CHANGING

SPACES

Figure 1. Fincube, Studio Aisslinger, Ritten, 2010

CHANGING SPACES

HOW ARE MODERN DWELLINGS BEING INNOVATED INTERNALLY AND EXTERNALLY TO ACCOMMODATE A WORLD RUNNING OUT OF SPACE AND RESOURCES?

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KEY WORDS

OPTIMISATION

MICRO-LIVING

MODULARITY

FOOTPRINT

DWELLINGS

With population levels at an all-time high and the planet increasingly becoming depleted of finite resources, the world is seemingly presenting fewer spaces for developing common habitable structures. With new innovations and trends being discovered and applied to modern dwellings, a sense of uniqueness and ownership is being created, moving away from the norm of conventional living.

With exterior structures of modern dwellings becoming increasingly challenged in terms of aesthetic and function, there is a greater quantity of modern property creators looking for an increased individuality.

While the goal is notably to survive in the common constructs of society, modern properties are seemingly looking to break the boundaries of stereotypical living to create an enhanced yet functional experience. In a society that is striving on the new notions of sustainability, optimisation and maximum efficiency in common life practices, the focus is now turning to how these can be applied to the spaces we live in. This dissertation evaluates the changing movements of how dwellings are being innovated externally and internally to produce functionality, efficiency, and individuality within a living space.

Through investigating the developments within micro-living, modularity, sustainability and compact interior innovations, this thesis will draw a narrative that counteracts and compels against the norm of conventional living. Moreover, directly exploring the existing development in external and interior structures, gaining a greater consensus on the gaps in dwelling developments. This, furthermore, exploring how with a planet where footprint is being dramatically compromised, modern dwelling innovations are beginning to take over.

INTRODUCTION

Of all the architectural genres and genuses, the home is perhaps the most enduring symbol of innovation and change. A smart, self-contained statement of intent which represents in mass, the underpinning motive of the world's key obsession, modernity.[1] The start of the twenty-first century set in motion a force of societal changes, that was inevitably going to affect the pathway that the population globally housed themselves in the foreseeable future. Amongst the foremost attributes propelling these changes, was the transformation and surge of the family's non-traditional household, whose make-up sits differently to that of fifty years previous. In line with these demographic shifts, changes in lifestyle habits have progressed user attraction to new prototypes to which breaks the norm of generic interior layout, exterior layout, and aesthetic.[2]

With the sustained pressure of city housing crises and problems of decreasing opportunity for larger scaled properties, users have needed to find a solution to adapt to pressuring notions. This has taken multiple forms, such as the reduction of housing footprints in a form coined micro-living, which looks to create an equilibrium between size reduction and maintained efficiency.[3]
The notion that living small is less has been perceived as a hinderance within various dated dwellings, yet modern innovations in exterior and interior dwellings seemingly look to break this adherence. Whilst a reduction in footprint promises less open space, the clever use of what space is available, and the cautious arrangement of functions almost defy their diminutive aspect. The body exemplars such as The Macy Miller House and Slim House, demonstrate how using less footprint does not

1 Jonathan Bell, '*21st Century House*',edt by Jonathan Bell, 1st edn, , Laurence King Publishing Ltd, London, England, 1st April 2006 , pp. 91

2 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 7

3 Emma Clinton, 'Micro Living: Why occupants chose to live in very small dwellings', *Australian Planner*, vol 55, 23rd June 2019, pp. 189-197

seemingly equal cramming amenities into uncomfortable settings, yet allowing innovation to be increasingly expansive.[4]

Coining the ability to live small yet efficiently, has opened an expansive and explosive route for dwelling innovations beyond simply reducing footprint within the twenty-first century. Notably, creating spaces with enhanced modularity and reduction of the static space links to the variable of time in architecture. With removal of the concept of transiency and creating a dynamic dimension from a permanent entity, the temporary and adaptable dwelling as expressed in Prefab Lighthouse is an important technological innovation in accommodating a world running out of footprint.[5] Yet, living small and efficiently has progressively opened a harmonious merging of sustainable incorporations to resourceful living with a compact footprint. Within a world running out of resources and a society committed to the new notions of efficiency and optimisation in common life practises; this sustainable approach is being transferred into the spaces we live in. This is demonstrated through The Silo House and Fincube, which pose alternative solutions to how dwellings can reduce consumption and exploiting untapped environments.[6] Moreover, populations are seemingly adapting dwellings with a more conscious focus on the necessity of utilizing resources and footprint, in an assault on the stereotypical norm.[7]

Accordingly, exterior potential of dwellings needs to be matched by interior functionality to work harmoniously and fit the innovating ethos of adapting to a world running out of space. This is best exemplified in Compact Living, designed and innovated by Spacon & X to re-shape, re-define and utilize their current footprint, adapting alongside their changing household.[8]

4 Phyllis Richardson, '*Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 13

5 De Beradinis, P. Marchionni, C. Capannolo, 'MO:BOM: a multi-functional prefabricated and flexible module', *International Journal of Computational Methods and Experimental Methods*, vol 5, iss 4, 1st June 2017, pp. 522

6 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 71; Michelle Gabriel, Philippa Watson, 'From Modern Housing to Sustainable Suburbia: How Occupants and their Dwellings are Adapting to Reduce Home Energy Consumption', *Housing, Theory and Society*, vol 30, iss 3, 1st September 2019, pp. 223, 232

