

NATURE'S INGENUITY:

The Integration of Biomimetic Architecture for the Holistic Sustainable Advancements of Transitional Housings for Statutory Homelessness



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ABSTRACT

Homelessness is something one shouldn't turn a blind eye to. Although temporary solutions have been invoked, homelessness continues to persist even in the most prosperous societies; Leading one to think that current solutions are faulty. Advancements produced are rarely discussed in a holistic manner, where user's needs are also taken into account for architectural directives.

This paper aims to investigate how the integration of biomimetic architecture can provide holistic sustainable advancements for the design of transitional housing for statutory homelessness. Careful considerations for the limitations of this research have been made through theoretical research and qualitative-based analysis to select the statutory homeless population as the users. Three direct focuses from the natural world were then analysed and chosen: *Nautilus pompilius*, *Meles meles*, and *Cordulia aenea*; which will then be further examined their correlations to layout, thermoregulation, and daylighting. Through the analysis, this paper discusses the principles that should be brought into designing transitional housing and examples of implementations. This method highlights the importance of a developed solution that doesn't only focus on answering immediate humanitarian concerns but aligns with unique user needs and holistic sustainable advancements. The systematically produced findings shows the biomimetic principles that promotes user's wellbeing in transitional housing, advocating for a long-lasting compilation of distinctive design interventions. Ultimately, this paper attempts to draw attention to how critical existing conditions and serves as a benchmark information for future research and design guidance in these environments.

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For all those not mentioned that have made impacts in this research, my gratitude goes out to you.

DEDICATION

To a wider awareness and respect of society's two victims— nature and the vulnerable;
May a better future await.



"Nature does nothing uselessly"

- Aristotle

*"After all, a homeless man has every reason to cry,
everything in the world is pointed against him".*

- Jack Kerouac

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INTRODUCTION

UNDERSTANDING THE RESEARCH PROBLEM

Our world is marked by imperfections. With disasters and calamities, the fracturing of the natural world and vulnerable communities becomes more apparent. These imperfections manifest as unsolved challenges in our society. A classic example of this is homelessness. By lacking an appropriate home, one is denied of having a stable and secure base which leads to bigger multifaceted problems.

In this community of deep division, if there is a consensus amongst homeless populations, it is that advanced solutions are needed. Although the momentum for acting on homelessness is favourable, homelessness has not been properly addressed (EESC, 2022). Imperfections extend to every sector directly contributing to the elimination of homelessness. Even with solutions provided now, it has been proven that such answers are not of merit. The issue of a better design for homeless housing stands as a formidable challenge that designers continue to grapple with.

It compels us to shift focus from merely managing homelessness to resolutely aiming toward ending it. The services we have in hand currently have long served only as temporary solutions that only focus on immediate humanitarian concerns. They are no longer sufficient to meet the complex needs of individuals experiencing homelessness as they only lead to a continuous cycle of an uncertain future. Prolonged reliance on these services will not end the problem- rather, it is just a misleading perception that the problem is dealt with.

There is abundant research on many biomimetic designs; However, not in a specific targeted approach. This paper's position is that a biomimetic approach can alter the design framework of transitional housing which generates relevant impact on statutory homelessness.

LITERATURE REVIEW: A DEMAND FOR HOLISTIC SUSTAINABLE ADVANCEMENTS

Homelessness is a global issue, with the United Nations Human Settlements Program estimating that over 100 million people lack housing and 1.6 billion in inadequate housing. This issue affects various communities across the globe and is exerting adverse consequences (Institute of Global Homelessness, 2019). The statistics are sobering. These numbers emphasise homelessness' magnitude and the imperative to find lasting solutions.

Multifarious solutions have been offered as governments are continuously campaigning to tackle homelessness. Though the recognition and urgency to address homelessness has started, it's evident that our current approach to this issue is flawed (Rigo et al., 2018). The persistence of homeless populations indicates that current design principles, focusing on temporary solutions, will not be successful. Growing homeless populations in urban centres continues to pose a significant challenge for planners. Those tasked with providing solutions to address this critical issue struggle to create quality housing (Hoque et al., 2023) - unfortunately, guidance for more robust solutions is not available.

Whilst architecture can be directly linked with terms like 'housing', its relationship with homelessness was minimal. Architecture has been conditioned to design for one's ego. Thus, leading the architect estranged from social responsibility (Willis, 1991). This in turn has decreased the functionality of buildings, as they can no longer sustain their purposes; therefore making them inconsequential. Such gaps can be predominantly seen in homeless housing, as they are left unsolved. A demand for advancements is needed, one that recognises adequate transitional housing is intertwined with the long-term fundamental human rights of its users and society.

Social issues like homelessness, are the product of a dysfunctional social structure as it's neglecting advancements to accommodate rapid solutions. The same structure also centres around the distribution of resources that exist all over nature. When we look at what is truly sustainable, the only real model that has worked over long periods is the natural world. Current schemes do provide developments, but that doesn't necessarily mean advancements which are heading to a positive trajectory.

Biomimetic architecture goes beyond applying natural principles merely for aesthetics, as its designs focus on function. (Benyus, 1997). Thus, one can only question the correlation between biomimetic architecture and its relationship with other issues in the same social structure, such as homelessness. Consequently, it is essential to conduct a comprehensive analysis of natural strategies, examining their inherent effectiveness and identifying transferable principles that can be applied to transitional housing, particularly in the context of statutory homelessness.

METHODOLOGY: THE PREVALENCE OF BIOMIMETIC ARCHITECTURE IN HOMELESSNESS

The research in this paper proceeded through two stages. This begins with gathering information from prior publications and research to establish a foundational understanding and research scope. The second stage included analysis of strategies and case studies to validate initial hypotheses. The university's research ethics and regulations were adhered to throughout the research. The ethics application form was thoroughly filled, submitted, and approved. Qualitative theoretical methodology underpins the research, providing contextual findings for the integration of biomimetic architecture into transitional housing for statutory homelessness.

"The Displaced Population" delves into complexities of homelessness and an exploration of its challenges. This chapter highlights the significance of a targeted approach, recognising specific user needs within statutory homeless population. Existing conditions were analysed against legal standards, with two cases providing first-hand accounts of living conditions in existing temporary housing: London's Croydon Complex and Fred Wigg Tower in Leytonstone.

"A Balanced Pursuit" emphasises the need for a holistic approach, incorporating nature to discuss social concerns. Discussing presumptions surrounding a need to, highlight the necessity of integrating biomimetics architecture for a fundamental shift. This section will include discussions of its impact towards a better common future.

"A Natural Foresight" is rooted in the premise of biomimetic architecture's role in advancing solutions for homelessness. The results and findings show a set of criteria to delineate the research's scope. Particular consideration is placed on aligning selected strategies by acknowledging the interlinked nature of the research's focus. A thorough analysis explores specific biomimetic strategies and their capacity to address predefined criteria, demonstrating implementation towards three key functions: layout, thermoregulation, and daylighting. The chapter closes with a discussion of how the strategies can catalyse sustainable practices within transitional housing design. Through underscoring the significance of this approach when compared to current ones, the research becomes replicable, applicable, and contributing to broader impacts.

Altogether, this research establishes defining principles and evidence of biomimetic architecture being an adept response to statutory homelessness. The findings of this paper can be the base of further guidelines that can promise to reshape the built landscape of transitional housing. The understanding of each case study is directly connected to the proposal of better solutions to existing problems in current system, confronting conditions of inadequate housing and transcending to a home that holistically accommodates progressions.

THE DISPLACED POPULATION

LASTING PRESSURE POINTS

'Our Goal is to make Britain the best-housed nation in Europe', expressed in the 1983 Conservative Party election manifesto. It has been 40 years since that manifesto was published, and the worst forms of homelessness remain to increase its number across Great Britain (Fitzpatrick, 2023). The situation is dire, with tens of thousands individuals experiencing homelessness across Great Britain, including over 200,000 households in England. Over the past five years, homelessness has steadily increased, reaching its peak in 2019 at more than 219,000 households. By the end of 2021, the number had climbed to 227,000 households (Homelessness Monitor, 2022).

It is a social issue as homelessness stems from various social causes. Unaffordable housing and unemployment, as well as life events like leaving prison, care, or the military without a home, become some of the reasons. Relationship breakdowns, job loss, mental and physical health issues, and substance misuse also contribute to homelessness, exacerbating these problems. All of the conditions above can be easily classified as statutory homelessness.

