Investigating Bio-Inspired Approaches for Designing Psycho-Oncological Support Units in Egypt

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Abstract: Historically, cancer patients have used to rely on the medical treatments only in the diagnosis of this disease. Nowadays a field of cancer support is called psychosocial oncology or psycho-Oncology has been emerged and spread worldwide to support medical treatments in order to improve patients' recovery. However, here in Egypt there is still shortage despite the real need. In this respect, it is critical to adopt an architectural approach based on the human-nature relationship that has a positive impact on people with cancer well-being and, improve their therapeutic program. Then, this paper aims to reach that approach to connect people more closely to nature and, learn from it. To fulfill the research main goal a comparative analytical study was done. Whereas, connecting building with nature is taking different pathways, bio-mimicry, bio-philia, and digital morphogenesis, all have the same concerns but, with different priorities, weightings, and principles. This research ends by selecting digital morphogenesis as an approach for the design of supportive care units in Egypt. The selection of digital morphogenesis as an approach is based on the comparison that, distinguishes between the three mentioned bio-inspired approaches, not to draw borders but, to clarify what is currently happening in the overlapping fields of bio-inspired design and, to fill in gaps found in the adopted approach in further researches.

Keywords: Psychosocial Support, Digital Morphogenesis, wellbeing, Nature, Cancer Wellness.

1. Introduction

Cancer psycho-oncological support units were designed internationally, to lead a new concept of cancer care to complement hospital medical treatment**.** The units provide practical, emotional, and social support to people with cancer, their family, and friends. Initially built on the grounds of specialist cancer hospitals in the UK, the units have become an international model for holistic and social healthcare designed to create a bridge between hospitals and community care (Butterfield & Martin, 2016).

Centers of psycho-oncological support units have developed from the first building opened in Edinburgh in 1996 to over 30 sites, found primarily across the UK, but also in Hong Kong, Japan, and Spain. The charity is independent of state healthcare systems, and the services centers provide are complementary to those offered in the adjacent hospitals. Charles Jencks, an architectural historian, described in his book *"The Architecture of Hope*": "All the centers are built with certain fundamental themes in mind and an appreciation of how the environment can affect well-being" (Liu, n.d.).

The architectural atmospheres of the centers are purposefully enrolled in the provision of advice, supportive care with responding to the same one brief but offering different interpretations.

Centers' evidence-based program and architectural and landscape brief (Liu, n.d.), offers a set of prompts for the architect to consider how their building will evoke emotional responses in its users (Martin, Nettleton, & Buse, 2019). Accordingly, the centers are described as emotionally charged buildings that shape the ways care is staged, practiced, and experienced in everyday life through the orchestration of architectural atmospheres (Duff, 2016; D. Martin et al., 2019).The research, is adding a new layer for designing such centers and units by adopting digital morphogenesis. Digital Morphogenesis is an approach that could be so rewarding from psychology of space point of view. As it is taking its inspiration from biology, departing from the idea that consider architecture as form-finding that privileges appearance, emphasis on ‘material performance’ and ‘processes over representation’. (İçmeli, 2013). Whereas, using science and technology has begun to sense the intimate connection between living structure and architecture. (Alexander, 2005).

2. Methodology:

Comparative analytical study aims to identify the similarities and differences between bio-inspired design three approaches; bio-mimicry, bio-philia, and digital-morphogenesis, and their abilities to influence cancer patients’ therapeutic environment positively and promote their recovery. To attain this aim, the research is examining each approach in terms of definition, principles, form finding techniques and cognition and emotional response of each approach attributes. In order to clarify what is happening in the overlapping fields of bio-inspired design, and fill in gaps found in the adopted approach.

3. Biomimicry, biophilia and digital morphogenesis

Bio-design is the integration of design with biological systems, to achieve the design that mimics nature, to obtain better well-Bing for building users (biophilia) and to have better ecological performance (bio-mimicry). Designers create interactions between people and nature, mediating a historically troubled relationship and creating opportunities to connect in new ways for mutual benefit. Bio-design is an expression of this integration; of harnessing nature for human purposes, foretelling beauties and new functions for design yet also warning of dangers (Myers W., 2014). It is important to define the difference between bio-inspired design approaches.