7 S.B Yazyeva, I.A Mayatskaya, 'Eco-sustainable architecture and comfortable living environment', *IOP Conference Series. Materials, Science and Engineering*, vol 1031, iss 1, February 2021, pp. 1-6

8 Anna Yudina, '*Home Work, Design Solutions for Working From Home*', Thames and Hudson Ltd, London, England, 8th March 2018, pp. 155

With the need for a compact footprint, the rational organisation and integration of space saving technologies is seemingly innovating how users personalise and customise an interior setting to fit their ever-changing needs.[9] This culmination of cases, providing a base point for exploration into sculpting the appearance of a new functioning world. A world where the constraints of compact space and reduction of resources are no longer a hinderance but a point of new possibility and expansion.[10]

Figure 8, Greta Thunburg, 1975 Lyrics, HIghlighting The Need For Change In Society, 2019

Figure 9 Changing Demographic Representation, 2022

9 Simona Canepa, 'Living in a Flexible Space', IOP Conference Series: Materials Science and Engineering, vol 245, iss 5, 1st October 2017, pp. 1-10

10 Wei Wu, Brad Hyatt, 'Experiential and Project-based learning in BIM for sustainable Living with Tiny Houses', *Procedia Engineering- International Conference on Sustainable Design, Engineering and Construction*, vol 145, 2016, pp. 580

LITERATURE REVIEW

The questionable and critical solutions behind the innovation of modern dwellings in response to resource and footprint deficiency, presents us with a selection of engrossing perspectives. With a series of authors and theorists importantly debating the contemporary outcome of specimen surrounding changing and retracting spaces. These conjunctions can be separated into different areas of focus such as, micro-living including tiny houses, to modularity and sustainability within modern dwellings, and further analysis into the shaping of the interior to accommodate new compact forms of occupation in space. Joshua Wotton, Agnes Borssos, Marrielle Silva and Hosseini Raviz pose crucial viewpoints across my analysis, concentrating on Wotton's emphasis of micro living, 'combatting current un-sustainable scales of development whilst striving for new notions of 'self-actualisation'.[11] While, Raviz focuses critically on reshaping the static interior, creating new types of spatial distribution and formatting.[12]

Within the domain of micro-living in tiny houses, Wotton argues that the changing social dynamic of families has thus brought large influence on the housing sector. Hereto, driving alongside the current unsustainable scales of housing developments and shaping the route to smaller living. Wotton claims, that living smaller focuses more on the 'functional and amenity' needs of the user. [13] Similarly, when analysing the trend behind the movement, Stephanie Brokenshire is particularly useful in highlighting the creativity, vitality and portability of living small to occupy and adapt in pressing circumstances of limited spatial capacity.[14] With this in mind, Ria Roy likewise explores how

11 Joshua Wotton, Henry Skates and Leigh Shutter, 'Tiny House, When Size Matters', *Australian Planner*, vol 55, 14th June 2019, pp. 209-220

12 Hosseini Raviz, Seyed Reza, Nik Eteghad Ali, Ezequiel Uson Guardiola, Antonio Armesto Airo, 'Flexible Housing: The Role of Spatial Organization in Achieving Functional Efficiency', *ArchNet-IJAR: International Journal of Architectural Research*, vol 9, iss 2, 13th July 2015, pp. 65-76

13 Joshua Wotton 'Tiny House, When Size Matters', 14th June 2019, pp. 212

14 Stephanie Brokenshire, 'Tiny Houses, desirable or disruptive?', *Australian Planner*, vol 55, 2nd October 2018, pp. 230

this new innovation has allowed a return to a decluttered existence, using a compact footprint dwelling to reformat spatial consumption in a concrete reality.[15] Yet, Krista Evans conveys the innovation in a greater cultural perspective, highlighting the larger societal attribute benefits, providing potential for the homeless, driving down costings and thus increasing resource efficiency.[16] With this in mind, Maurie J. Cohen delineates the need for the adaptation within dwellings, downsizing to aid in the sustainable consumption transition and degrading finite resource capacity.[17] Looking specifically at functionality, Emma Clinton poses a compelling examination into tiny living, providing alternative options that reduces space while maximizing personal utility. Clinton presents the need to maximize space and internal amenity in "lieu of reduced floor space" amongst pressing environmental and economic circumstances.[18] Moreover, the emphasis is drawn by Clinton that with the residing levels of substandard living methods, there is a need and current fluidity in transition with more compact forms of occupation being implemented.[19] Much like micro-living, modular living supports the transition towards compact forms of habitation yet, is subject to a different application of its principles. Marielle Silva is critical in analysing the new architectural typology that is helping optimize the efficiency of resource use, arguing by allowing the building to grow, it displays flexibility and adaptability. Silva argues, the integration of prefabrication and modularity opens more possibilities to arrange and expand dwellings according to the needs of users.[20] Similarly, Agnes Borsos contributes to this narrative when exploring the deeper analysis of modular living units. Borsos poses the idea to "create the incomplete" building,

15 Ria Roy, 'Tiny House, A Big Movement?', *International Society for Performance Improvement*, vol 58, April 2019, pp. 28

16 Krista Evans, 'Tackling Homelessness with Tiny Houses: An Inventory of Tiny House Villages in the United States' *The Professional Geographer*, vol 72, 2020, pp. 360