Statutory homelessness is a legal status in the UK that applies when individuals or households unintentionally lack a place to live and meet specific criteria, including having no reasonable accommodation available and having a priority need for housing. The local council is legally obligated to provide housing or suitable accommodation. However, to receive assistance for statutory homelessness, local authorities may initially provide temporary accommodation. (Wilson & Barton, 2022)

THE HOMELESS LOSE OUT

In the 1960s politicians were saying that Britain's housing problems were over. By 1976, cuts in public investments for housing were started by Labour and later endured by Conservatives. It was suggested that most of the population was well-housed, leading to the belief that the housing crisis must be over. Nothing could be further from the truth. This belief led to a misconception that the housing crisis had been resolved (Wilson, 1986). They wrongly declared an end to Britain's housing problems, downplaying the ongoing issues. The 1977 Housing (Homeless Persons) Act ignores that it's also a matter of social inadequacy, thus neglecting other vital considerations such as its users. These Measures lack substance as they hinder actually solving the problem. Appalling conditions and growing inequalities form a deeper strain, as resources are redirected, at the expense of adequate temporary housing.

Numerous reports have been filed highlighting awry conditions of temporary housing. While those legally classified as statutory homeless have a right to suitable housing, the reality often falls short. Instead of a place that can support them to rebuild their lives, they face prolonged periods of frustration and suffering. The fact that they are stacked up in subpar living conditions is indicative of a system that is not working. Being placed in temporary accommodation is a trap in a vicious circle; causing job loss for those employed and discrimination against those seeking work. Not to mention the escalating living cost further forces their dependence towards this flawed system. It has taken a toll on their physical and mental well-being, isolating them from loved ones, creating instability, and preventing them from leading normal lives.

EMPTY GESTURES

In a civilised society, decent housing should be a right for all. It should be an effective base for life where people can be themselves, obtain peace and security, and flourish both mentally and physically. (McKechnie, 1986). Unfortunately, the current scheme are nagged by insecurity, living with constant strain and tension, lacking privacy, disease-spreading infestations, physical danger, and cheated of essential facilities (Heath, 2022). Where homeless housing should've prioritised inclusivity, sustainability, and sensitivity to users' needs, the current condition has repeatedly shown it is unfit to live in.



Fig. 1 Mural by Christopher Statton and Megan Wilson (Templeton, 2015)

Housing authorities are responsible for continuously assessing housing conditions under HHSRS. It classifies hazards into two categories, with Category 1 hazards representing threats that pose serious and immediate risk to a person's health and safety. When evaluating the suitability of accommodation to place statutory homeless people, housing authorities should, at the bare minimum, ensure that the accommodation is free of Category 1 hazards. Findings show that 19% of accommodation inspected had at least one Category 1 hazard (Heath, 2022)

The design and functionality of a place can detrimentally impact how users respond to it. People are left with limited opportunities to make constructive plans for their lives. Barriers to jobs, isolation, division of families, suffering health, and setbacks in children's development- are just some of the many impacts that these people have to suffer through, which is fundamentally inhumane.

SPEAKING FOR THEMSELVES

At its worst, temporary accommodation can be a nightmare. Users start losing touch with normality. This section covers two cases showing conditions of these housing.

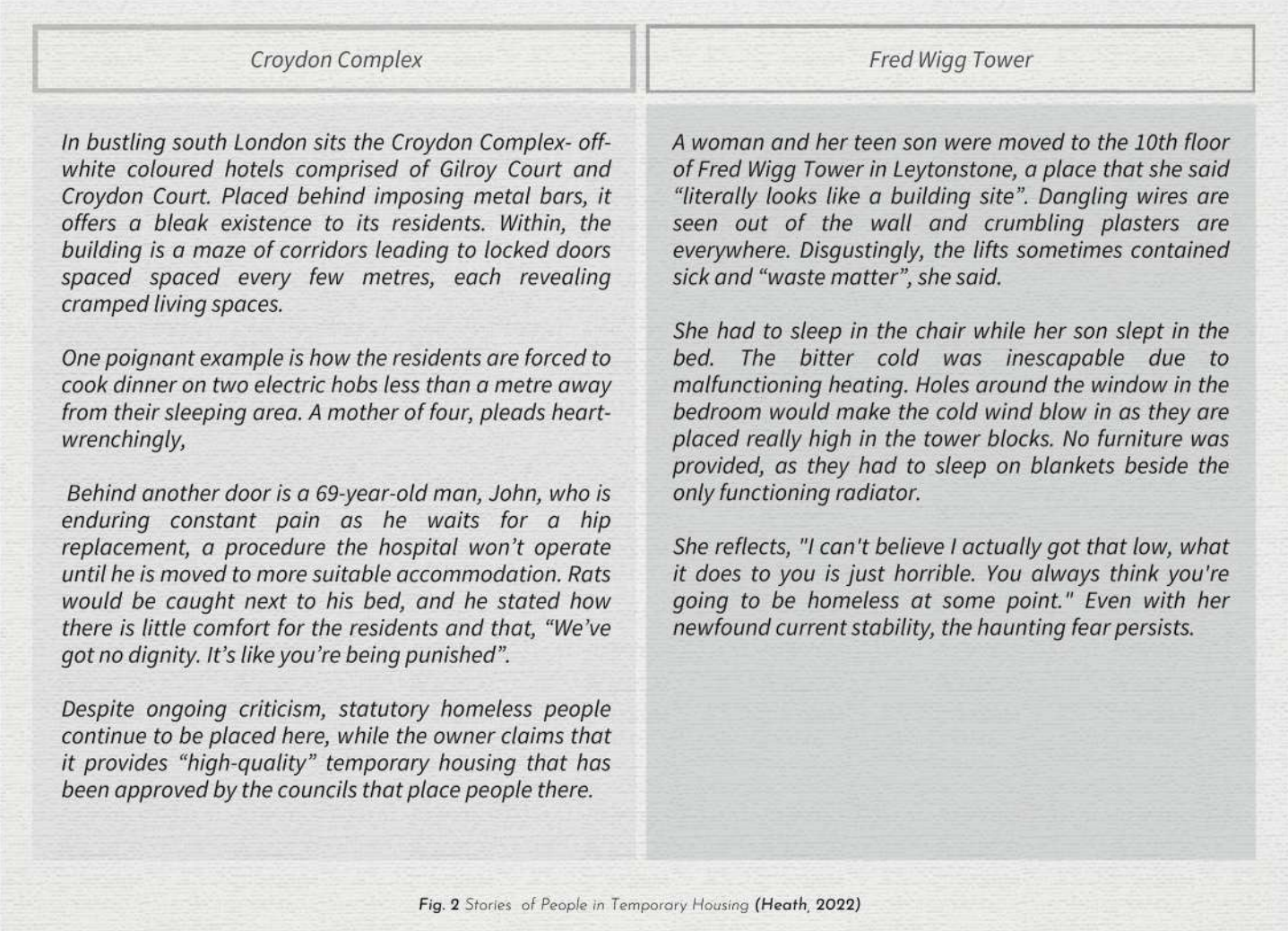


Fig. 3 John's room at Croydon Court (Simpson, 2022)



Fig. 4 Plaster crumbling off the walls at Fred Wigg Tower (Simpson, 2022)

A PRESCRIBED DESIGN: A MOVE FOR TRANSITION

As discussed, the root cause of homelessness resides in the flaws of an existing system, and working within that system has proven to have had limited success as social gaps widen and priorities on these initiatives shift. Understanding the actors and importance of using transitional housing, encompasses comprehension towards what designs are needed to.

Transitional housing refers to a supportive type of accommodation that is meant to bridge the gap from homelessness to permanent housing by providing supervision, support, life skills, and training (Gaetz, 2014). Referring to housing as "transitional" rather than "temporary" carries advantages. It imparts a positive connotation, implying progress towards stable living. The term also signifies a long-term forward looking perspective and a commitment to addressing homelessness on a more holistic and sustained basis, emphasising that these housing solutions should be part of a broader strategy. Furthermore, it respects dignity and upholds aspirations of the statutory homeless, acknowledging their pursuit of a better future.

Inevitably the main concerns reside in user's living conditions. Building systems should be altered to suit their needs. Recognising that it's important to understand how the homeless demographic can alter design approaches Below are the main types of statutory homelessness and their specific user needs identified:

veterans	<i>statutory homelessness often are caused through lasting physical and mental health needs, stemming from conflict or battle (veterans), thus needing calming spaces that counteract PTSD.</i>
Victims of Domestic Violence & Trafficking	<i>around 80 per cent of statutory homeless mothers and children have experienced domestic violence, trafficked, or exploited for sex. Designs should lead to a sense of privacy and safety.</i>
Addiction & Substance Abuse	<i>It should also be noted that some clients have addiction and substance abuse problems. Design should allow efficient space for belongings, eliminating hiding spots for contraband.</i>
Individuals with Mental Illness	<i>one-third of statutory homeless individuals suffer mental illness. Simultaneously homelessness itself is a cause of trauma. Designs should lead to a soothing impact in the long term.</i>
Chronically homeless individuals	<i>they have become continuously homeless for 12 months or at least four times in the past three years for a period adding up to 12 months, these individuals can benefit from a design that instils a sense of place, respect, and ownership to encourage the person to utilise the space.</i>

Fig. 5 User Groups and Needs of Statutory Homelessness (Light et al, n.d.)