3.1 Biomimicry: Nature inspired innovation.

Approaches to bio-mimicry as a design process usually fall into two categories: The first is defining the human needs or design problems and looking to the ways other organisms or ecosystems have solved. This approach requires designers to identify problems and biologists to then match these to organisms that have solved similar issues(Aziz & El, 2015). The second is identifying a particular characteristic, behavior or function in an organism or ecosystem and translating that into human designs. (Pedersen Zari, 2013). Within the two approaches discussed, three levels of bio-mimicry that can be applied to a design problem as the following form, process and ecosystem (adapted from Pedersen Zari, 2007). As shown in figure 1

The first level is the **organism level** whereas; species of living organisms have typically evolved for millions of years. These forms have adapted to constant changes over time although the different circumstances. Humans therefore have a wide range of examples to use to solve problems experienced by society that organisms may have already addressed, usually in energy and materials effective ways This is beneficial for humans, especially with changing access to resources, climate change, and an increased understanding of the negative environmental impacts of current human activities on many of the world's ecosystems. (Anatomy et al., 2015)

The second level is the **behavior Level** where, a significant number of organisms face the same environmental conditions that humans do and need to solve similar issues that humans encounter. Organisms that are able to control the flow of resources to other species and who may cause changes in biotic or abiotic (nonliving) materials or systems are called ecosystem engineers (Salonen, Lahtinen, Nevala, & Morawska, 2013). Humans are effective ecosystem engineers, but may gain valuable insights by looking at how other species in nature are able to change their environments while creating more capacity for life in that system.

The third level is the mimicking of ecosystems is a vital part of biomimicry as described by Vincent (2007). The term Eco-mimicry has also been used to describe the mimicking of ecosystems in design (Widera, 2017). The objective is the wellbeing of ecosystems and people. Proponents of industrial, construction and building ecology advocate mimicking of ecosystems (Graham, 2003, Kibert et al., 2002, Korhonen, 2001) and the importance of architectural design based on an understanding of ecology is also discussed by researchers advocating a shift to regenerative design (Reed,2006).

3.2 Biophilia: The human nature relationship.

In the Biophilia Hypothesis (1986), Edward O. Wilson, one of the world's most acclaimed biologists, noted that humans needed daily contact with nature to be healthy and gain longevity. This affiliation with nature continues to be critical in the modern-day human health and wellbeing literature and practice (Browning, Ryan, & Clancy, 2014).In the research area of human health and wellbeing, a growing body of research shown that exposure to nature continues to result in positive health benefits. Architects use biophilia as a tool to connect people inside buildings to nature outside them through design patterns and relevant parameters. Biophilic patterns have a wide range of applications in both internal and external environments, bringing physiological, cognitive and psychological benefits. Building is evaluated biophilic design building when it achieves availability of biophilic design criteria with number out of 14 patterns with percentage of availability of the pattern of the three main categories of biophilic patterns, namely**, "Nature in space"**, **"Natural analogues", "Nature of space".** However, not every space can be designed to integrate all the principles of biophilic design; there are often many elements that can collectively enhance the space design and well-being of people within it (Architecture, n.d.).Nature in the Space encompasses seven biophilic design patterns, while Natural Analogues encompasses three patterns of biophilic design, and, Nature of the Space encompasses four biophilic design patterns.

The first category is **"Nature in the space"**; this refers to providing the built-up environment with natural elements. This is considered the easiest way to introduce biophilia to the space. Views to nature from the inside of the building, natural light, and direct access to nature; courtyards, gardens and roof terraces planted with greenery, also fall into this category. This Connection with Nature has proven to reduce stress, showed more positive emotional functioning, and improved concentration and recovery rates. Second is **"Natural analogues"**, this concept refers to human-made elements which mimic nature. Artificial plants, preserved moss walls, representational artwork, patterns and architecture that evoke nature are all examples of natural analogues. Woodgrain and building materials mimicking shells and leaves used in interior of exterior decoration are all excellent illustrations of the use of natural analogues. The third refers **"Natural of space"** to the physiological way in which space is planned and architectural design effects on our human responses. As we have evolved over millennia and our success is partially due to our ability to connect with nature.