17 Maurie J. Cohen, 'New Conceptions of Sufficient Home Size in High-Income Countries: Are We Approaching a Sustainable Consumption Transition?', *Housing, Theory and Society*, vol 32, iss 2, 15th March 2021, pp. 173,174

18 Emma Clinton, 'Micro Living: why occupants chose to live in very small dwellings', *Australian Planner*, vol 55, 23rd June 2019, pp. 189-197

19 Emma Clinton, 'Micro Living: why occupants chose to live in very small dwellings', 23rd June 2019, pp. 191

20 Marielle Ferreira Silva, 'Another way of living: The Prefabrication and modularity toward circularity in the architecture', *IOP Conference Series: Earth and Environmental Science,* vol 588, iss 4 1st November 2020, pp. 1

allowing residences to form their own spaces and ability to reconfigure their own functional and structural system.[21] The element of reconfiguration is re-enforced through Raquel Silva, who ultimately builds a construct surrounding the combination of modularity and space, producing an effective solution of a temporary and permanent nature.[22] Silva demonstrates the benefit of modularity to space, reducing the dependency on a closed system and providing a functional conceptualization in response to urban space limitation.[23]

Alternatively, Ornella Iuorio and William Riggs in places question the relationship between the interior and modularity. Instead, Iuoria claims while modularity in modern dwellings opens a new style of living that allows established ownerships, functionality, and mass customization; both scrutinize how the surrounding innovation could breed precarious and uncertain relationships with the 'home'. Similarly, Riggs queries the limitations of land use including regulatory barriers, lot size and environmental concerns.[24]

In general, however, Riggs' argument positively explores how modularity brings innovation in bridging the gap between prefabrication and microunits, with their included benefits outweighing the minute queries suggested.[25] When analysing physical interventions, R.Silva and De Beradinis are valuable for exploring the convertibility, temporariness and multifunctionality of modular dwellings. De Beradinis depicts the benefits of the "temporal dimension" linked with the concept of transiency in architecture, allowing an efficiency in the integration of new modular living units into a net system.[26] Thus, similarly to Borsos, provides valuable insight to how modularity in architecture presents an endless variety in matching different

21 Agnes Borsos, Jeno Balogh, Balazs Kokas, Balint Bachman, 'An eco-approach to modularity in Urban Living', *International Journal of Design & Nature and Eco dynamics*, vol 42, iss 2, 30th June 2019, pp. 83

22 Raquel Silva, Ines Campos, 'Advantages of Modularity Applied in Architecture', *IOP Conference Series- Materials Science and Engineering*, vol 603, iss 3, March 2019, pp. 9

23 Raquel Silva, Ines Campos, 'Advantages of Modularity Applied in Architecture', March 2019, pp. 1

24 William Riggs, Menka Sethi, Wesley L. Meares, David Batstone, ''Prefab Micro Units as a Strategy for Affordable Housing', *Housing Studies*, 14th October 2010, pp. 23

25 William Riggs, Menka Sethi, Wesley L. Meares, David Batstone, 'Prefab Micro Units as a Strategy for Affordable Housing', 14th October 2010, pp. 1

26 De Beradinis, P. Marchionni, C. Capannolo, 'MO: BOM: a multi-functional prefabricated and flexible module', *International Journal of Computational Methods and Experimental Methods,* vol 5, iss 4, 1st June 2017, pp. 522, 524

people's diverse needs.[27]

Within the development of contemporary housing, environmental implications poise the question of what it really is to live sustainably and what reaction is being initiated in modern dwellings. It has been argued by Michelle Gabriel, that with the new moralities that surround energy consumption and the relationship between space technology practise, display a dwelling that is never static. Gabriel identifies the need for alternative solutions in dwellings, using sustainable materials to maximize efficiency.[28] Pernilla Hagbert shares and extends Gabriel's outlook, discussing how living sustainably within the home provides conceptualizations beyond the contemporary 'norm' to break the resource dependencies. Similarly, the work of Ali Basin Alfuraty draws on the further need to rationalize material usage in dwellings, posing the need for integration of sustainability in design to minimize negative environmental impacts.[29]

Whilst in physical application, Wei Wu states that the development of sustainable micro living can help to significantly reduce the ecological footprint of the home. Wu further conveys, how incorporations of solar power, reduction in footprint and sustainable considerations can contribute to a net-zero dwelling energy status.[30] Comparably, H.C Leindecker questions how much a person really does need to live, suggesting a reduction in footprint and structural re-densification, provides a viable alternative in the form of a sustainable and resource efficient approach in an urban context.[31] Furthermore, with the combination of sustainable alternatives in materials and process, S.B Yazyeva like Leindecker, consolidates creating a built sustainable

27 Agnes Borsos, Jeno Balogh, Balazs Kokas, Balint Bachman, 'An eco-approach to modularity in Urban Living', 30th June 2019, pp. 84

28 Michelle Gabriel, Philippa Watson, 'From Modern Housing to Sustainable Suburbia: How Occupants and their Dwellings are Adapting to Reduce Home Energy Consumption', *Housing, Theroy and Society*, vol 30, iss 3, 1st September 2019, pp. 227, 232

29 Ali Basin Alfuraty, 'Sustainable Environment in Interior Design: Design by Choosing Sustainable Materials', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 2

30 Wei Wu, Brad Hyatt, 'Experiential and Project-based learning in BIM for sustainable Living with Tiny Houses', *Procedia Engineering- International Conference on Sustainable Design, Engineering and Construction*, vol 145, 2016, pp. 580