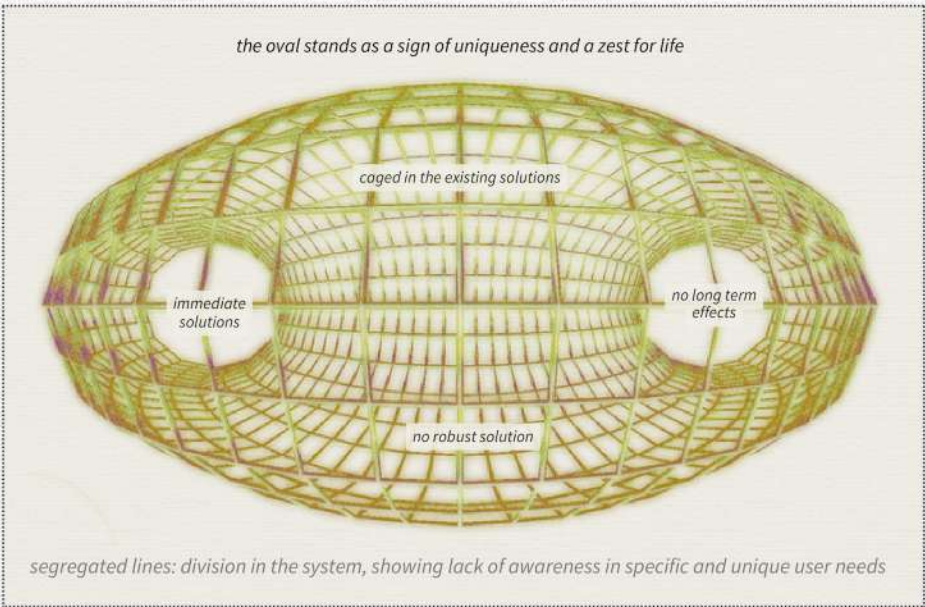


Fig. 6 The Oval Model (Author, 2023)

The oval model serves as a blueprint that explains this much-needed progress, emphasising that healing individuals and the environment are intrinsically linked. It is through such holistic and transformative approaches that we can make a significant impact on homelessness and move from the segregated oval model to a true oval.

A BALANCED PURSUIT

A PARADIGM SHIFT

Amidst the myriad of environmental and social challenges in the world, the paradigm shift to sustainability offers a fundamental reevaluation of our relationship with the planet and holds the potential to create an unprejudiced future for the vulnerable. It represents a significant change from the previous economic development model with its desecrating social and environmental repercussions, as exemplified in statutory homelessness. While these consequences were once deemed inevitable and acceptable, it is now conceded that substantial threats to the prosperity of humans and the environment, in pursuit of economic development, are incompatible with the sustainability paradigm (Baser, 2016).

Sustainable advancements are long-lasting as they are designed to enable a more interconnected world. As sustainability grows in popularity, its definition expands beyond environmental concerns and bridges towards social aspects (Cronley, 2020). This development beckons a fundamental change in our approach to homelessness. Holistic sustainability is the crux of this change, discerning that a broader perspective is essential to address the interconnected challenges of homelessness for a full reintegration into society. Such approach will not only protect our ecosystem for future generations, but can improve your quality of life- which is an important factor in designing transitional housing. (Lev, 2021)

OUR COMMON FUTURE

As we contemplate the importance of sustainable advancements, biomimetic architecture emerges as a powerful response to these challenges. Through its integration, creation of better transitional housing can be achieved. In this way, biomimetics presents itself as a compelling response, bridging the gap between homelessness and architecture, and providing a plethora of nature-inspired solutions.

With the aid of biomimetics, care can be rewarded to both between humans and nature and between humans and their own. This new way of living can spread its appeal to the city at large and invite others to its promise of reform. An effect that homelessness can have is disconnection. As communities are formed socialisation can act as an antithesis to these symptoms, creating unity through a common cause, which can reinvigorate social bonds and reinvent communities as a whole. Creating structures that also enhance human well-being and social cohesion.

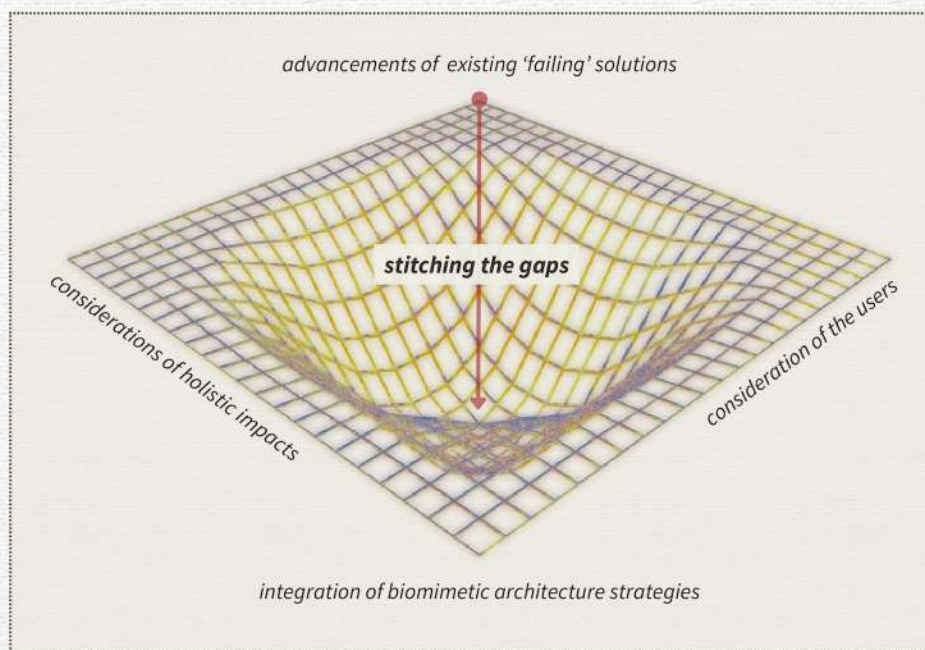


Fig. 7 The Net Model (Author, 2023)

A NATURAL FORESIGHT

WISDOM OF THE NATURAL WORLD

Following evolution, nature has mastered the art of achieving enduring solutions with peak performance and minimal repercussions (Gordon, 1976). Biomimetic architecture is a comprehensive approach to a holistic sustainable design that delves into application of natural principles, moving beyond using nature solely for replication (Ghisleni, 2020). This approach prioritises functionality over aesthetics (Benyus, 1997), prompting inquiries about its connection to broader societal issues.

The primary challenge in biomimetic design is its interdisciplinary nature. With technological developments arising intricate social issues, alternative obliged an advanced solution. Priorities should shift from working against nature to working with nature, as seen in biomimetics. A discussion of sources and limits of knowledge within biomimetic principles that positively affect transitional housing for statutory homelessness will provide an understanding of how systems of nature can be harnessed to address current problematic conditions.

THE ART OF INSPIRATION VERSUS IMITATION

Nature constantly regenerates and undergoes transformation (Blackman & Baumol, 2018). The interconnectedness of Earth's natural systems, serves as the theoretical foundation for this research. Designs shouldn't only be evaluated by its success in facilitating survival, but also how it impacts our way of life. (Gandall, 2009). Biomimetic applications offers a mean to harmonise man and environment and should extend beyond mimicking organic forms to translating natural behaviours into specific user needs.

Progressions from formal imitations of nature towards biomimetic architecture align with the complex character of homelessness. Historical interplays demonstrate that biomimetics presents its relevance, at a systemic level, to serve as a valuable guide for fostering spaces that drive social and ecological advancements holistically (Wahl, 2018).