3.3 Digital morphogenesis and theory of emergence

The term 'digital morphogenesis' refers to the 'emergence' of forms and behavior from the complex systems.(Hensel, Menges, & Weinstock, 2012). The techniques and processes of digital morphogenesis are mainly mathematical where, the analysis and production of complex forms or behavior are fundamental. Computers make it easier to develop designs through versioning and gradual adjustment. In 'Morphogenesis and the Mathematics of Emergence 'studies the origins of the concepts and provides a database of the mathematical basis of processes then produce emergent forms and behaviors, in nature and in computational environments. Digital morphogenesis places emphasis on **'material performance'** and **'processes over representation'**. It requires recognition of buildings not as fixed bodies, but as complex energy and material system and, exist as part of its environment. (Kolarevic, 2004). Branko Kolarevic defined digital morphogenesis: "*In contemporary architectural design, digital media is increasingly being used not as a representational tool for visualization but as a generative tool for the derivation of form and its transformation*".(İçmeli, 2013)

Adopting digital-morphogenesis as a generative tool in the design process by depending on algorithmic approach can be considered the tool that has the ability to apply wider range of patterns that understanding the relationships between biology/ecology and humans to improve human technology or to improve human psychological wellbeing. Digital morphogenesis is concerned with the shapes tissues, organs and entire organisms and the positions of the wide range of specialized cell types and the main question of how biological form and structure are generated (Kolarevic, n.d.).Digital morphogenesis includes an understanding of organs as well as their formation. It also addresses the problem of biological form at many levels, from the structure of individual cells, through the formation of multi-cellular arrays and tissues, to the higher order assembly of tissues into organs and whole organisms. (İçmeli, 2014).

4. Biomimicry, biophilia and digital morphogenesis: Differences and similarities.

In order to, highlight the main differences between the three approaches in terms of **form finding techniques**, **processing, connectedness to nature** and **principles of each approach** in depth, the research at first is defining each as the following:

Bio-mimicry is the "mimicry," or more accurately, the emulation of life's engineering, bio-mimicry is an innovation method to achieve better performance. In contrast biophilia describes humans' connection with nature and biophilic design is replicating experiences of nature in design to reinforce that connection and it is an evidence-based design method to improve health and wellbeing. Whereas, Digital morphogenesis requires the recognition of buildings not as fixed bodies and solely unites but as complex energy and material systems that exist as part of its environment and have a life span. Architect Michael Weinstock, in his article "Morphogenesis and the

Mathematics of Emergence" (2004), urges to integrate the mathematical processes into architectural systems design, so that architecture becomes rapidly "intelligent" with responsive emergent forms and behaviors that demonstrate higher levels of complexity.(Hensel, Menges, & Weinstock, 2004).

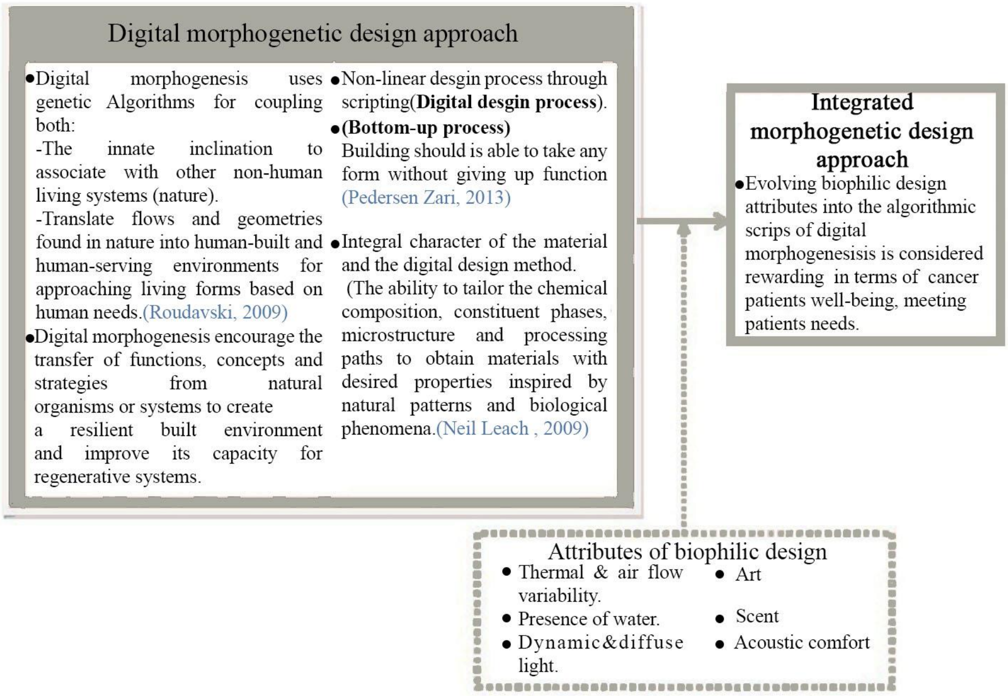
Table 4 is illustrating the main differences, between biophilia, biomimicry and bio-digital

