The Grasshopper+Rhino for 3D Modelling in Indonesian's Education of Biomimetic Architecture

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ABSTRACT
In the past, humans used nature as building inspiration. Natural inspiration is translated into buildings through a trial and error process that is practically in the field to find the ideal shape that suits the natural conditions. Currently, the use of natural inspiration as an idea for the form of biomimetic architectural buildings is increasingly facilitated by increasingly sophisticated technological developments. One of the technologies currently used by biomimetic architects in designing is using computational equipment. Architects use computing equipment in the form of digital technology to facilitate the translation of design ideas, which is related to the translation of natural inspiration into building forms. Grasshopper+Rhino software is one of the software used to translate natural inspiration that has a dynamic form into a detailed model design. However in the world this software used widely for academic needs to translate natural inspiration into building designs, but in Indonesia used others software to implemented natural inspiration into technologies. So, the purpose of this paper is to determine how far the gap in the use of Grasshopper+Rhino software in Indonesia for biomimetic architecture education. The method used is descriptive quantitative by counting the design case samples using Grasshopper+Rhino software. The results show that 97% of cases in Indonesia use other software to design building technology inspired by nature. This shows that the gap between Indonesia compared to other countries about Science and Technology of Biomimetic Architecture Education.

Keywords: *Digital technology education, Biomimetic architecture, Grasshopper+Rhino.*

1. INTRODUCTION

Science in architecture is constantly evolving along with the development of human needs and the increasing development problems that occur, especially the need for a decent place to live. Humans are trying to find solutions to adapt to various environmental conditions. Human science impacts the development of technology used by humans so that the development of science and technology becomes attached. Computing technology is one of the methods used by humans today to facilitate finding solutions. *Computing technology* is a human scientific development that combines computing and communication devices. Computing technology becomes a human intermediary to collect information that helps humans more effectively and efficiently. The development of science and technology in academia is required to make adjustments as soon as possible due to the demands of the times. Lagging at the academic level in introducing and adapting to the development of science and technology has resulted in a lack of qualified human resource capabilities in the era of globalization. So it is necessary to adjust the world of higher education to align with world technological developments.

Grasshopper+Rhino software is one of the most popular software in Biomimetic Architecture science in the era of globalization. The way the Grasshopper software works, which uses mathematical and parametric calculations, makes this software have the privilege of creating large diversity efficiently. Grasshopper software is widely used to translate natural inspiration into human technology because the diversity of natural elements can be translated measurably with this software [1]. The author raised this theme to see how far the Grasshopper software as a tool in design learning with a biomimetic architectural approach has been carried out in Indonesia.

2. LITERATURE

2.1. Nature to Human Technology Translation

Humans have felt the inspiration of nature as part of solving building problems since time immemorial. Humans started by using materials from nature and getting lessons from nature to survive on earth. Nowadays, inspiration from nature is increasingly being used with increasing advances in human science and technology. The field of science began to collaborate between sciences to create more innovative technologies such as biology and architecture. Various kinds of communicative computing tools support nature as an inspiration for human technology in building natural principles into a technological design.

Nature, in general, has nine principles of life [2]. Humans use these principles to translate nature into human technology. The principles consist of (1) Nature prioritizes cooperation, (2) Nature continuously adapts functions, (3) Nature is a collection of diversity, (4) Nature is recycling, (5) Nature depends on local elements around it, (6) Nature limits itself from within, (7)Nature tries to its limits, (8)Nature uses the energy it needs, (9) Nature depends on the sun. These nine principles produce the complexity of natural elements that work optimally, efficiently and effectively. These traits are translated into human technology.

Nature can influence human technology [2] in some ways based on the nine principles of nature's life, namely the ability of nature to directly be a source of inspiration, nature can produce water, nature responds to the sun as an energy source, efficient forms of natural structure, natural materials consist of a size scale with specific functions, the natural selection process results in the ability of natural evolution to survive, the use of materials that are not toxic to the body, natural tissues adapt environmental resources, nature has adequate circulation and movement so that it uses less energy, nature can survive and regenerate, nature responds to environmental conditions; lastly the natural cycle is sustainable. Humans use these twelve principles in producing some innovative technologies. Biomimetic Architecture uses a building design approach that uses inspiration from nature to be applied to new building design technologies both as models, measurements, and mentors [2].

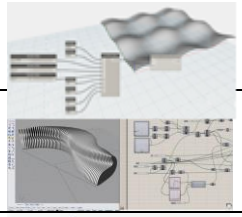
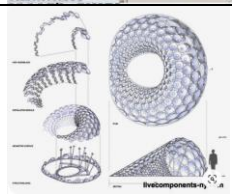
2.2. Grasshopper+ Rhino in 3D Modelling

Grasshopper is a visual programming language in an additional plugin in the Rhinoceros 3D modelling software (). Rhino is a modelling tool widely used in the world of architectural design and has been involved in some of the most ambitious design projects (quoted from www.rhino3d.com accessed January 8, 2022, 11.00 am). Rhino builds modelling using scripting languages, while artists and architects rarely learn scripting languages to create models. The Grasshopper plugin helps build algorithms that generate modelling in Rhino with more accessible techniques so Grasshopper+Rhino used a graphic engineering approach that can make it easier for artists or architects to design models without studying scripts.

