



Biophilic Design: Why Do Designers Incorporate Living Organisms in Furniture Design?

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Abstract: Biophilia theory proposes that human beings have an innate tendency to connect with nature. Biophilic design is Biophilia applied to the design of the built environment. A survey of the literature found a gap in the application of Biophilic Design to furniture design. Thus, this study aimed to understand the relationships between Biophilic design and Furniture Designs with Living Organisms (FDLOs). This paper discusses the results of interviews with designers of FDLOs. Moreover, this paper discusses the development of a conceptual model to identify and categorise the rationale behind why designers embedded living organisms into furniture design, based on a typology of 235 FDLOs (incorporating plants, animals, and insects). The conceptual model was also tested through an online survey along with a brief explanation of the preferences, perceptions and emotional responses towards selected FDLOs, by participants in the study. Main findings of the study are in relation to the intentions of the FDLO designers for embedding living organisms in furniture, which were found to be predominantly for functional and experiential purposes, rather than for experimentation, or simply as an aesthetic pursuit.

Keywords: Biophilia; Biophilic Design; Furniture Design with Living Organisms.

1. Introduction

Biophilia theory proposes a reconnection with nature (Wilson, 1984). Biophilic design helps people to be close to nature, especially in the built environment (Kellert et al., 2008). Designers, architects, and others have studied the importance of connecting people with nature to improve human health and well-being. The people who design with nature in mind may have different reasons for doing so, and this is found to be a subject worth studying. Several related studies have been conducted in the fields of psychology, human behaviour and health. Studies about the effects of plants in hospitals and workspaces have shown that being close to nature helps in patients' recovery (Baun et al., 1984; Odendaal, 2000; Walsh, 2009a; Walsh, 2009b, among others), or have a positive effect on the performance of workers in their offices (Kaplan, 1995; Gray and Birrell, 2004; Grinde and Patil, 2009). Even images of greenery can help patients to feel better. Pot plants or small aquariums in

living spaces or offices can make a big difference in people's attitude, behaviour, and lifestyle (Kaplan, 1995; Gray and Birrell, 2004; Grinde & Patil, 2009). After reviewing several previous related studies, the literature review evidenced that there were no apparent research studies regarding biophilia theory or biophilic design specifically related to furniture design. Studies by Wolfs (2015) and Windhager et al. (2010) were found to be the most relevant to the project described here. Also, studies by Roth (2005) and Gatersleben (2011), confirmed that online questionnaires based on images are valid tools to gather data in this field. Studies on emotional design, especially by Desmet (2000, 2012), Dazkir and Read (2011) and Barrass (2013) were also used as guidelines to plan the online questionnaire with the aim of obtaining an understanding of possible emotional responses to FDLOs.

Embedding living organisms in furniture designs may be undertaken for many different reasons which are worth investigating. In addition, reactions by potential users, or the general public, to such furniture designs may provide useful design information or guidelines. This research project was developed in five stages, namely: 1) an initial compilation and classification of FDLOs was carried out, 2) a conceptual model was developed, 3) online survey to validate the conceptual model was undertaken, 4) interviews were conducted with designers of FDLOs, and finally 5) triangulation of the findings from the online survey and the interviews was performed. This paper only summarises the main aspects of these five stages.

2. Furniture designs with living organisms (FDLOs): initial observations

To identify this new genre of furniture design, hundreds of design sources were reviewed, including design books, magazines and websites. This type of furniture design was usually categorised under 'eco-design', 'sustainable design', 'green design' or 'biomimicry', and was even called 'living furniture' by certain design media. Although having living organisms in furniture could be related to bio-inspired design or biomimicry, the cases here are not necessarily "inspired" by nature, but rather incorporate it. As such, we do not consider them as Biomimicry examples.

The development of a new typology to classify FDLOs is one of the main contributions to the knowledge of this research project. FDLOs can be defined as furniture design which incorporates natural living organisms, such as live plants or animals as seen in Figure 1.1 below. FDLOs may vary in type, function, shapes and forms, materials, and colours. In the final phase of this research, 235 FDLOs were classified, mainly according to function (chair/ bench, table and other types of furniture design) and context (indoor and outdoor). The 235 selected pieces were divided as follows; 38 indoor chairs or benches, 38 outdoor chairs or benches, 52 indoor tables, 18 outdoor tables, 67 other types of indoor furniture, and finally 22 other types of outdoor furniture. These categories form the initial basis of the typology proposed in this research, as will be discussed later.

