Chair Design Analogy between Rafflesia Plant Cellular Structure and Transformation Design Theory

Zulkifli Muslim
(Student: Fu Chew Xiang)

Introduction

This research sets out with the principal aim of seeking an appropriate chair transformation process of design analogous to Malaysia endemic plant, Rafflesia Azlan (ii) cellular structure using a reference benchmark of Transformation Design Theory (A Meta-Analogical Framework) in the mechanical domain. The fundamental transformation principle is a comprehensive transformation process potential and analogy between the product, nature and function. Rafflesia Azlan ii, a Malaysian endemic species, is used as a subject for the development of a product such as a chair transformation design process.

In order to achieve the aims, the following objectives were formulated at an early stage of this research. First and foremost, to identify the characteristic and growth principle of R.A structure and form endemic to Malaysian identity analogue chair design. Secondly, to establish the mechanical transformation process design theory and R.A cellular structure analogue in chair design based on Malaysia products. Last but not least, to develop the benefits and guidelines to students/educators/ designers of using R.A cellular structure to use as an analogy in developing chair design.

Research Questions

There are three main research questions in this study. Firstly, what is design through transformation and how does transformation facilitate chair design? The second research questions is; how is analogue defined and what are the advantages and disadvantages of an analogue chair design? The third one is 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 on the characteristic and growth principle of R.A structure/form endemic to Malaysian resources; transformation process design theory that may influence the analogy between R.A cellular structure/form and chair design as a Malaysia identity product; and the benefits and guidelines to students/ educators/designers an using R.A cellular structure as an analogy that facilitates the development of chair design.

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 published by Sinclair (2006). Another line of thought on transformation by Jason Weaver (2010) suggests that transformation is the act of converting state of something to improve value and quality or adding on new function. The strength of transformation is in providing a foundation for developing design-by-analogy to insipired greater, different , and an eclectic collection of problem-solving in design. It is clear that transformation can facilitate chair design to 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 DePreliminary observations by Jason Weaver (2010) showed that transformation makes things truly portable. Products that transform are now called transformer in this paper. An example by Salom (2012) clearly exhibits the portability of transformable furniture as shown in Fig.1.0. This foldable chair was designed for easy storage and accessiblility, with a smart and elegant look of flat packed wood. Hence, it has becoming a highly flexible hybrid of chair and transformer and is supported by Jason Weaver's (2010) contention that flexibility conveniece can be achieved when the furniture is transformable.

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 achieve 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 defined the flexibily principles based on flexible fuel cell in his studies, therefore the researcher attempts to adopt the transformation principles more specifically on product transformer in order for the researcher to study an appropriate transformation process.

Figure 1: The Leo Salom "Folding Chair"

Salom, L. (2012, April 28). *trends: leo salom folding chair.* Retrieved from Trend Hunter Art & Design: http://www.trendhunter.com/trends/leo-salom-folding-chair.

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 3-4).

Figure 2: Examples of expand/collapse Vikramjit Singh, S. M. (2009). Innovations in Design Through Transformation: A Fundamental Study of Transformation Principles. Journal of Mechanical Design.

Figure 3**:** Examples of fuse/divide Vikramjit Singh, S. M. (2009). Innovations in Design Through Transformation: A Fundamental Study of Transformation Principles. *Journal of Mechanical Design.*

Figure 4: Examples of expose/cover Vikramjit Singh, S. M. (2009). Innovations in Design Through Transformation: A Fundamental Study of Transformation Principles. *Journal of Mechanical Design.*

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

Table 2 Transformation Principles and Its Meaning

	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.

Morphological Identification of Rafflesia
Introduction
In order to gain better understanding of the morphology, the next section provides a general discussion of Rafflesia taxonomic. 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. 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 (Figure 5).