Results 3D Modeling using Grasshopper+Rhino offers the ability to create complex 3D model formations with simple iterations. The repetition is controlled by an algorithms approach that allows a more flexible form display than other 3D Modeling software. Grasshopper+Rhino can create detailing, the possibility of creating shapes outside of the general structure, and the possibility of producing complex curved shapes with freeform surfaces. The ability of Grasshopper + Rhino makes it easy for biomimetic architects to translate nature with organic forms with high diversity into a technological design efficiently [3]. Grasshopper+Rhino's other advantages of Grasshopper+Rhino are detailing, automation, better speed, availability of modules, and ease of integration with other interfaces.

The view of Grasshopper before creating a 3D parametric model in Rhino view can be algorithmic, numerical, textual, audio-visual and expands into building analysis. The main window of Grasshopper is canvas and palettes, which has several essential components such as zooming user interface, component palettes, colour picker, find dialogue, multi-document interface, command prediction, and node-based editor. Based on the colours, textures and shapes generated from the visual image display of Grasshopper+Rhino as shown in the table 1 below.

Table 1. Character display 3D modelling Grasshopper+Rhino

No	Character	Visual Display	Description
1	Color[a]		The colour displayed from the visual image of Grasshopper+Rhino is a combination of shades of grey gradation with colours that tend to be soft/not flashy.
2	Texture		The tendency of texture appearance on the image produced by Grasshopper+Rhino is smooth and shiny
3	Form		The appearance of the shape of the visual image produced by Grasshopper+Rhino, in general, has a shape that tends to be curved, repetitive, high diversity and detail.

3. METHODS

The method used is the descriptive quantitative method. The quantitatively obtained by calculating how much the primary image data (case design studies with Biomimetic Architecture in Indonesia) have similar visual information if compared with Grasshopper 3D modelling stage image. Parameters to compared are colour, texture and shape (from theory Analysis Similarity Image Feature) [4]. The research results are expected to provide benefits as data for the implementation of science and technology, in this case, the Grasshopper software in Indonesian biomimetic architecture education to reduce the gap in biomimetic architecture education in Indonesia and abroad.

4. RESULTS AND DISCUSSION

The condition of the development of architectural education related to the implementation of Biomimetic Architecture in education can be described in some scientific papers produced at the College of Architecture. Papers equipped with pictures as the primary source in analysing the similarity of visual image results are essential data from this research. Meanwhile, after screening the data of scientific works produced in architecture lectures with the Biomimetic Architecture approach or Bioimicritic Architecture in Indonesia, 30 scientific papers were found in theses, theses, journals, and scientific articles were chosen randomly. For the 30 scientific papers, data were taken to display visual images resulting from 3D Modeling in translating natural inspiration into architectural technology. The results of the visual image data are compared with the results of the visual image data from Grasshopper+Rhino. The comparison results will be found visual images of design cases using 3D Modeling computational technology with Grasshopper+Rhino in Biomimicry Architecture learning. So with this comparison, it is found to what extent the massive use of Grasshopper Software used in foreign countries has been implemented in 3D Modeling of Indonesian Biomimetic Architecture.

The comparison of the similarity of the 30 data with the characteristics of the visual image display using Grasshopper+Rhino is as shown in the table 2 below.