31 H. C Leindecker and D R Kugfarth, 'Mobile Tiny Houses, Sustainable and Affordable', *IOP Conference Series: Earth and Environmental Science*, vol 323, 1st August 2019, pp.7

environment.[32]

Yazyeva takes into consideration two sides of harmonious development, a reduction in material waste and a rational use of resources to innovate the modern dwelling, creating new and sustainable ways of living on multiple scales.[33] Nonetheless, with the differing standpoints of modern dwellings' exterior developments, particular authors have refocused on how the interior is reshaped to adapt to material and land shortage. Sura Aziz is particularly useful in exploring the key use of flexibility in an interior setting and maximizing the potential of existing spaces, creating long term adaptability through modern technologies.[34] Hala Hassanein ultimately builds on this, through the exploration of kinetic architecture, displaying a practical application in an ability to enhance, maximize and re-configure space.[35] The optimization of the internal borders of space are analysed by Simona Canepa, whom argues the need to make the interior space as flexible as possible. Canepa's comprehensive demographic analysis, heads towards displaying flexible interiors creating maximum functionality and enhancing living within the contemporary city.[36]

With this in mind, the facet of flexibility within interiors is investigated further by Jenny Preece, whom analyses how living smaller with aspects of multifunctionality in space, can break the stigma behind the normalcy in home living.[37] By arguing this positive deviation from the norm, Preece highlights similarly to Hosseini Raviz, how adaptive techniques can help to take back control of a reduced living space while drawing out dynamism and new types of spatial relationships in one area. The cohesion drawn from this technological development is argued by Raviz to have reshaped the spatial

32 S.B Yazyeva, I.A Mayatskaya, 'Eco-sustainable architecture and comfortable living environment', I*OP Conference Series. Materials, Science and Engineering*, vol 1031, iss 1, February 2021, pp. 1

33 S.B Yazyeva, I.A Mayatskaya, 'Eco-sustainable architecture and comfortable living environment', February 2021, pp. 1

34 Sura Aziz, Alobaydi Dhirgham, Amna BM. Salih, 'Studying Flexibility and Adaptability as Key Sustainable Measures for Spaces in Dwelling Units: A Case Study in Baghdad', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 5

35 Hala Hassanein, 'Utilization of "Multiple Kinetic Technology KT" in Interior Architecture Design as Concept of Futuristic Innovation', *The Academic Research Community Journal*, vol 2, iss 4, 1st January 2019, pp. 306

36 Simona Canepa, 'Living in a Flexible Space', *IOP Conference Series: Materials Science and Engineering*, vol 245, iss 5, 1st October 2017, pp. 7

37 Jenny Preece, Kim McKee, John Flint, David Robinson, 'Living in a small home: expectations, impression management and compensation practices', *Housing Studies*, 11th October 2021, pp. 1, 2

hierarchy, highlighting how the dwelling is ultimately dynamic, while highlighting the importance of configuration being fundamental for the relationship between form and space.[38]

However, while both Preece and Raviz draw analysis within different entities of spatial consumption research, both argue from different topic fields. They do not address the current integration between different themes of reducing space, such as the blend of modularity and micro living to benefit a reduction of footprint in modern dwellings, which my dissertation will refer to.

From the literature used, it can be suggested that new technologies have benefited the design and implementation of innovative adaptations in modern dwellings. This is further explored by De Berandinis, showing a careful development of how the planet is strategically utilizing space from a static to dynamic dimension. This paralleled with a seemingly efficient yet also need for the reduction in dwelling footprint.[39] When applied to my dissertation, such notions can be used in the analysis of the progressing link of innovations between exterior and interior micro living. Furthermore, drawing my examination of sustainable and modular habitation and helping present the planet becoming more resource and spatially efficient.

38 Hosseini Raviz, Seyed Reza, Nik Eteghad Ali, Ezequiel Uson Guardiola, Antonio Armesto Airo, 'Flexible Housing: The Role of Spatial Organization in Achieving Functional Efficiency', *ArchNet-IJAR: International Journal of Architectural Research*, vol 9, iss 2, 13th July 2015, pp. 65,68

39 De Beradinis, P. Marchionni, C. Capannolo, 'MO:BOM: a multi-functional prefabricated and flexible module', *International Journal of Computational Methods and Experimental Methods*, vol 5, iss 4, 1st June 2017, pp. 522

METHODOLOGY

It is possible to define spatial composition under the use of available space to create a desired environment. This coinciding with Le Corbusier's reference of 'the house is a machine for living', draws on my analysis of how users now inhabit, adapt, and re-develop the humble home within a planet forever retracting in available footprint.[40] Isolating a conscious selection of case studies provided the scope to deal with the coinciding themes surrounding the spatial optimization and efficiency of the modern twenty-first century dwelling.

Rationalizing the content situated in the specific chapters is considered, namely the ability to live in a 'micro' environment, with separate adaptations of its principles. This way, there is a fluidity in reference to what it is to live small yet providing the rationale to exploit how the separate studies are important yet meeting the same goal. This can be exemplified in The Slim House and Fincube, in which both are compact properties yet have different underlying principles, spanning from functional efficiency to sustainable consumption. Other factors justified, range from modularity within exterior living spaces to the innovations within the compressed urban interior being explored and exploited for efficiency and usability.