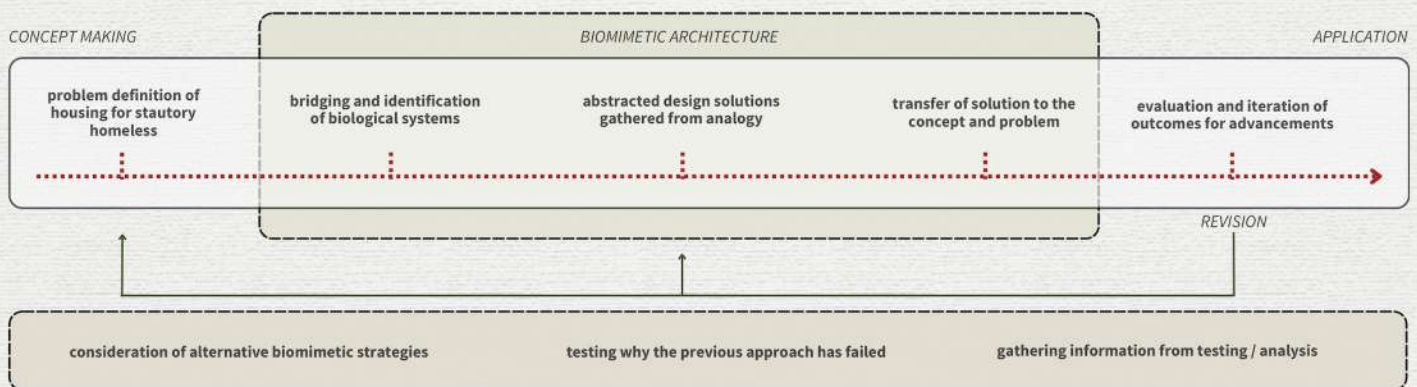


Fig. 8 Biomimetic Design Analysis Framework (Author, 2023)

ESTABLISHING THE CRITERIA

Rapid changes in planning and design are essential to address the multifaceted challenges driven by factors such as the complex dynamics of statutory homelessness- which have adversely impacted users' and space's longevity. Hence, this research will narrow its focus to achieving advanced living standards. In particular, the user-centric design aspect underscores the need for housing solutions that cater to the user's unique needs. Furthermore, climate adaptability necessitates a closer look at locations with the highest rates of homelessness. By homing in on this rationale, the project will focus on the climate of type of London, a major urban centre with a high incidence of homelessness. This ensures that its findings are relevant to the real-world problem at hand.

NATURE'S INGENUITY

This part of the paper identifies the biomimetic principles which are applied to three case studies, assessed through their respective key functions: layout, thermoregulation, and daylighting. The analytical process included a classification of parameters, case extraction, and the synthesis of interpretive evaluation. This helped to identify biomimetic strategies that appear most critical, which provides benchmark information for future research.

ANALYSIS OF PARAMETERS

Biomimetic architecture draws on the theory that an innate human connection exists to nature and natural processes and that fostering these inbuilt connections in our spaces promotes health and well-being (Kellert & Calabrese, 2015), encouraging emotional health, and reducing stress to trigger positive shifts (Abdelaal & Soebarto, 2019). Other evidence shows that exposure to biomimetic principles crucially affects supportive care, particularly important for statutory homeless, who often have to deal with psychological distress (Tekin et al., 2023).

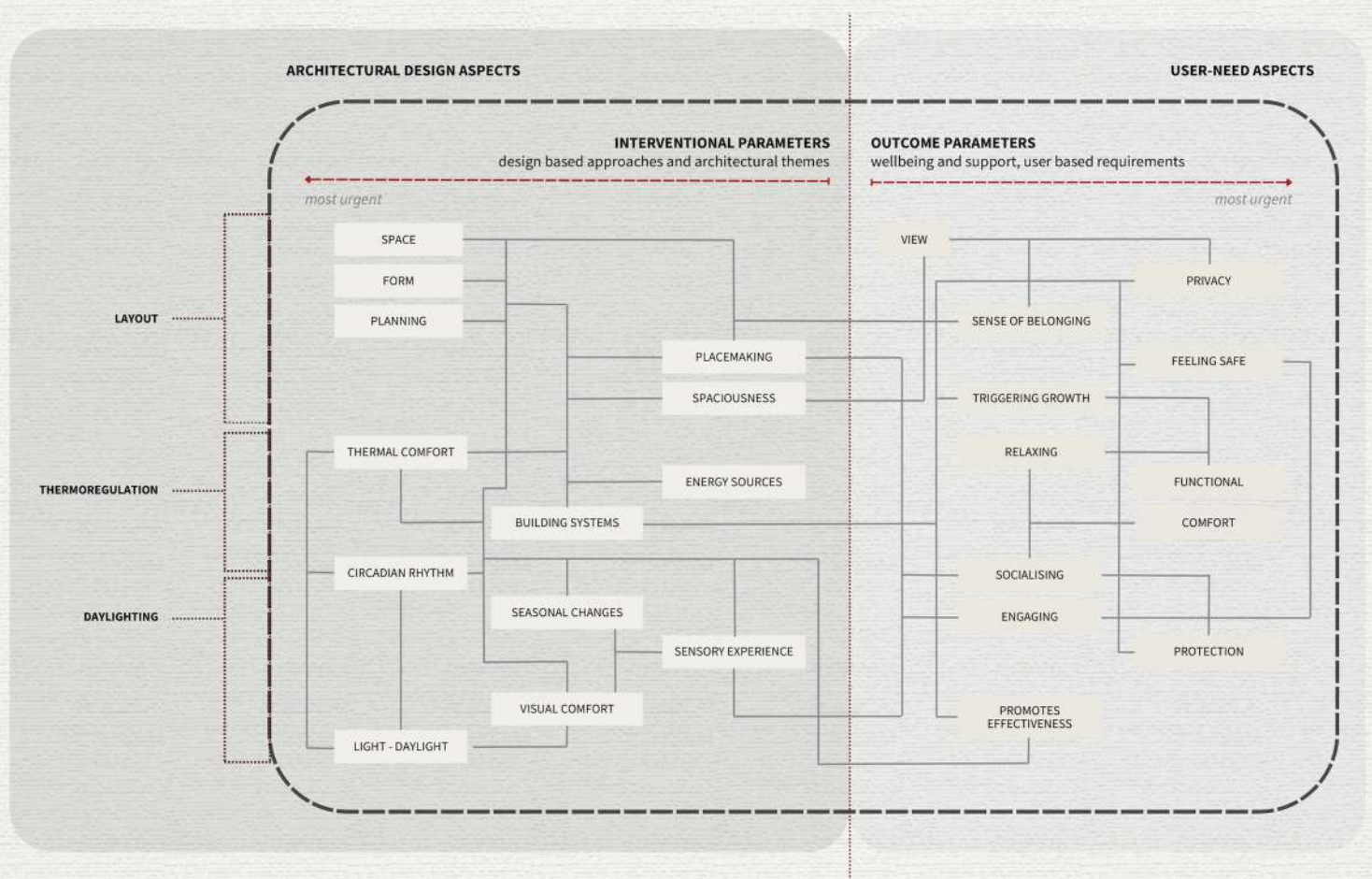


Fig. 9 Parameters of Biomimetic Strategies for Transitional Housing (Author, 2023)

As seen above, the parameters are interconnected, contributing to the success of one another. These parameters serve as points of examining the strategies' suitability on providing advancements in an integral way, generated to maximise user's experience. The next part will introduce the biomimetic's integration which fulfil these parameters and criterias as they will sequentially present each interventional points and their corresponding outcomes, presenting direct connection between biomimetic strategies and their more user-specific key functions.

The Space of Things to Come : LAYOUT

Layouts are the building blocks of design, significantly influencing space, form, and planning (Guo & Li, 2016). In finding the best layout, architecture can look into nature for insights on optimising form and adaptability (Goldsmith, 2014). The aim is to create efficient layouts based on user-defined programs.

Nature abounds with logarithmic spirals, manifesting in diverse forms and scales due to interplays between physical forces and matter, naturally converging toward the shape (Hadhazy, 2014). The ubiquity of these spirals has resulted in their integration into architecture. In biological organisms, the presence of spirals can be attributed to the principle of parsimony, a conjecture suggesting that entities are inclined to develop in the most efficient manner (Woolfe, 2015).

The chambered nautilus (*Nautilus pompilius*) exhibits a shell that, upon sectioning, reveals a nacre lining organised in an equiangular spiral pattern. More specifically, nautilus shell is a logarithmic spiral, characterised by its self-similarity as it retains an identical shape at different scales (Bartlett, 2018). They are the most commonly found spirals in nature (Woolfe, 2015). Recent research has demonstrated biomimetics derived from nautilus shells in optimising factory layout effectively reduce internal transport costs within factories (Tinello et al., 2016). It divides internally into chambers known as camerae, marked by septa penetrated by a central duct called the siphuncle. When it outgrows its space, spiral extensions are added to its shell, retaining old chambers by closing them off to aid buoyancy. The creature inside creates an interior for seamless movement between habitat and food source, highlighting efficiency.