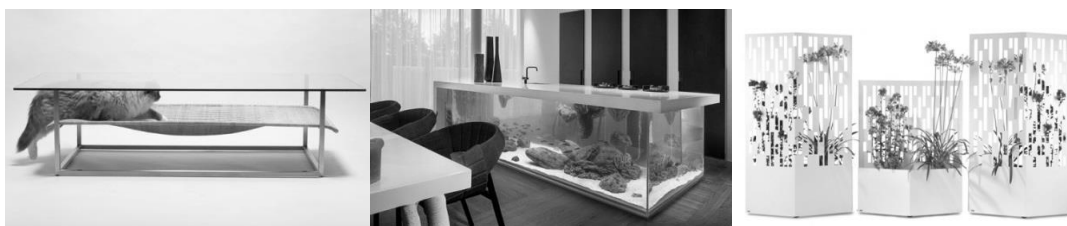


Figure 1.1: Selected examples of FDLOs (source: Sayuti, 2016)

2.1. Development of a conceptual model to classify FDLOs

A conceptual model was developed to identify and categorise selected furniture designs and to identify the reasons why designers embed living organisms in furniture (Sayuti et al., 2015). After several iterations, the final conceptual model was designed with 6 variations of 4 colours to aid understanding: Blue (A), Orange (B), Purple (C), and Green (D). This conceptual model also includes a coding which helped to identify, categorise and visualise the results from the interviews

with FDLOs designers and surveys with designer groups. The final conceptual model consists of 4 main categories (Sayuti et al., 2015), which are *A: Function and Practicality*, *B: Aesthetic and Semantic*, *C: Experience* and *D: Experimental* and 24 subcategories, wherein each main category has 6 subcategories, as listed in Figure 1.2. The detail subcategories of each main category in the conceptual model can be seen in Figure 1.2 below. The conceptual model was tested and validated through an online survey, as well as through interviews with designers of selected FDLOs.