Following a starting point based on the analysis of the tiny house movement that is exemplified through The Macy Miller House, a focal point is drawn on the essence of micro-living, asking the initial question of what it is to live small. Furthermore, the reader is drawn to the initial notion of spatial utilization, presenting focus on the functional and amenity needs of spatial composition where efficiency is paramount. Carrying out a discussion of other specific adaptations of living with a reduced footprint, whilst also merging the notions of resource degradation is especially

40 Marielle Ferreira Silva, 'Another way of living: The Prefabrication and modularity toward circularity in the architecture', I*OP Conference Series: Earth and Environmental Science*, vol 588, iss 4 1st November 2020, pp. 1-5

important. The binding factor focusing on spatial efficiency in response to external factors, resulting in users living in a more compact yet seemingly comfortable environment.

Thematically, elements including the use modularity within living, focuses on how space can grow or move in a module that can be aggregated individually or in a group according to the users spatial or functional requirements. The inclusions of Loftcube and Prefab Lighthouse culminate the advantages of modularity in modern dwellings while showing different yet feasible applications of the principle. I will further discuss how this is applied to whole dwellings with a more selective approach of innovations of its interior application looked at further on in the structure of the dissertation.

The structural positioning of the case studies draws on creating a fluid discussion of the decisive factors surrounding the optimization of space within an overpopulated world. Notably, each case-study broadens out the perspective of the planet's spatial adaptations to a footprint reduction. However, they are positioned systematically to develop the contributions of the adaptations and innovations of spatial capacity. Notably, The Macy Miller house opens the reader into the realm of compact living, with a systematic journey taken from the routes of the innovation to the broader applications of the principle. Similarly, the selected material I have chosen for my case-studies has been extracted from a variety of carefully chosen authors material which includes a larger sum of non-academic texts. Whilst the visual images, pose as an opening between a written emphasis and the physical application in the concept of living small. These studies alluding carefully to the specific topic of micro-living, whilst providing a large yet focused breadth of material that I have carefully selected to culminate my over arching point.

Differing from the standardized 'norm' of living encompasses this dissertation's focus, with a rational alluding to the importance maximizing yet sustainably managing the planets potential footprint. These figures expressed similarly to Ria Roy, who delineates that the adaptation of dwellings in a modernist approach, fights against 'a concrete reality', innovating through a changing format of spatial consumption.[41]

41 Ria Roy, 'Tiny House, A Big Movement?', *International Society for Performance Improvement*, vol 58, April 2019, pp. 28-30

Figure 10 Slim House, Alma-nac, London, 2012

DETATCHED


INTEGRATED

Throughout the twentieth century, the single-family private house was fetishized as the epitome of modern architectural achievement, an object desired by many but achieved by few. The contemporary house, however, has come to break these boundaries whilst mirroring social change and cultural aspiration.[42] The house plays a pivotal role, both as means of architectural expression and experimentation, while being consistently developed through new materials, forms, and spatial arrangements to achieve what many search for. Gradually, the twentieth-century house has evolved from its role as the flag-bearer of the avant-garde, to becoming that of an utterly constrictive system in search for a new way of expression and without definable ethos.[43]

Amongst the foremost attributes propelling these changes was the transformation and surge of family's non-traditional household, whose make-up sits differently to that of fifty years previous. Notably, the number of singled headed and childless families has steadily increased, shifting the demographic composition, with 19.5 percent of couples between 55-64 years old being childless in 2021, a significant increase.[44] This culminated with the prediction of single child families making up 50 percent of all families in the United Kingdom within seven years.[45] In line with these demographic shifts, the progression of changing lifestyle habits in users has now created a new line of houses, re-shaping and challenging the conventional 'norm' of space and structure in dwellings.[46]

42 Jonathan Bell, '*21st Century House*', edt by Jonathan Bell, 1st edn, Laurence King Publishing Ltd, London, England, 1st April 2006, pp. 10

43 Jonathan Bell, '*21st Century House*', edt by Jonathan Bell, 1st April 2006, pp. 9

44 Mike Friedrich, 'First-Ever Census Bureau Report Highlights Growing Childless Older Adult Population', *United States Census Bureau*, < https://www.census.gov/newsroom/press-releases/2021/childless-older-adult-population.html >, 31st August 2021

45 Jessica Gibb, 'One Child Families: The New Norm', *Made for Mums*, <https://www.madeformums.com/news/one-child-families-the-new-norm/>, sited from ONS

46 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 7

With this merit of reconsideration amongst the development of the house, comes the harsh reality of decreasing potential footprint for development.[47] Alongside the rapid decrease in urban density, the question now poses how much spatial capacity a person really needs to live. There is a search for breaking the 'norm' of the generic interior, reshaping the unused pieces of the urban fabric map, presenting the new possibility of living with both less consumption and built space.[48]

With the sustained pressure of city housing crises and decreasing opportunity for larger scaled properties, users have needed to find a solution to adapt to pressuring notions. A minute yet expansive concept surrounding the idea of a reduction in housing footprint has taken the form coined micro-living.[49] This has been adapted in multiple modes of composition, yet one movement which has been a progressive force in the adaptation of footprint reduction has been that of the tiny house movement. A movement persisting of small yet consciously responsible homes that are part of a critical reassessment of how we now live, emerging as more than just a trend. The tiny-house movement re-evaluates the common perception of normal collective living, producing modern innovation and adaptation of how users can live more efficiently, portably, and effectively without compromise.[50] This in doing so, brings an attempt in returning to a de-cluttered existence while relinquishing the acquisitive lifestyle.[51] These compact homes, are defined as less than thirty-