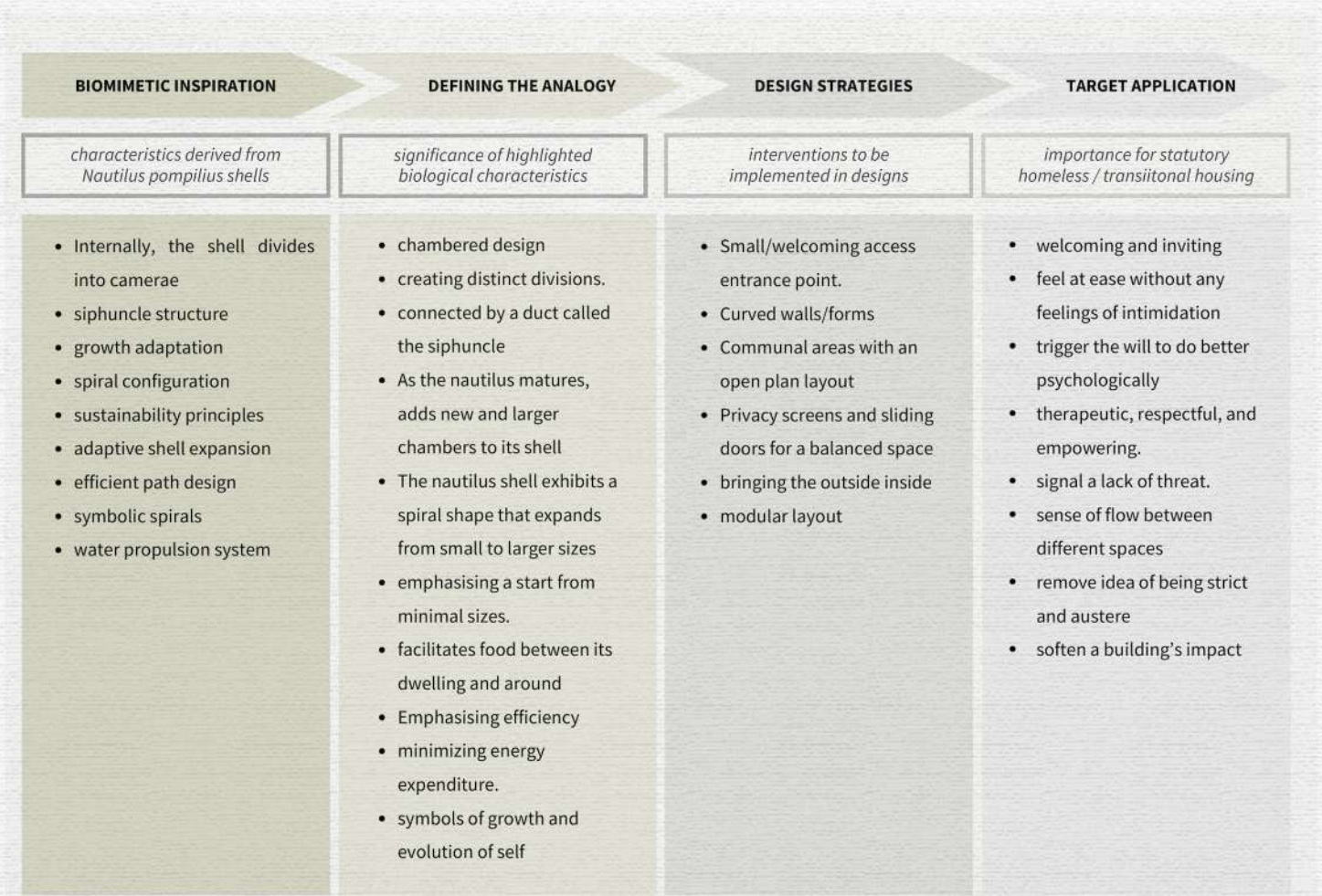


Fig. 10 Layout Biomimetic Strategies derived from Nautilus Pompilius Shells (Author, 2023)

Biologically, the nautilus have a small opening compared to its overall body size. They're used for expelling water for propulsion, enabling it to move in and out of its shell. In terms of transitional housing layout, the design of entrances is paramount. The initial impression should be welcoming and inviting, creating a sense of home (Greenwood, 2018). It is crucial that users feel at ease upon entering the building without any feelings of intimidation. This 'at ease' feeling to can trigger the will to do better psychologically (Ng, 2020). Avoiding imposing structures is crucial for transitional housing as they become more therapeutic showing that it's not just efficient but also respectful and empowering. Small entrances have been observed to provide a reassuring and calming effect, allowing people to prepare themselves before entering the facility (Tekin & Gutiérrez, 2023).

Research has shown that rounded forms inherently signal a lack of threat. Curves not only create focal points within a space but also serve to soften a building's visual impact, blending with surrounding environment (Best, 2014). Drawing inspiration from the efficiency of the nautilus' spiral geometry, curves in design contribute to a sense of flow between different spaces. This subtle guidance provided by curves can significantly enhance the overall experience of transitional housing, making it more welcoming, calming, and aesthetically pleasing (O'Connor, 2019). Homeless housings are viewed as being strict and austere. This curved form will interactively play with the users and soften a building's impact, helping the structure meld into the improvement of those staying inside.

Transitional housing layouts should prioritise creating a safe and relaxing environment, departing from compartmentalised layouts. Open plan configuration promotes spontaneous socialising and allows glimpses of communal activities without feeling intimidated or obliged to participate (Alfaiz, 2023), facilitating visual connections within spaces, offering control and awareness of ongoing activities, eliminating any potential danger. This enhanced the sense of belonging and pride among homeless individuals, leading them to actively participate in social interactions (Rutenfrans-Stupar, 2019). Inspired by the nautilus siphuncle—a duct penetrating all its chambers—the design envisions interconnected spaces, fostering a seamless flow. The spiral shape of the nautilus shell emphasises primacy of content and continuous connectivity, encouraging an layout that optimises functionality and flexibility, creating communal spaces that promote interaction and adaptability (Kennedy, 2019).

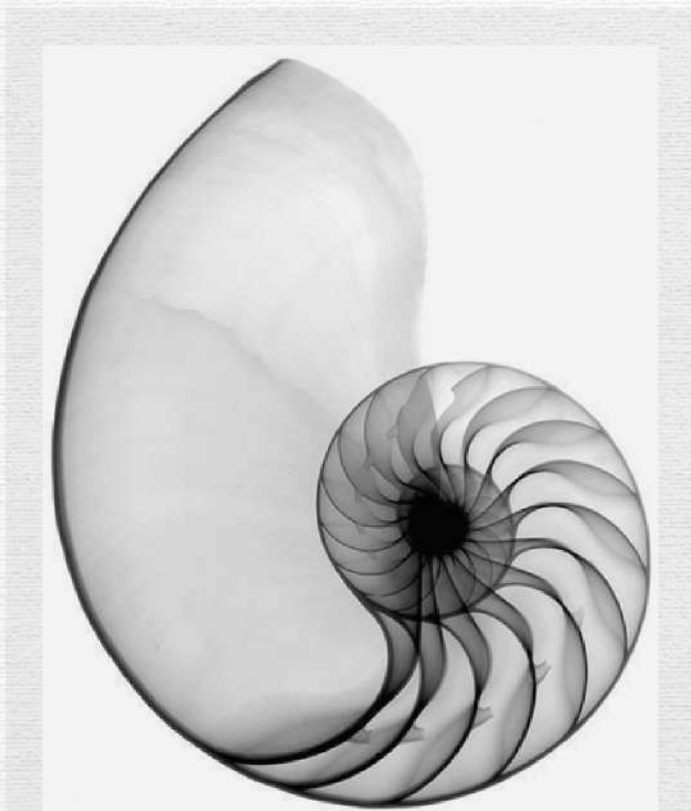


Fig. 11 X-ray *Nautilus pompilius* Shell (Myers, 2014)

While open-plan layouts may raise privacy concerns, as long as they enable withdrawal, pose no threat (Tomah et al., 2016). Overcrowding accentuates the need for personal space (Olsen et al., 2008). Inversely, distinct divisions instill a sense of ownership and security within shared environment (Muzaffar et al., 2020). The nautilus' chambered design inspires layouts that offer privacy without complete isolation. Each chamber, while separated by septa, remains connected, allowing the creature to move between chambers while maintaining continuity. This concept translates into creating spaces that provide privacy when needed, without entirely cutting off occupants. Maintaining visual or physical connection between private spaces and surrounding environment, fosters an interconnected atmosphere. This approach facilitates individuals to access for private spaces when desired while remaining part of the larger environment, promoting both solitude and community. The inclusion of sliding doors subtly indicates privacy, allowing to feel at ease and move freely without hesitation or needing to inspect rooms upon entering; ensuring a sense of space, ownership, and security within shared environment (Altman, 1975).