Table 2. Visual image similarity comparison

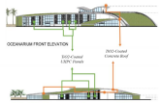
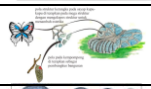
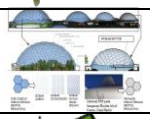
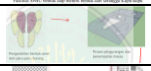
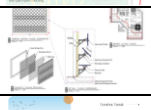
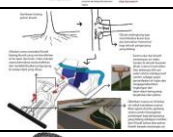
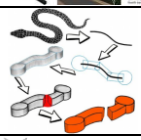
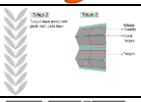
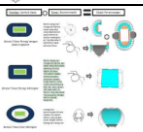
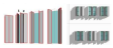
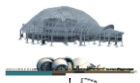
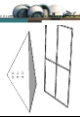
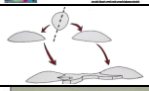
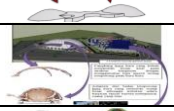
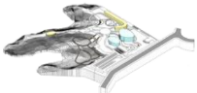
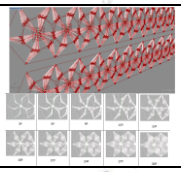
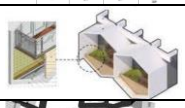
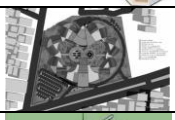
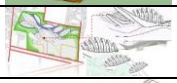
No	The Case of Technology in Indonesia Education	Visual Image Display		
		Color	Texture	Form
1 [5]		X (no grey gradation)	X (not shiny)	X (curve with no repetition)
2 [6]		X (no grey gradation and flashy color)	X (not slippery and shiny)	X (curve with no repetition)
3 [7]		X (flashy color)	X (not slippery and shiny)	V (curve with repetition)
4 [8]		X (flashy color)	X (smooth but not shiny)	X (curve with no repetition)
5 [9]		X (flashy color)	X (rough and not shiny)	X (curve with simple repetition)
6 [10]		V (color grey gradation)	X (not shiny)	X (curve with no repetition)
7 [11]		V (color grey gradation)	X (rough and not shiny)	X (typical form)
8 [12]		V (color grey gradation)	X (rough)	X (curve with no repetition)
9 [13]		V (color grey gradation)	X (rough and not shiny)	X (curve with no repetition)
10 [14]		X (flashy color)	X (rough)	X (no repetition)
11 [15]		X (flashy color)	X (rough)	X (curve with no repetition)
12 [16]		V (color grey gradation)	X (rough, not shiny)	X (typical repetition)
13 [17]		V (flashy color)	X (rough, not shiny)	X (curve with typical repetition)
14 [18]		X (flashy color)	X (rough, not shiny)	X (curve with, simple typical repetition)
15 [19]		X (color grey gradation)	X (not shiny)	X (simple typical repetition)
16 [20]		V (color grey gradation)	X (not shiny)	X (typical repetition)

Table 2. Cont.

No	The Case of Technology in Indonesia Education	Visual Image Display		
		Color	Texture	Form
17 [21]		X (flashy grey gradation)	V (shiny)	V (curve, and repetition with diversity)
18 [22]		V (color grey gradation)	X (rough)	X (typical repetition)
19 [23]		V (color grey gradation)	X (not shiny)	X (curve with typical repetition)
20 [24]		X (flashy color)	X (not shiny)	X (curve with no repetition)
21 [25]		V (color grey gradation and soft)	X (not slippery and shiny)	X (curve with no repetition)
22 [26]		X (flashy color)	X (not shiny)	X (curve with no repetition)
23 [27]		X (flashy color)	X (rough)	X (curve with no repetition)
24 [28]		V (color grey gradation)	X (not shiny)	X (curve with no repetition)
25 [29]		V (color grey gradation, and soft)	V (slippery and shiny)	V (curve, repetition and detailing)
26 [30]		X (flashy color)	X (not slippery and shiny)	X (simple typical repetition)
27 [31]		X (flashy color)	X (rough)	X (curve, typical repetition)
28 [32]		X (flashy color)	X (rough)	X (curve with no repetition)
29 [33]		X (flashy color)	X (not shiny)	V (curve, repetition with diversity)
30 [34]		V (color grey gradation and soft)	X (not shiny)	V (curve, detailing with repetition)

Based on the comparison table between the visual image characters of Grasshopper+Rhino and the visual image of the case of building design with the Biomimetic Architecture approach, it was found one case of a building sourced from scientific papers in Indonesia using Grasshopper+Rhino software and 97% using other software in producing 3D Modelling designs. With Biomimetic Architecture. These results show that the use of Grasshopper + Rhino in the academic world in Indonesia to support the development of biomimicry architectural designs has not followed the development of foreign science and technology.

Table II also shows that 77% of design cases using the Biomimetic Architecture approach demand to produce design works with a curved shape. A *curve shape* is a form that characterizes organic formations. In addition, the shape characteristics also show that 50% of

design works require a form that contains repetition to translate natural inspiration into design form. Both of these things show the ability of 3D Modeling software for academic educational activities. Biomimicry Architecture must support the ease of translating nature which has various forms, high flexibility, detail and organic so that the tool will increasingly accommodate users in the academic field to translate natural inspiration more flexibly, such as 3D Grasshopper+Rhino.

5. CONCLUSION

Grasshopper+Rhino is a 3D Modeling software that offers convenience in parametric design. The advantages of software to produce shapes with high diversity and detail quickly make it easier for designers with Biomimetic Architecture to translate natural inspiration into designs. This result is evidenced by the Grasshopper+Rhino software used, which is still quite international in Biomimetic Architecture education. Based on the research results in Indonesia, this software has not been widely used to help translate natural inspiration into 3D Modeling designs to translate the form of technology so that the gap in the ability of science and technology in Indonesia is relatively high besides education in the world for biomimetic architecture. In contrast, the demands for the translation of natural inspiration, which has curved and repetitive characteristics, into human technology design requires the help of computational techniques that can work efficiently and effectively.

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