47 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', 7th October 2013, pp. 9

48 Phyllis Richardson, *Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 13

49 Emma Clinton, 'Micro Living: why occupants chose to live in very small dwellings', *Australian Planner*, vol 55, 23rd June 2019, pp. 189-197

50 Mimi Zeiger, '*Micro Green, Tiny Houses in Nature*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 22nd March 2011, pp. 7,9

51 Ria Roy, 'Tiny House, A Big Movement?', *International Society for Performance Improvement*, vol 58, April 2019, pp. 28-30

eight meters square and are integrated primarily as a full-time dwelling that is seemingly permanent or mobile.[52] The culmination of reduced footprint and using less resources draws down the environmental impact of the dwelling, using less energy for lighting, heating and cooling, whilst encouraging lower consumption.[53] With the current un-sustainable scales of housing developments, micro-living has begun to combat and contest the current development norms. This coinciding with a pure focus on the amenity and functional needs of the user.[54]

Consumers are becoming noticeably aware of the rising environmental, spatial, and budgetary implications in ownership of a large single-family home. This especially considering the questionable distribution of user activities and functions within the larger dwellings.[55] To be efficient, small dwellings must seemingly be carefully designed due to minor decisions resulting in significant impacts to the interior and exterior entities. The awareness of the movement in response to social implications and creating affordable housing solutions systematically, has been consciously exploited by a changing demographic of users.[56]

52 H. Shearer, P. Burton, 'Towards a typology of tiny houses', *Housing Theory and Society*, vol 36, iss 3, 2019, pp. 298-318

53 T. Carlin, 'Tiny homes: Improving carbon footprint and the American lifestyle on a large scale', *Celebrating Scholarship & Creativity Day*, 24th April 2014, pp. 2-20

54 Joshua Wotton, Henry Skates, Leigh Shutter, 'Tiny House, When Size Matters', *Australian Planner*, vol 55, 19th June 2019, pp. 20

55 Steven Kurutz, 'The Next Little Thing', The New York Times, 11th May 2011

56 Krista Evans, 'Tackling Homelessness with Tiny Houses: An Inventory of Tiny House Villages in the United States' *The Professional Geographer*, vol 72, 2020, pp. 360-370

Figure 11 Tiny House Form Representation, First Light Studio, Ohariu, 2021

Figure 12 The Macy Miller House, Back View, Macy Miller Boise, 2011

The Macy Miller House began as an efficient solution to these pressing economic hardships yet became unexpectedly an embodiment of this tiny house movement. The house posed a positive financial proposition in response to specific economic hardships and a possibility of being situated in close proximity to Boise. The systematic construction, with a financial budget of $11,000, contributed to forming a sustainable solution of living that brought alongside integrated options of use. In response to city regulations of a six hundred minimum square footage for dwellings, Miller had to work around the existing code, creating a mobile structure.[57] The Miller House presents a compelling suggestion of the benefits surrounding the alteration of users' outlook to living small.

57 Mimi Zeiger, '*Tiny Houses in the City*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 20th March 2009, pp. 55

The structure typifies the goals behind the movement, breeding vitality, creativity, and portability within a singular living unit. The ability for Miller to occupy and personalise in response to pressing circumstances in the form of a completely functional living space, highlights the social and environmental benefits the movement is stimulating.[58]

The dwelling presents an initial perception of simplicity yet is simultaneously intricate. As shown in figure thirteen, with meticulous attention to detail, the house includes on the exterior: a detailed radiant floor heating system including a third axel to support the thermal mass, a six-thousand-pound tile system and a hand-crafted steel frame. Alongside the efficient framework, the exterior board cladding is formed from salvaged and recycled pallets which have been systematically cut to fit. Alongside it's structure, the combination of timber, large windows and ambient lighting creates a humble yet innovative beacon.[59] Notably, these environmental considerations enhance the compatibility to research suggesting that micro-dwellings incorporated systems can add important contributions towards rapid emission decline within the housing sector.[60]

58 Stephanie Brokenshire, 'Tiny Houses, desirable or disruptive?', *Australian Planner*, vol 55, 2nd October 2018, pp. 3-4

59 Mimi Zeiger, '*Tiny Houses in the City*', 20th March 2009, pp. 55

60 R.H Crawford and A Stephan, 'Tiny house, tiny footprint? The potential for tiny houses to reduce residential greenhouse gas emissions', *IOP Conference Series: Earth and Environmental Science*, vol 588, 1st November 2020, pp. 1-3

Figure 13 The Macy Miller House, Materials Use, Boise, 2011

Figure 14 The Macy Miller House, Portability, Boise

Figure 15 The Macy Miller House, Macy Miller, Interior Entrance, Boise, 2011

Similarly, the interior constructs of The Miller House are suggestively just as meticulous in delivery of the innovative housing goals surrounding micro-living. With incorporations such as an efficiently crafted narrow kitchen, opening out into an open living space and an abundance of hidden storage as shown in figure nineteen, Miller strove for a thorough approach towards no wasted space.