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

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)

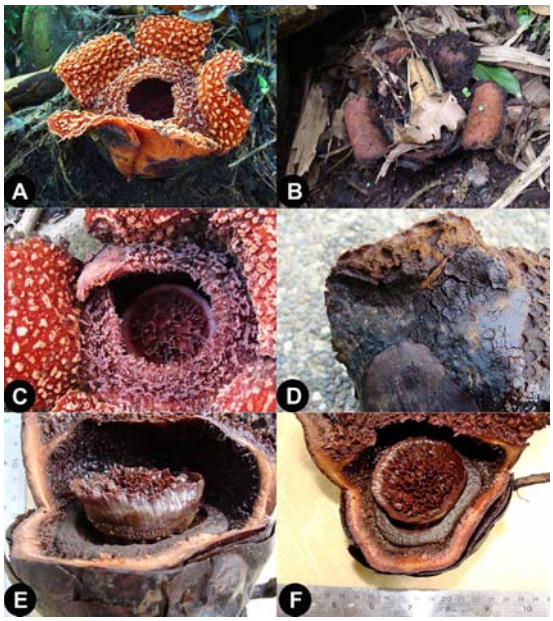


Figure 5: RafflesiaVerrucosa's Taxonomy

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 Rafflesiacantleyi 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 Rafflesiaarnoldii 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 Raflessia 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 Rafflesiaazlanii , 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 Rafflesiacantleyi and its endophytic component.

In contrast to what has been said, the researcher finds the study for Rafflesiaazlanii is of paramount importance, this is because, as far as the researcher is 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 Rafflesiaazlanii, to help the creation 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 similarities 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 apperance 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 rules incorporating innovative ideas to maximize the production. To summarise, analogy strongly affects design process especially during the idea generation phase, which in other word , 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 (Figure 6).

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 6: Breathing Chair by Yu-Ying Wu
Taoyang, S. (2009, October 26). cctv : special news. Retrieved from http://www.cctv.com/: http://www.cctv.com/english/special/news/20091026/103440.shtml

Mushroom furniture has always been fantasized to be brought to the real-world design. Another example from Klarenbeek (2013), a Ducth designer whom has created a 3-D printed Fungus Chair which makes the dream-come-true from fairy tales. Erik allowed yellow oyster mushroom (Figure 7) 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 7: Fungus Chair by Erik Klarenbeek
Klarenbeek, E. (2013, October 25). Ew, A Chair 3-D Printed Out Of Fungus. Retrieved from fastcodesign: http://www.fastcodesign.com/3020570/ew-a-chair-3-d-printed-out-of-fungus.

Next, one more example adopted from Noxmag, reported by Noelia (2014), the unique Durian Sofa Design (Figure 8) 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.

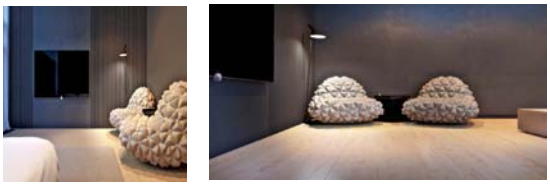


Figure 8: Durian Sofa
Noelia. (2014, July 2). Unique Durian Sofa Design At Room Corner Ocean Rocky House Image. Retrieved from NoxMag: http://www.nox-mag.com/brilliant-rocky-house-design-architecture-plan/unique-durian-sofa-design-at-room-corner-ocean-rocky-house/

Last but not least , this is one of RCA student who executed chair structure analogous to bubble (Figure 9). 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.