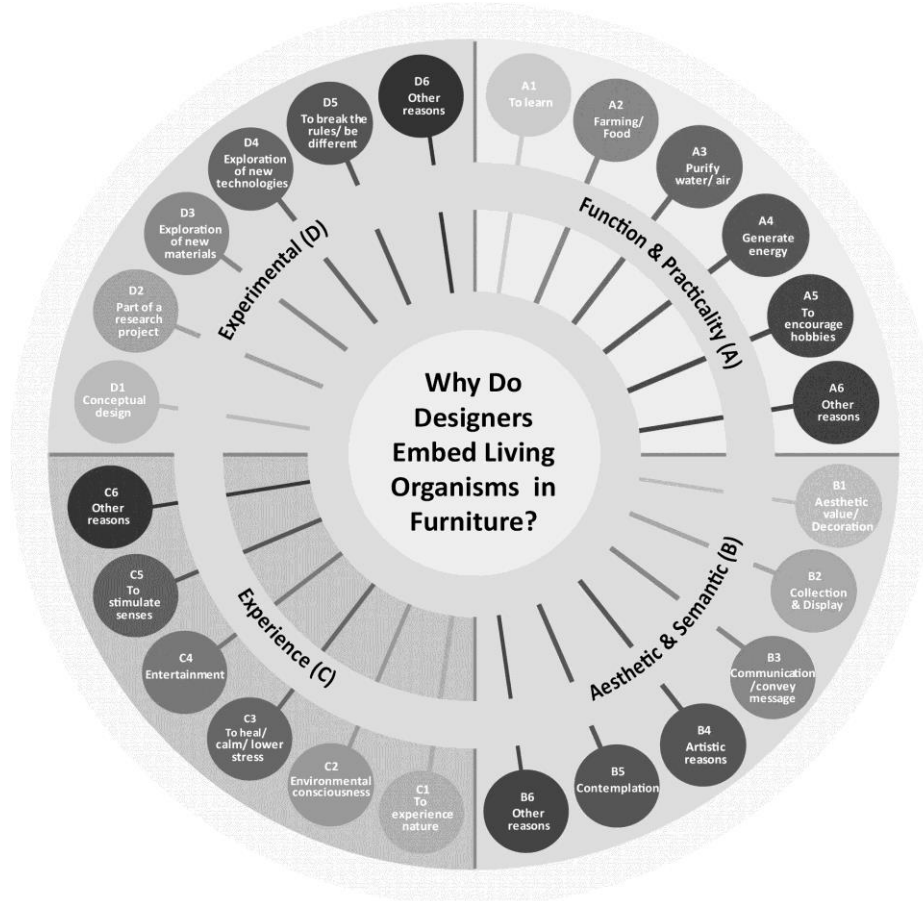


Figure 1.2: Final development of a conceptual model for FDLOs (source: Sayuti, 2016)

3. Online survey

Initially, a range of people aged 18 to 60 and from different countries was chosen randomly to participate in an online questionnaire disseminated through social media and emails. Around 287 responses were received. For brevity, this paper only discusses the findings from 92 respondents (Designers group). The identified respondents were from the areas of *Art and Design/ Creative or International Designers (ID)* which consist of 65 respondents, and 27 responses were sourced from *Australian Designers (AD)*. These above groups were the most significant (stratified) for this study. Table 1.1 below shows the breakdown of respondents received for this study.

Table 1.1: The breakdown information of data gathered from the online survey respondents

Online Survey Data	Respondents
Overall number of Respondents	287
First Data Set – General Respondents	260
Second Data Set – Stratification Group (Designers, Educators, and Students)	197
Third Data Set - Australian Designers (AD)	27
Fourth Data Set – Australian Designers (AD) and International Designers (ID)	92


Several iterations of the questionnaire, as well as pilot tests, were conducted. The final online questionnaire had five sections and was designed to gather different data using surveyGizmo.com online tool. Section A informed *Basic Demographics*. In section B (*Design Preference* section, consisting of 10 questions) respondents were asked to choose their preferred designs. Section C (*Emotional Design*, also 10 questions) asked respondents to rate their emotions while seeing the images of the FDLOs. In section D (*Conceptual Model* section), as noted again below, respondents were asked to choose a minimum of 4 from 24 subcategories, in relation to 10 selected FDLO images. The final Section E, (*Biophilic Design*) asked about respondents' personal preferences about nature and living organisms, and their knowledge about biophilic design. Section E used closed-ended questions and Likert Scales. A pilot study was carried out before the actual survey with a small group (7 invited people) before the actual questionnaire was disseminated to ensure the questionnaire was easily understandable and practical for respondents. Amendments were made to plan and refine the questions or features of the questionnaire for findings analysis. All of the data were analysed using SPSS (The Mann-Whitney test and the Kruskal-Wallis H test) and Microsoft Excel software.

For brevity, in this paper, discussions are restricted to the overall summary for Section D and related interviews, as both were linked to the conceptual model. The findings from Section D were also triangulated with the findings gathered from the interviews.

3.1. Summary of results of Section D: conceptual model for classification of FDLOs

As noted, Section D was related to the *Conceptual Model*. Through the online survey, respondents were asked to choose at least 4, from 24 subcategories, to describe the given images. This section was designed to validate the proposed Conceptual Model shown in Figure 1.2 above. Brief information about each FDLO was provided near each image to help respondents answer the questions based on information about the furniture piece so as not to only rely on the visual appearance of the FDLOs. Table 1.2 below summarises the top 10 answers from the online survey, as chosen by the two designers groups listed in Table 1.1 above. The coding on the subcategories helps to relate this to the categories in the conceptual model. These subcategories were selected according to the well known Pareto Principle which states that 20% of the causes can result in about 80% of the effects (<http://betterexplained.com/articles/understanding-the-pareto-principle-the-8020-rule/>). As such, results over 20% were selected to define the main category to which the FDLOs belonged to. It was concluded from the findings that both designer groups agreed that *The Rococo Retrofitted Chair* in Table 1.2 belonged to the three categories of 1) Experimental, 2) Experience and 3) Aesthetic & Semantic. The similarity in subcategories can also be seen below.