Bio-design approach	Definition	Design strategies	Values in design application	Design process features	Limitations
Biomimicry	**Biomimicry** is the conscious emulation of natural forms, patterns, and processes to solve technological chalenges. **(an innovation method to achieve better perfomance).** **(Baumeister, 2014)** **Example: Eden Project** It is a good example of **biomimicry** because the architects emulated examples from nature to develop a remarkably lightweight structure that outperforms conven-tional methods and meets the chal-lenging needs of this unique project.	Approaches to biomimicry as a design process typically fall into two categories: a) Defining a human need or designing problem and looking to the ways other organisms or ecosystems solve this, termed here Design looking to biology (Top-Down approach). b) Identifying a particular characteristic,behaviour or function in an organism or ecosystem and translating that into human designs, referred to as Biology influencing design (Bottom-Up approach). The 3 Essential Elements of Biomimic design; **-Emulation** **-Ethos** **-(Re)Connection**	**-Accomplish multiple objectives with a single gesture:**In nature, there are no single-purpose tools. For example, trees provide shade with their leaves, which also generate energy, and bark, which also help to protect and cool the moving water beneath the surface. Imagine surfaces and systems that could accomplish multiple functions with one simple, multi-functional design(Anatomy et al., 2015) - **Adapt to context and climate:**Rather than fighting against the context by using energy and resources to hold nature at bay, nature leverages cyclic processes and builds with readily-available materials and energy. **Embody resilience** The ability to identify and apply principles and recipes for adapting to change is key(Pedersen Zari, 2013).	This field learns from - Nature as model. -Nature as measure. -Nature as mentor.	-Higher initial or maintenance costs. -Special production requirements. -Complexity in design. -Lack of systems expertise.
Biophilia	**Biophilic** design endeavors to forge this connection by leveraging or inserting instances of nature, natural patterns, or spatial conditions into the built environment.**(an evidence-based design method to improve health and wellbeing).(Browning and Ryan, 2020;Kellert, 2008b,2018)** . **Example:The Clif Bar Bakery&-company** Visual Connection to Nature through views to the outdoors, and Material Connection with Nature through the use of local natural materials. **It is not biomimetic doest not emulate any natural form, function, or process to solve a challenge.**	-Increase natural ventilationusing operable windows, vents,narrower structures, etc -Simulate natural air and venti-lation through operable win-dows, vents, airshafts, porches,clerestories, HVAC systems, etc.(Browning et al., 2014Gou et al.,2014) -Bring in natural light via glasswalls, clerestories, sky-lights,atria, reflective colours/mate-rials, etc. -Mimic the spectral and ambientqualities of natural light, such asby arranging multiple low-glareelectric light sources, ambientdiffused lighting on walls/ceiling, and daylight preservingwindow treatments(Browning et al., 2014Kellert,2018) -Build waterscapes such as foun-tains, constructed wet-lands,ponds, water walls, rainwaterspouts, aquaria, etc -Bring vegetation indoors bypotting plants and indoor greenwalls(Chang and Chen, 2005Kellert,2018).	- Enrich sensory variability andreduce boredom and negativityby imitating the subtle changesof natural air and ventilation - Broaden the acceptable range of thermal comfort to decrease energy demand (Browning et al., 2014Nicol and-Humphreys, 2002) -Dynamic lights and shadows formtransitions between indoor andoutdoor spaces, which are fascinating. -High-contrast lights bring atten-tion and evoke a sense of sacredness(Aries et al., 2015; Browning). - Increase green space coverage,native plants ratio, and biodiversity - Improve shading/sheltering ability and reduce building energy consumption	-Water -Air -Daylight -Plants -Landscape -Weather -Connection to place -Materials, texture, and colour -Patterns and geometries	- Natural ventilation may increase the circulation of pollutants . - Ventilation when outdoor humidity is high will bring excess moisture that increases the risk of mould contamination - High-volume and large-turbulence water that affects acoustic quality and humidity - Plants could cause structural problems, excessive humidity, insect trouble, odour issues, etc.(Barton and Pretty, 2010; Kellert,2018) - Artificial water features may increase energy consumption