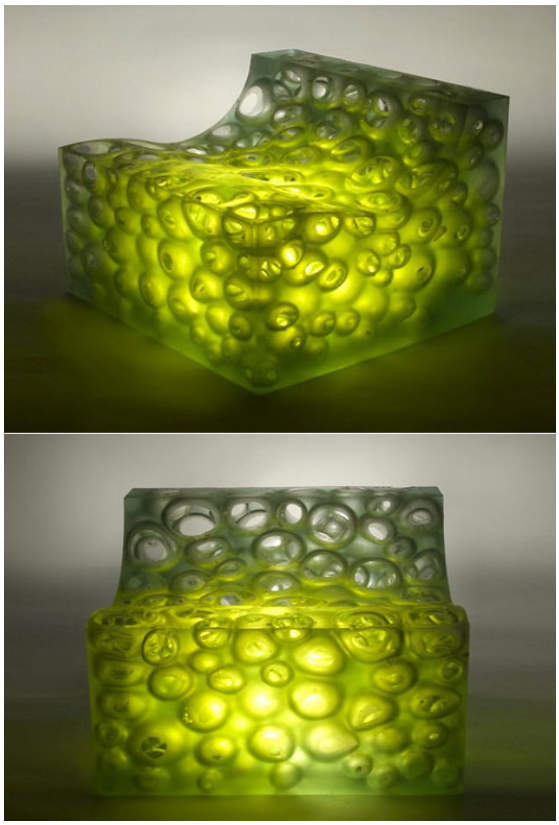


Figure 9: SuperFoam Chair by Rich Gilbert Noe, R. (2009, October 26). "SuperFoam" Chair. Retrieved from Core77: http://www.core77.com/blog/news/superfoam_chair_15042.asp

To recap, there are many advantages in 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 makes 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 fashinable sense but it also improve effectiveness and efficiency even for long sitting hours.

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.

Conclusion

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.

References

Atif Qureshi, J. T. (2006). PRINCIPLES OF PRODUCT FLEXIBILITY. ASME 2006 International Design Engineering Technical Conferences & Computers and.

Brandon Walther, J. K. (2007). Design for Transformation : Theory, Method and Application. ASME 2007 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference.

Danilo S. Balete, P. B. (2010). Rafflesia Verrucosa (Rafflesiaceae), a new species of small-flowered Rafflesia from Eastern Mindanao, Philippines. Magnolia Press, 49-57.

Davis, C. C. (2008). Floral Evolution: Dramatic Size Change Was Recent and Rapid in the World's Largest Flowers. Current Biology.

J. S. Linsey, J. T. (2006). Representing Analogies: Increasing The Probability Of Innovation. International Design Engineering Technical Conferences & Computers and Information in, September 10-13.

J.F. Barcelona, P. P. (2009). Taxonomy, ecology, conservation status of Philippine Rafflesia (Rafflesiaceae). Blumea, 77-93.

Jason Weaver, K. W. (2010, September). Transformation Design Theory: A Meta-Analogical Framework. Journal of Computing and Information Science in Engineering, 10. doi:10.1115/1.3470028

Julie F.Barcelona, P. B. (2007). Rafflesia Banahaw (Rafflesiaceae), A New Species From Luzon, Philippines. BLUMEA, 345-350.

Klarenbeek, E. (2013, October 25). Ew, A Chair 3-D Printed Out Of Fungus. Retrieved from fastcodesign: http://www.fastcodesign.com/3020570/ew-a-chair-3-d-printed-out-of-fungus

Noe, R. (2009, October 26). "SuperFoam" Chair. Retrieved from Core77: http://www.core77.com/blog/news/superfoam_chair_15042.asp

Noelia. (2014, July 2). Unique Durian Sofa Design At Room Corner Ocean Rocky House Image. Retrieved from NoxMag: http://www.nox-mag.com/brilliant-rocky-house-design-architecture-plan/unique-durian-sofa-design-at-room-corner-ocean-rocky-house/

Refaei J, J. E. (2011). Endophytic Fungi from Rafflesia cantleyi: Species Diversity and Antimicrobial Activity. Mycosphere.

Rubin, D. (2014, June 24). USB DIRECT : Our Technology Blog. Retrieved from Have Some Fun with Your USB Flash Drive: http://usbdirectcanada.ca/blog/2014/06/24/have-some-fun-with-your-usb-flash-drive/

Salom, L. (2012, April 28). trends: leo salom folding chair. Retrieved from Trend Hunter Art & Design: http://www.trendhunter.com/trends/leo-salom-folding-chair

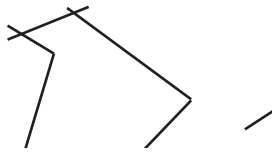
Sinclair, J. (2006). Collins Cobuild Advanced Learner's English Dictionary. Glassgow: HarperCollins Publishers Limited.