Additions such as the elevated bed, adds storage capabilities underneath and alongside built-in bookshelves with a pantry, Miller's quest for maximum functional efficiency is embodied.[61] Thus, a construct is built where the space is defined without cluttering. An approach is taken in a removal of seldom-used furniture and a system created that embeds the function into the structure.[62]

61 Mimi Zeiger, '*Tiny Houses in the City*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 20th March 2009, pp. 55

62 Yenna Chan, 'Small Environments: Contemporary Design Detail', 1st edn, Rockport Publishers, Beverly Massachusetts, 1st March 2007, pp. 1- 197

Figure 16 The Macy Miller House, Macy Miller, Hallway, Boise, 2011

Figure 17 The Macy Miller House, Bedroom, Boise 2011

Figure 18 The Macy Miller House, Bathroom, Boise, 2011

Figure 19 The Macy Miller House, Iconic Hallway, Boise, 2011

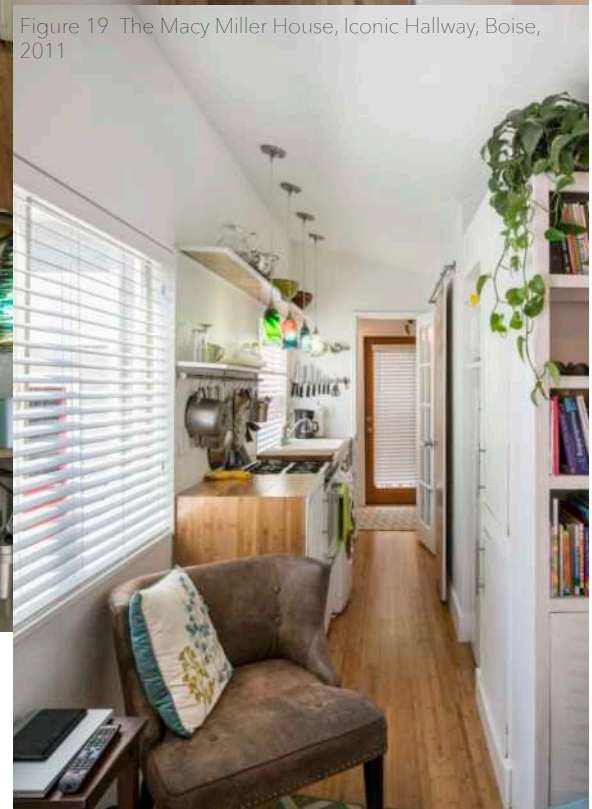


Figure 20 The Macy Miller House, Macy Miller, Exterior Entrance, Boise, 2011

Figure 21 The Macy Miller House, Macy Miller, Kitchen,Visual, Boise, 2011

Yet, it is seemingly profound willingness of users to indulge in material and structural experimentation as well as placing an overt emphasis on environmentally sound methods of construction and living systems, to create an innovative spatial entity. Between striving for new forms of urban residential architecture, the tiny house begins to re-assess and represent residential design according to the ways we live. This opposed to creating the statement of a dwelling based on a perceived lifestyle or expressing an ultra-formal aesthetic approach.[63] In turn the application of rural micro-living as shown in The Miller House, reverts from the supposed 'norm' of dwelling construction and confronts the pressing geographical footprint limitations. In addition, the introduction of what was a counter-culture type dwelling has been increasingly embraced, presenting a more creative and flexible way of living and capitalizing on the available land efficiently.[64] As explored by Elgin Duane surrounding micro-living, "The intention of voluntary simplicity is not to dogmatically live with less. It's a more demanding intention of living with balance.".[65] Duane furthermore supports the emphasis behind the morals and incentives of The Miller House, creating a balanced environment for functional efficiency yet without complete obedience. Moreover, bringing creativity and adaptability to the reduction of its footprint, without hinderance of spatial diminution and still being able to live well.[66]

63 Jonathan Bell, *21st Century House*', edt by Jonathan Bell, 1st edn, Laurence King Publishing Ltd, London, England, 1st April 2006, pp. 16,17

64 Krista Evans, 'Tackling Homelessness with Tiny Houses: An Inventory of Tiny House Villages in the United States' *The Professional Geographer*, vol 72, 2020, pp. 367

65 Elgin Duane, 'Voluntary Simplicity and the New Global Challenge', *The Environment in Anthropology: A Reader in Ecology, Culture, and Sustainable Living*, vol 1, 2006, pp. 459

66 Hosseini Raviz, Seyed Reza, Nik Eteghad Ali, Ezequiel Uson Guardiola, Antonio Armesto Airo, 'Flexible Housing: The Role of Spatial Organization in Achieving Functional Efficiency', *ArchNet-IJAR: International Journal of Architectural Research*, vol 9, iss 2, 13th July 2015, pp. 69,70

Figure 22 The Macy Miller House, Macy Miller, Compact bedroom utilization, Boise, 2011

Figure 23 The Macy Miller House, Macy Miller, Main exterior visual, Boise, 2011

The culmination of features incorporated into The Miller House, draws an emphasis on how living small can help users adapt to pressing circumstances in separate locations, like the rural application of the dwelling. Expanding on the locational benefits in the adaptation of living small on a rural setting, the concept holds several societal advantages such as offering affordable housing solutions and reducing environmental footprints.[67] The portability of the tiny houses complements the internal and external functions of the dwellings, searching for reduced clutter and functional efficiency. This warranting the attempt to return to the basic amenities of living, in the further search for positive and active responses to the planets reducing footprint.[68]