The nautilus models a seamless integration of indoor and outdoor spaces, akin to its feeding symbiosis mechanisms. This approach yields various advantages, including improved well-being, better ventilation, and increased natural light access. By erasing boundaries between interior and exterior spaces, layouts can emulate the nautilus's ability to coexist with its surroundings. People highly value connection between indoors and outdoors, primarily visual connections to natural elements (Grindle & Patil, 2009), which contributes to a welcoming and relaxing atmosphere, making the space feel like a safe, inviting, and healing environment—elements essential for transitional housing.

Modular housing offers a flexible and accommodating environment. Similar to how the nautilus adds chambers as it grows, such method allows rooms to progress and adapt, catering to evolving needs. Applying modularity also ensures personalised support for homeless individuals, having flexibility and scalability to offer various levels of assistance, from shared facilities and support services to more independent modules. Hence, individuals' evolving stages are accommodated, offering a progressive path to stability. By providing a step-by-step framework, it empowers individuals to regain control over their lives. Efficiency is also promoted by reducing space waste and optimising resource utilisation, which is crucial for addressing homelessness on a broader scale (Bryant et al, 2008).

The Climate of Comfort : THERMOREGULATION

Ensuring an appropriate body temperature is critical for biochemical and physiological functions, with animals dedicating considerable energy to temperature regulation (Mazzoleni & Price, 2013). Statutory homeless people encounter extreme weather conditions coupled with limited social support (Anderson et al., 2021). Homeless individuals are particularly vulnerable due to challenges in accessing cool environments, water, and the intricate interplay of mental health, medications, and substance use disorders, heightening the risk of heat-related illnesses (English et al., 2022). Conversely, cold weather poses substantial risks too, especially for the homeless population already grappling with constraints and inadequate access to essential resources, amplifying life-threatening concerns (Zhang et al., 2019).

This section specifically addresses London's climate type due to its status as a rapidly growing urban capital with a notable increase in homelessness. The London assembly estimated in August 2023 that one in 50 people in the city is homeless, reflecting a 54% rise in homelessness cases from 2013 to 2023 (evolvehousing.com, 2023). Focusing on the climate type of a location with significant levels of statutory homelessness is essential for identifying immediate needs in transitional housing advancements. Therefore, examining a native mammal in the area is a logical approach to address these challenges.

Mammals, utilising homeothermy, can thrive in diverse bioclimatic zones while maintaining a narrow core temperature range (Crompton et al., 1978). Consequently, mammals such as badgers, employ strategies in their setts to complement physiological thermoregulatory mechanisms (Terrien et al., 2011). Badgers (*Meles meles*), widespread in London's outer suburbs (London Wildlife Trust, 2020). The impact of microclimate on earthworm availability influences badger population dynamics, showcasing thermoregulation's governance over badgers setts (Jiménez and Decaëns, 2000; Macdonald et al., 2010). Having evolved various thermal adaptations, badgers setts offer insights for the biomimetic strategies of thermoregulation. This suggests that transitional housing could enhance its thermoregulation by utilising the badger's setts properties to simulate thermal comfort for the statutory homeless.



Fig. 12 Badger Setts (Northumberland Badger Group, 2013)

BIOMIMETIC INSPIRATION	DEFINING THE ANALOGY	DESIGN STRATEGIES	TARGET APPLICATION
<i>characteristics derived from Meles meles Setts</i>	<i>significance of highlighted biological characteristics</i>	<i>interventions to be implemented in designs</i>	<i>importance for statutory homeless / transitional housing</i>
<ul style="list-style-type: none"> • Badgers live in a system of interconnected tunnels and chambers called a sett. • Every badger clan has one main sett, relatively large • Most badger tunnels have a distinctive shape, being wider than they are tall, with a flattened base. • Multiple types of setts: Main, Annexe, Subsidiary, Outlier 	<ul style="list-style-type: none"> • having a main center area and surrounding complimentary areas • buffer zones, hierarchy of different areas • prioritising spaciousness than heights, focusing on scale of occupants • interconnected system with distinctive qualities 	<ul style="list-style-type: none"> • multiple corridors / entrances / vestibules • wide openings • spatial organisation as compound or clusters 	<ul style="list-style-type: none"> • ventilation • heat dissipation • regulation of humidity • prevent overheating • microclimate regulation • reduced heat island • optimisation of space

Fig. 13 Thermoregulation Biomimetic Strategies derived from Meles meles Setts (Author, 2023)

The setts interconnected tunnel system offers biomimetic insights for thermal regulation (Davison et al, 2008). The configuration translates architecturally to multiple corridors, aiding with maintaining consistent temperatures by facilitating airflow, allowing for the escape of warmer air and the entry of cooler air, and assisting a consistent internal temperature, especially during warmer periods. Statutory homeless people have faced housing with poor ventilation, leading to dampness and mould (Nuut, 2023). This adaptation aligns with the aim of transitional housing required to regulate indoor air quality and thermal comfort. Efficient ventilation not only ensures a healthier environment by eliminating airborne contaminants but also plays a crucial role in managing indoor temperature for better occupant comfort (Roulet, 2012).

Simulating the sett's wide entrances, wide openings should be employed in transitional housing. In warmer weather, heat dissipation is more efficiently present with wider entrances. By facilitating convective currents and expelling warm air out of the area, the approach contributes to a cooler internal temperature. This leads to improved airflow through a better humidity regulation, preventing the accumulation of excessive moisture and mould growth. Eventually, overheating can be avoided within enclosed spaces by fostering better air circulation, reducing the risk of heat accumulation. These considerations extend beyond resident satisfaction, significantly impacting health. Addressing thermal discomfort is vital for overall human functions (Ormandy & Ezratty, 2016). Notably, thermal comfort strongly influences occupants' productivity, with reports of discomfort correlating with decreased productivity levels among occupants (Bueno et al., 2021). With better thermal conditions, better user performance can be achieved, which triggers more successful transitional housing.

As the badger's setts are arranged in clusters, such arrangement for structures offers better thermoregulation compared to a single large block building. Clustering buildings creates varied microclimates within the compound, thus providing a range of sun exposure and shade, facilitating controlled temperature gradients across the area (Gunawardena et al., 2017). Microclimates represent actual physical conditions experienced by organisms (Kearney, 2021), which influence the energy, activity, and behaviour of individuals within transitional housing. Block structures contribute to the heat island effect, elevating daytime temperatures, diminishing nighttime cooling, and increasing air pollution levels (Santamouris, 2020). With clusters, heat-islands are reduced and can mitigate heat-related illness, including discomfort, respiratory issues, cramps, exhaustion, and non-fatal heat stroke (Vaidyanathan et al., 2020). Moreover, clusters have better thermal control as they optimise land use, leaving open spaces for integrating green areas, shaded zones, or water elements, enhancing environmental cooling through evaporation and shading- contributing to a more relaxed and cooler environment.

Daylight is the holistic combination of sunlight’s luminosity from direct and diffuse solar radiation, referring to the illumination of indoor spaces through openings (Knoop et al., 2019). Well daylighting is necessary for vision; it enables humans to sense and perceive surroundings as it affects physiological and psychological health (Heschong et al., 2013). Natural light possesses restorative and therapeutic qualities, promoting relaxation, mindfulness, and influencing our circadian rhythm. It also helps the homeless with depression and anxiety by stimulating serotonin production (Augustin et al., 2009). Additionally, housing users with increased exposure to light express higher productivity, satisfaction and comfort levels (Sansone & Sansone, 2013).

Homeless housing often lacks proper daylighting, relying on subpar electric lighting. Those put in these housing should get a clear vision of event or performance. As the system fails to provide a stimulating environment at the same time it creates pressure on the overall advancement of both building and users (Yasin et al., 2017). Prolonged reliance on artificial lighting, in the absence of sufficient daylight, can lead to significant adverse effects on human health and productivity (Heschong, 2002). Integrating daylighting in transitional homes will significantly enhance occupants’ performance on their journey to overcome statutory homelessness.

Recognising the profound connection between daylighting within transitional housing, this research employs the visual anatomy traits of the Downy emerald dragonfly (*Cordulia aenea*), frequently spotted in the UK’s wetlands (Drinan et al., 2011). They possess well-developed nervous and sensory systems (Verbe et al., 2020), exemplified in their compound eye structure which efficiently captures and diffuses light across a wide visual field (Phan et al., 2021). Unlike humans, who rely on three opsin genes, dragonflies boast between 15 and 33 opsin genes, indicating exceptional visual capabilities (Parker, 2022).