Digita morphogenesis	**Digital morphogenesis** is parametric modelling and performance-based generative techniques ,that derives forms using algorithms that mimic the biological process of form-finding.**privileging of performance** **(İçmeli, 2013)** **Example:The Bothnian Bay cultural center** -This work employs algorithmic design methods in a process that uses natural phenomena as the basis of its architectural morphology. -The process is based on the muta-tion of the seed . -The design have not made the process to serve a single building specific problem but made the tools for the process first and then used them in practise when designing the building	-The techniques and processes of emergence are intensely **mathematical** and have spread to other domains where the analysis and production of complex forms or behaviour are fundamental. -'DigitalMorphogenesis traces the origins of the concepts and provides an account **of the mathematical basis of processes that produce emergent forms and behaviours, in nature and in computational environments.(Hensel, Menges, & Weinstock, 2012)** -Morphogenetic strategies for design are not truly evolutionary unless they incorporate iterations of physical modelling, nor can we develop systems that utilise emergence without the inclusion of the self-organising material effects of form finding and the industrial logic of production. -Emergence requires the recognition of buildings not as singular and fixed bodies, but as complex energy and ma-terial systems that have a life span, and exist as part of the environment of other buildings, and as an iteration of a long series that proceeds by evolutionary development towards an intelligent ecosystem.(Kolarevic, 2004). -Non-linear desgin process through scripting**(Digital desgin Process). (BOTTOM-UP)**	-Computer-sustained automation can enable manipulation of otherwise unmanageable and even unimaginable complex situations. -The ability to propagate conceptual changes through parameters helps to evaluate consequences of creative moves, for example when adjustments made at the beginning of a generative sequence can automatically reconfigure the arrangement of manufacturable parts. (Kolarevic, n.d.). -Amplified imagination. In the creative-practice discourse,morphogenesis has been discussed in relationship to fractals,evolutionary development and cellular automation. The benefits of the concept in the context of creative practice include algorithmic visual creation, potentially leading to unusual results. -Exploration and selective utilization of biological principles promises additional benefits in building useres psychology.	-Algorithmic form generation. -Mathematical basis of processes that produce emergent forms and behaviours, in nature. -Natures' design principles (database for digital morphogenetic design)such as; o Symmetry o Cellular structures o Self-assembly o Segmentation	-Lack of systems expertise. -The need for coordination of different professions. -Unfamiliar systems.

5. Conclusions

Based on this study, the following conclusions can be drawn:

The analytical comparative study done in research has showed that, selection of digital morphogenesis as an approach for designing psycho-oncological support units is definitely rewarding. Whereas, the comparison has shown that digital morphogenesis emphasis on the form not as a shape of a material object alone, but as processes that integrate material and form together, multitude of forces, environmental conditions, and modulations that generates from the exchange of an object with its specific environment. By this integral character of the material and the digital design methods a building should be able to take any form without giving up function, instead of redefining the design process from being as straightforward as that: *imagine, draw, apply, analyze then construction follows.* Digital morphogenesis design process depends on inverting this process and start from analysis by the integration of physical considerations and environmental constrains within the computational tools to create novel ways of a biological-based form generation based on cancer patients needs and achieve a higher level of performativity. Based on the comparison on this research, it is recommended to take up the advantages of biophilic design approach, in terms of stress reduction, cognitive performance and emotion, mood preference in addition to the significant advantages of digital morphogenesis as shown in (figure 1). In order to have a complete morphogenetic framework that, connects people with cancer more closely to nature and affects their therapeutic program positively.



(Figure 1) Integrated morphogenetic design approach

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