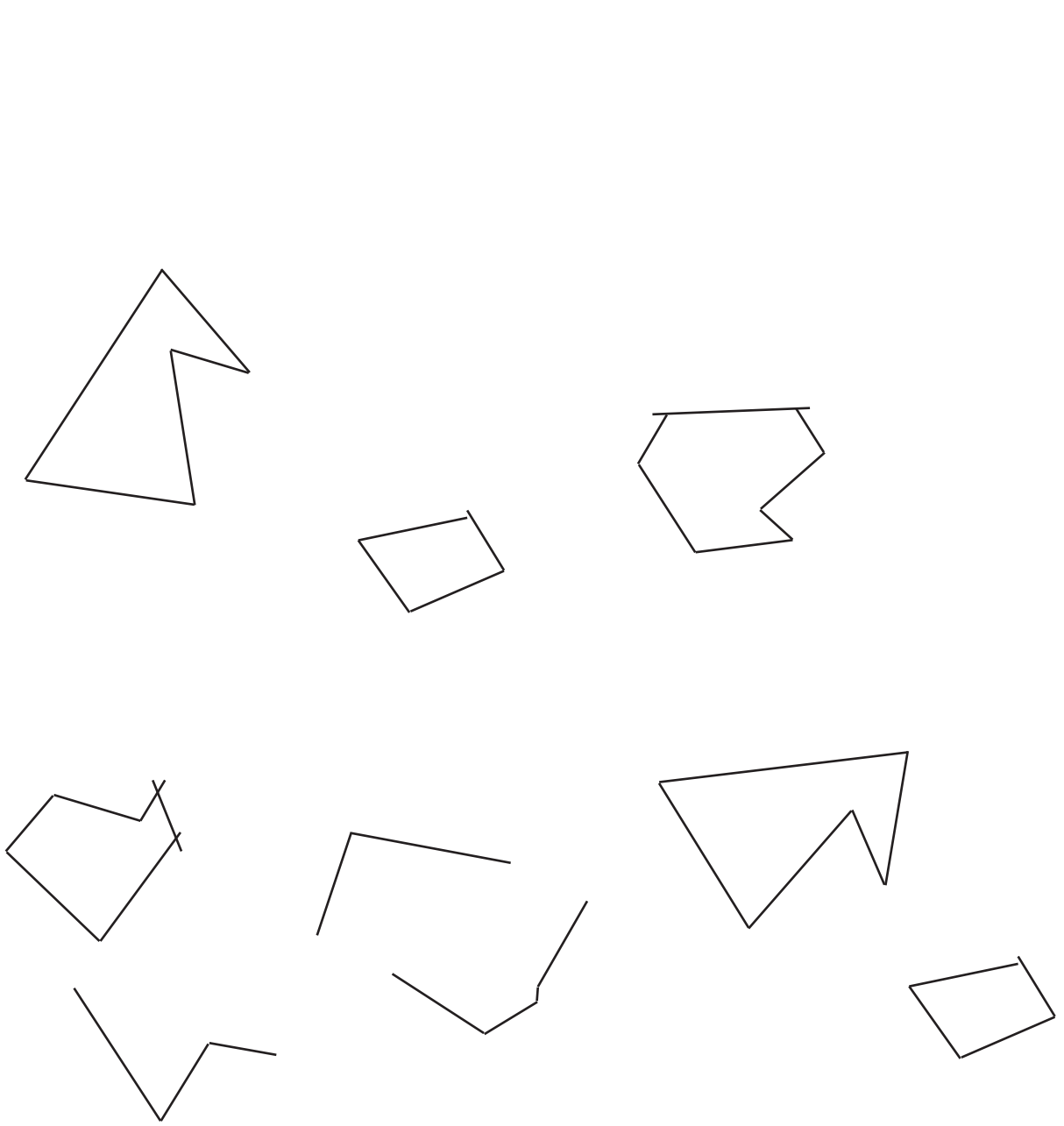
Takeo Igarashi, S. M. (1999). Teddy : A Sketching Interface for 3D Freeform Design.

Taoyang, S. (2009, October 26). cctv : special news. Retrieved from http://www.cctv.com/: http://www.cctv.com/english/special/news/20091026/103440.shtml

Vikramjit Singh, S. M. (2009). Innovations in Design Through Transformation: A Fundamental Study of Transformation Principles. Journal of Mechanical Design.

Wagner. (2014, May 7). Chairs for a healthy lifestyle. The star newspaper.





industrial design