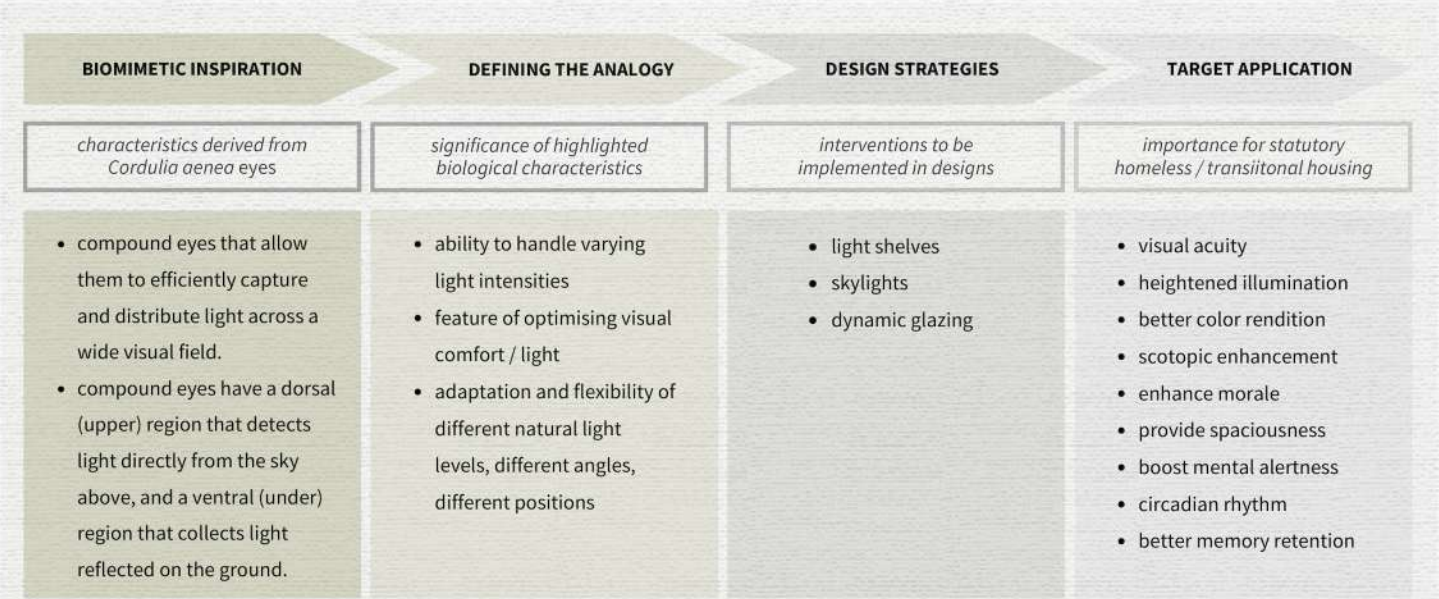


Fig. 14 Daylighting Biomimetic Strategies derived from Cordulia aenea Eyes (Author, 2023)

Visual discomfort, defined as 'discomfort or pain in or around the eyes' (Boyce & Wilkins, 1975), can arise due to glare and flicker from light sources, causing immediate impacts on visual acuity. This diminishes our ability to discern task, requiring a recovery period, before resuming the interrupted activity. The strain on our visual system in challenging conditions leads to visual fatigue, manifesting as symptoms like eye tension, light sensitivity, reduced vision, and headaches. Besides, glare management is vital, as it can limit performance and well-being (Sok-Paupardin, 2021). Dragonflies' compound eyes efficiently capture and distribute light, demonstrating adaptability to varying light levels. This adaptability aligns with the concept of dynamic glazing, adjusting transparency in response to external light, offering optimal illumination while minimising glare and heat gain, inspired by the dragonflies' ability to handle diverse light intensities. This approach would mitigate flicker effects by reducing electric lighting usage, removing any impending health issues that might be triggered.

The use of light shelves are inspired by the compound eyes' ventral region ability to reflect objects off the ground, designed to capture and distribute natural light, allowing it to penetrate deeper into interior spaces by redirecting daylight entry from different angles (Kontadakis et al, 2018). Positioned above eye level, it sports a highly reflective surface that also shades areas near windows (Lee et al., 2022). This biomimetic concept optimises diffusion and spread of natural light, elevating illumination while minimising glare and heat build-up in structures. The concept of illuminance influencing perceived safety, linked to mobility and perception, plays a crucial role in development of inhabitants (Zeng et al., 2023). This fosters a collective trust, promoting a heightened sense of security and stability. Consequently, it enhances acceptability of health and social interventions in transitional housing.

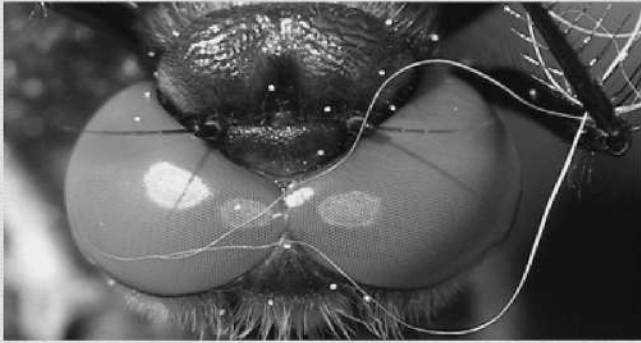


Fig. 15 Female Downy Emerald Dragonfly Eyes (Smaragdlibelle, 2009)

The upper eye region of the dragonflies compound eye have the ability to detect light from the sky. Similarly, skylights in architecture permit natural light from above to enter buildings. They replicate the compound eye's strategy by directing sunlight into interior spaces, boosting overall illumination. Skylights are crucial in homeless transitional housing as they offer multiple advantages. It acts as a supplementary openings, reducing the need for artificial lighting, thus cutting energy costs. Additionally, they enhance aesthetics, elevate mood, and create a link to the outdoors, positively impacting occupants' well-being.

The incorporation of these strategies results in improved visual acuity, heightened illumination levels, better color rendition, and scotopic enhancement. Proper daylighting in transitional housing significantly enhances occupants' morale and performance by stimulating mental activity, inducing a calming effect, and boosting mental alertness through circadian responses. It aids memory retention and long-term health, contributing to a healing environment with a non-institutional feel, fostering positivity tranquility, stress reduction, and a sense of safety and privacy.

THE DOMINO EFFECT

Humans share an intrinsic affinity with nature, a connection ingrained in our very existence. This innate bond drives an instinctive attraction toward nature, fostering a deep-seated longing within us. Harnessing this inherent connection serves as the entry point for intergrating biomimetic architecture in addressing homelessness. This model exemplifies the paper's findings wider impacts. By bridging insights from diverse fields, particularly in transitional housing, this approach aims to enhance the living conditions of individuals experiencing statutory homelessness.

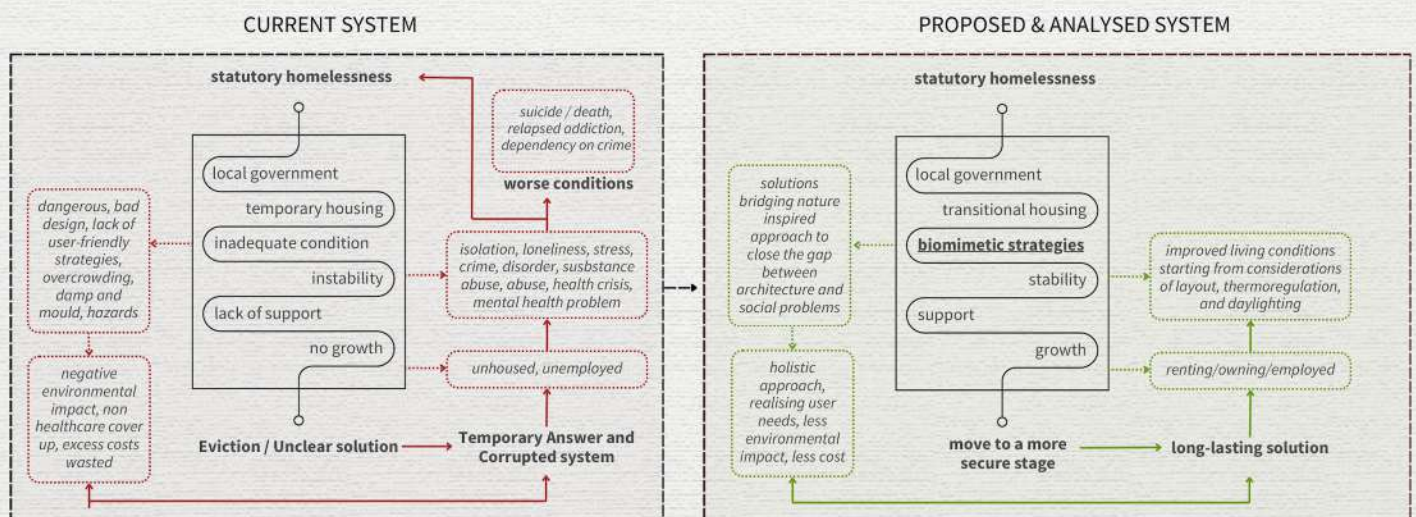


Fig. 16 Comparison of Current and Proposed Approach (Author, 2023)

The anticipated impact of implementing these principles spans multiple dimensions. It addresses the diverse needs of the statutory homeless, focusing on both their psychological and physical well-being. This approach extends beyond the individual level, envisaging a broader social impact, fostering societal well-being through advanced transitional housing. Focusing on user needs and quality of life in architectural design drives holistic advancements with lasting impact. The approach not only profoundly enhancing occupants' health and well-being, but also steers away from ineffective strategies, conserving energy and promoting sustainability by reducing carbon footprints. It fosters a strong connection to nature, elevating immediate life quality and fostering sustainable coexistence between architecture and nature. Moreover, the environmental implications are substantial, advocating for biomimetic that are essentially sustainable practices, reducing environmental impact and promoting ecological balance.