Table 1.2: Example of the top 10 answers for a specific FDLO linked to each question in the subcategories of the Conceptual Model in the online survey (source: Sayuti, 2016)

Furniture Design with Living Organisms (FDLOs)/ Questions	Subcategories of the Conceptual Model – from the Online Survey					
Q1: The Rococo Retrofitted Chair 	Australian Designers (AD)	D5	B4	D1	B2	D2
		70.40%	63.0%	63%	33.30%	22.20%
		C2	C5	C1	C4	D3
		22.20%	22.20%	18.50%	18.50%	18.50%
		Experimental: D5, D1, D2, D3 Experience: C2, C5, C1, C4 Aesthetic & Semantic: B4, B2				
	International Designers (ID)	D5	B4	D1	B2	B1
		50.80%	44.60%	41.50%	35.40%	33.80%
		C1	C4	D2	C5	B3
		30.80%	27.70%	23.10%	23.10%	18.50%
		Aesthetic & Semantic: B4, B2, B1, B3 Experimental: D5, D1, D2 Experience: C1, C4, C5				


4. Interviews with designers of selected FDLOs

Out of 100 designers contacted, seventeen (17) designers of FDLOs agreed to be interviewed via Skype. These interviews were conducted to find out the rationale and reasons behind the designs, and why the designers embedded living organisms into the furniture pieces. Interviewed designers were from the USA, Germany, Sweden, Norway, Iceland, Mexico, South Korea and Japan. In relation to methodology, Collins et al. (2007) and Onwuegbuzie and Collins (2007) recommended at least 12 respondents for common quantitative and qualitative research designs. A semi-structured interview format was used to gain feedback from respondents. 13 main themes were structured and analysed using NVIVO qualitative analysis software. The themes are; 1) *Reasons for using living organisms*, 2) *Main purpose for designing the furniture*, 3) *Communication and conveying a message*, 4) *Design concept of FDLOs*, 5) *Inspiration of FDLOs*, 6) *Commercialized or Conceptual furniture*, 7) *Knowledge of biophilia theory or biophilic design*, 8) *Awareness of biophilia theory or biophilic design while designing the FDLOs*, 9) *Reasons for choosing specific living organisms*, 10) *Knowledge of emotional design*, 11) *Application of emotional design*, 12) *The effects of natural elements towards furniture design*, and 13) *Response of viewers towards FDLOs*. The themes were mostly linked to the noted Conceptual Model. The overall results suggested that the designers were more focused on functionality, practicality and user experience reasons, rather than on experimental, aesthetic and semantic reasons. Nature, plants or animals, scored the highest percentages as inspirational bases to design the FDLOs. A classification table, as shown in Table 1.3, was developed to present the results visually and summarise the categories from the Conceptual Model for FDLOs in relation to furniture designs by interviewed designers.

4.1. Classification table

Table 1.3 below summarises, classifies and explains the FDLOs designed by the designers interviewed, in relation to the Conceptual Model. This table also summarises the reasons that designers employed to embed living organisms into their designs. For example, the Stitch Table can be categorised mainly in category B (Aesthetic and Semantic), because of a majority of 3 subcategories listed B1, B2 and B3, as stated by the d FDLO designers. Answers from the interviews determined the main category of each selected FDLO, where each main category received at least 2 or more subcategories responses.

Table 1.3: Sample classification table for the FDLOs obtained from the interviewed designers (source: Sayuti, 2016)

Designers and FDLOs	Subcategories of the Conceptual Model—from interviews/NVIVO software analysis				
GZ, USA, The Stitch Table	A3	A6	B1	B2	B3
	C1	C6	D1	D2	
 <p>Aesthetic and Semantic: B1, B2, B3 Function and Practicality: A3, A6 Experience: C1, C6 Experimental: D1, D2</p>					

5. Triangulation study of the online survey and interviews - Section D (Conceptual Model section)

Data and results from the online survey and interviews were triangulated to further validate the experimental findings. The results in Table 1.4 below have been categorised into two sections, namely, quantitative results from the Australian and International designers group, and qualitative results from the interviews. The results listed in the table were gathered and triangulated to

investigate the significance and similarities in designer opinions about the FDLOs. The table below only shows an example of a specific selected FDLO, the ‘*Rococo Retrofitted Chair*’.

