analogous chair not only provides a fashionable sense but it also improves effectiveness and efficiency even for long sitting hours.

RESULT

The primary results of this paper include the following:

- A review of transformation design theory and its context
- A morphological identification of Rafflesia and its advantages on R.A analogue chair design
- A review of design by analogy and its advantages

A review of transformation design theory and its context .The transformation design theory and its principles brings possible solutions to chair transformation design problems. It is a higher level of problem-solving principles helping to grow of chair design in Malaysia. The researcher has analysed the potential theory and principles to be applied in the chair design process which would benefits the furniture industry in Malaysia. Furthermore, new design methodology would be developed based on the foundation of transformation design theory.

A morphological identification of Rafflesia. The morphological identification of Rafflesia provides insights about the characteristic and growth principle of R.A structure and form endemic to Malaysia resources; transformation process design theory that may influence the analogy between R.A cellular structure and chair design as a Malaysia identity product; and its benefits and guidelines to students/educators/designers of using R.A cellular structure as an analogy in developing chair design.

A review of design by analogy. This section reviewing the benefits of an analogous chair design and the definition of analogy. The researcher attempts to elaborate and connect the latest design for the past five years in order to understand the design analogy better. This may be of great influence for designers in their future work to assure that design by analogy would be the fast-growing trend for a sustainable future. Besides, it increases the flexibility of movement with better ergonomic and aesthetic value, needless to say, it increases effectiveness and efficiency at the same time.

CONCLUSIONS

The field of Rafflesia-structural analogues in chair design is relatively new but is growing with great rapidity. It is believed to increase in popularity with the growth of Malaysia Furniture Design Industry on a local context. A better understanding of transformation processes and its application in chair design becomes more significant with the fantastic combination of R.A structure/form when chair designs become accustomed to the furniture design field. This new concept will be able to produce innovative, practical

solutions with transformation processes which ameliorates a Malaysia identity chair design.

This research has terrific potential in furniture development and beyond, to make better contemporary chair design and more. It provides a good basis for students/educators/designers for the development of creative, innovative and functional solutions in design space.

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