This transformation transcends conventional roles as it assumes the role of a policy advocate for the matter. The incorporation of these principles into legal frameworks could revolutionise various sectors, particularly in policy-making arenas. It acts as an agent of change, engaging design agencies and establishing replicable models that drive positive shifts of chain reactions in societal paradigms. By narrowing the gap between the built environment and nature, this conscious collaborative effort seeks innovative design concepts, initially perceived as disparate, ultimately creating harmonious and sustainable transitional housing solutions.

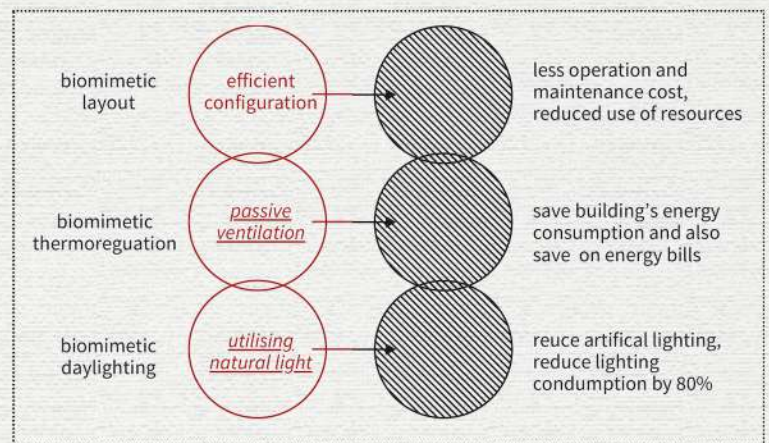


Fig. 17 Example of Chain Reaction towards Holistic Sustainability (Author, 2023)

CONCLUSION

SPECULATION

In transitional housing for individuals facing statutory homelessness, user needs concerns pose a significant challenge, exacerbating stress, depression, and anxiety about their circumstances. Users strongly emphasise the need for spaces that alleviate these negative emotions. Specific design elements, particularly those rooted in biomimetic design, play a pivotal role in shaping these spaces. The findings focus on three main categories: layout, thermoregulation, and which amalgamates several biomimetic architecture approaches. The success or failure of the adaptation is intrinsically linked to its impact towards the user's wellbeing, recognising its position as the trigger for further holistic sustainable advancements in other types of buildings. These design facets emerge as critical elements in a redefined framework for transitional housing for those experiencing statutory homelessness. The integration of biomimetics in transitional housing represents a shift from short-term to holistic solutions for statutory homelessness. This research lays the groundwork for more resilient transitional housing design through biomimetics, acknowledging its role towards a wider range such as affordability and energy efficiency. By merging biomimetics and social issues, it aims to surpass immediate resolutions and tackle enduring challenges, highlighting the link between adequate housing conditions and fundamental human rights, emphasising its holistic influences to the entire sustainability paradigm.

LIMITATION

While biomimicry has found applications across multiple disciplines, this paper realises that applying it to transitional housing has inherent limitations. These limitations stem from fundamental differences between the interdependent nature of natural systems and research's timeframe, constraining exploration depth. Furthermore, the study's geographic and demographic specificity, centering on London's climate and statutory homelessness limits the focus of unhoused population discussed. User well-being is the core discussion thus focusing primarily only on the fundamental aspects of layout, thermoregulation, and daylighting. The selection of three natural elements as inspirations, while strategic, may not encompass the entirety of potential biomimetic solutions available. The study's qualitative-based analysis and theoretical research pose constraints in directly implementing findings into architectural practice, shown as it focuses on welfare in new builds. This in turn limits discussions for existing spaces with more regards considering affordability or technological strategies. Despite these limitations, it's important to clarify that these constraints don't invalidate the research. Rather, they underscore the necessity of employing the findings as a foundation for refining and expanding upon actual design guidelines in future studies.

RECOMMENDATION

To enhance the transferability of these insights to diverse homeless populations across various regions and contexts, future studies should expand the scope of research to encompass a wider demographic spectrum beyond statutory homelessness. Additionally, addressing critical elements such as affordability and energy efficiency in transitional housing designs should be integrated into further investigations. Furthermore, for more robust validation and practical application, it is imperative to test and validate these principles in real-world architectural projects rather than solely relying on examples. As these principles serve as a foundational knowledge base, they should be developed into comprehensive design guidelines, facilitating their effective implementation in transitional housing projects aiming to alleviate homelessness. Such guidelines can be used as a roadmap, fostering sustainable, user-focused, and contextually relevant designs across diverse housing contexts.

CONTRIBUTION

The ability to grasp the interconnected impacts within transitional housing design is crucial for future advancements, particularly through interdisciplinary approaches. Recognising elements as connected is an ability not common to all, but something that can and vital to be acquired. The findings of this paper served as that start, offering insights into overlooked aspects within the nexus of biomimetic architecture and homelessness. By focusing on user well-being and integrating biomimetic principles into transitional housing design, this research contributes novel perspectives that emphasise holistic, sustainable advancements. Moreover, it sheds light on laying the groundwork for further research directions and interdisciplinary collaborations to refine design guidelines and address the complex needs of diverse homeless populations worldwide, fostering a foundation for future investigations.

GLOSSARY OF TERMS

Transitional housing: Temporary accommodation that aids individuals in transitioning from homelessness to more stable, permanent housing situations.

Statutory Homelessness: homelessness as recognized by government or legal entities, often entitling individuals to certain rights or support.

Well being: The state of overall health, happiness, and prosperity experienced by individuals or communities.

HHSRS (Housing Health and Safety Rating System): A tool used by local authorities to assess health and safety risks in residential properties in the UK.

Sustainable Paradigm: A holistic approach or framework that prioritizes environmental, social, and economic sustainability in various facets of life.

Sustainability: The ability to maintain or endure without depleting resources or causing severe ecological damage, ensuring future generations' needs can be met.

Holistic Sustainability: A comprehensive approach that considers multiple interconnected aspects of sustainability, such as environmental, social, and economic factors.

Biomimetic Architecture: A design approach that draws inspiration from nature's structures, processes, and systems to solve human problems and create sustainable architectural solutions.

Biomimetic(s): Pertaining to or involving biomimicry/biomimetic architecture

Chambered Nautilus (*Nautilus pompilius*): A marine mollusk with a spiral shell divided into chambers, often used as an inspiration for architectural design due to its structural intricacies.

Badger (*Meles meles*): A nocturnal mammal known for its burrowing behavior and setts, which may serve as an inspiration for certain architectural designs.

Dragonflies (*Cordulia aenea*): Insects with compound eyes, inspiring architectural designs related to light management and visual perception.

Chambers: Referring to separate compartments within a structure, often inspired by natural examples like the nautilus shell.

Siphuncle: A structure in some shells that regulates gas and fluid content within chambers, influencing fluid movement and pressure.

Compound eye: An eye structure found in insects and crustaceans that consists of multiple visual units, inspiring designs related to visual perception and light capture.

Setts: Burrows or underground tunnels created by certain mammals, such as badgers, which may influence architectural designs related to interconnected spaces or structures

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APPENDIX

APPENDIX A: CERTIFICATE OF ETHICAL APPROVAL

Nature's Ingenuity: The Integration of Biomimetic Architecture for the Holistic Sustainable Advancements of Transitional Housings for Statutory Homelessness



Certificate of Ethical Approval

Applicant: Joscelyne Eugene
Project Title: Nature's Ingenuity: The Integration of Biomimetic Architecture for the Holistic Sustainable Advancements of Transitional Housings for Statutory Homelessness

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Low Risk

Date of approval: 24 Oct 2023
Project Reference Number: P163054

NATURE'S INGENUITY:

The Integration of Biomimetic Architecture for the Holistic Sustainable Advancements
of Transitional Housings for Statutory Homelessness

Joscelyne Theophania Eugene Juhardi