Table 1.4: Section D - Sample of the triangulation of results from the online survey of interviewed designers (source: Sayuti, 2016)

SECTION D – CONCEPTUAL MODEL						
Online Survey: Australian Designers (AD) & International Designers (ID)				Interviews: (FDLO Designers)		
AD		ID		D		
<i>Q1: The Rococo Retrofitted Chair</i>						
<i>Experimental category</i>		<i>Experimental category</i>		<i>Experimental category</i>		
D1	D2	D1	D2	D1	D2	D3
D3	D5	D5		D4	D6	
<i>Experience category</i>		<i>Experience category</i>		<i>Experience category</i>		
C1	C2	C1	C4	C1	C5	
C4	C5	C5		C6		
<i>Aesthetic and Semantic category</i>						
		B1	B2			
		B3	B4			
<i>Function & Practicality category</i>						
A1						

The similarity of answers from the quantitative and qualitative results for the *Q1: The Rococo Retrofitted Chair* can be seen here. These responses can be compared to the answers given by the FDLO designer for *Experimental category* (*D1: Conceptual design, D2: Part of a research project, D3: Exploration of new materials,*) and *Experience category*: (*C1: To experience nature, C5: To stimulate senses,*).

5.1. Other reasons for using living organisms in furniture

From the interviews with designers of FDLOs, various “other reasons” were found for including living organisms in furniture. These were categorised under the subcategories A6, B6, C6, and D6, and further complement the conceptual model presented. Examples of these “other reasons” are listed in Table 1.5 below:

Table 1.5: Various other reasons expressed by interviewed designers, and to be considered for possible future developments of the conceptual model (source: Sayuti, 2016)

A6	B6	C6	D6
<ul style="list-style-type: none"> • Practicality reasons • Multipurpose/multifunction furniture • Commercialized products • Space saving • To bring life to the objects • To design small garden pieces • Solve seating need of project • Fitting visual for 	<ul style="list-style-type: none"> • None included 	<ul style="list-style-type: none"> • Growing up with plants • Having no plants inside the house is like missing something • Interest • To promote the strong relationship • To take care of your plants 	<ul style="list-style-type: none"> • Designed for a competition or exhibition • To question • Encapsulating landscape • New or other design genres: <ul style="list-style-type: none"> ○ Deformation ○ Symbiont or symbiosis ○ Permaculture

space/comfort and practicality	design
<ul style="list-style-type: none"> • Created a culture of work between man and nature • To find some synergy between nature, living organisms, which can give people a service • To decompose the furniture • To welcome insects rather than fighting them 	

6. Conclusions, discussion and future research

The main contribution to the knowledge of this investigation is the development of a new typology and conceptual model for classifying and better understanding Furniture Designs which incorporate Living Organisms (FDLOs). After a comprehensive review, no related empirical studies in furniture design, related to Biophilic design, were detected in the literature. There is strong evidence to suggest that the FDLOs identified and analysed in this investigation have not been compiled, documented, classified or fully described as a potential new genre in furniture design, despite the fact that there are multiple and very interesting examples of this type of furniture design.

By using the conceptual model as a basis, the reasons (of designers of selected FDLOs who participated in the interviews) for using the living organisms in the furniture designs studied were mainly found to be related to the *Function and Practicality category*, followed by the *Experience category*. These results suggest that most of the designers interviewed focused on the functionality of living organisms when embedding them in their furniture designs, (for example, plants to filter air), rather than merely to beautify or simply as experimentation. Many other reasons for designers to embed living organisms in furniture designs were found and discussed through the noted interview sessions. Nature, plants and animals, received the highest responses as the inspirational reasons for designers to incorporate them into the design of FDLOs.

Section D of this investigation tested the conceptual model, and the results identified the opinions of two groups of designers who observed the FDLOS (but did not design them), namely, Australian designers, and International designers. These results showed the similarity of their opinions towards FDLOs. This investigation also looked into the design preferences and emotional responses displayed by designers and the general public towards FDLOs, but this is a topic reserved for another paper.

Finally, it was found that FDLOs have the potential to be used inside the home since at least 55% of respondents stated they would like to have an FDLOs in their house. This also suggests potential marketing possibilities for FDLOs, which in many cases are simply design concepts, and not as yet commercial products.

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