67 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 45

68 Ria Roy, 'Tiny House, A Big Movement?', I*nternational Society for Performance Improvement*, vol 58, April 2019, pp. 28-30

Figure 24 The Macy Miller House, Macy Miller, Back exterior visual, Boise, 2011

With the current realisation that large dwellings are significant in costing to maintain, consumers are exploring alongside tiny homes, alternative yet affordable housing prototypes.[69] With the form of large, detached houses increasingly becoming an unsustainable approach, efficient innovations are being sought after. This perspective coupled with the shrinking and changing demographic of families, has resulted in a renewed interest towards a sub section of micro-living in narrow homes. Although being subjective, the narrow house tends to span between 7.5 meters in width and is typically part of a row. Drawing alongside the tiny-house movement, narrow homes share design aspects that seek to maximize their efficiency and functionality, whilst simultaneously reducing their environmental footprint. Coinciding with tiny-homes, narrow dwellings are commonly found in rural areas yet parallel to this, these dwellings are becoming commonly found in many urban settings.[70]

The relationship between the narrow form and reduced energy consumption, is also being seen as a compelling motive for users wanting to adapt their dwelling style to a narrow home. Notably, "a semi-detached structure with two narrow houses is 36 percent more energy efficient than a detached house, while a unit terrace can be up to 64 per cent more efficient than a detached house".[71] Alongside the energy benefits, the major advantage to users sits behind the availability to be situated deeper within a dense urban setting. Thus, becoming closer to commercial and personal amenities. Yet parallel to locational benefits, users are seeking to become more cost effective without sacrificing locational privilege.[72]

69 Krista Evans, 'Tackling Homelessness with Tiny Houses: An Inventory of Tiny House Villages in the United States' *The Professional Geographer*, vol 72, 2020, pp. 360-370

70 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', 7th October 2013, pp. 92

71 Avi Freedman, '*Homes within Reach: A Guide to the Planning, Design and Construction of Affordable Homes and Communities*', John Wiley & Sons, New Jersey, 22nd November 2005, pp. 1-304

72 Krista Evans, 'Tackling Homelessness with Tiny Houses: An Inventory of Tiny House Villages in the United States', *The Professional Geographer*, 2nd July 2020, pp. 367

Figure 25 Slim House, Alma-nac, London, Daytime, 2012

Figure 26 Slim House, Alma-nac, Careful material consideration, London, 2012

The Slim House, situated in London, true to its name is a slender seven and a half feet wide. The project while being a renovation, was a development of an existing terrace house that was constituted early on as an urban infill. Originally, the dwelling was built between an old alley behind the statelier houses in the street. As shown in figure twenty seven, despite being hemmed in on either side, the façade gives an almost deceiving aesthetic with an encompassed disguise. In development, the back of the house was re-worked to envelop as much natural light through a continuous slate clad roof and large windowpanes. Skylights help embrace the light, allowing a constant filtration of natural ambience throughout the dwelling.[73]

73 Mimi Zeiger, '*Tiny Houses in the City*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 20th March 2009, pp. 177

Figure 27 Slim House, Alma-nac, Main exterior atmospheric view, London, 2012

Figure 28 Slim House, Alma-nac, Occupational use, London, 2012

The open plan nature of Slim House uses a method commonly associated with micro-living, expanding the perception of the narrow space. Traditional walls commonly confine specific areas and limit exterior light penetration. Hence, by making the rooms multifunctional, partitions can be avoided. Therefore, rooms within the dwelling can flow into each other meaning they can share exterior views.[74] With an increased vertical height running through the interior, there is a re-negotiation of the conventional spatial norms. Adding multifunctionality into the interior setting provides a more instructive approach in response to downsizing without necessary compromise. Likewise, there is an inherent need for users to follow a sustainable consumption transition when adapting dwellings. This is displayed within Slim House, through the complete utilization of the spatial footprint to create functional efficiency.[75] A conscious effort has been deployed amongst the dwellings features to maximize internal amenity in lieu of condensed floor space.[76]

Yet, users are showing willingness for trading off features in exchange for more desirable amenities, including price and location. Furthermore, the smallest areas of land within condensed urban settings are now posing potential for micro-dwellings such as narrow homes.[77] These elements are made apparent within the construction of Slim House, that has noticeably been developed within a small window of footprint in the replacement of a back alleyway. Noticeably, the narrow dwelling fits alongside the perception that between the relationship of floor area and volume. The higher the story, the more comfortable the space feels.[78]

74 Connie Oliver, 'Create an airy feel with creative techniques', Vancouver Sun, 20th May 2011, < https://www.pressreader.com/canada/vancouver-sun/20110520/292714907447611>

75 Maurie J. Cohen, 'New Conceptions of Sufficient Home Size in High-Income Countries: Are We Approaching a Sustainable Consumption Transition?', *Housing, Theory and Society*, vol 32, iss 2, 15th March 2021, pp. 173-203

76 Emma Clinton, 'Micro Living: why occupants chose to live in very small dwellings', *Australian Planner,* vol 55, 23rd June 2019, pp. 191

77 Emma Clinton, 'Micro Living: why occupants chose to live in very small dwellings', 23rd June 2019, pp. 191

78 Zhang Yue, 'Study on the Elements for the Psychological Comfort of the Tiny House's Living Room in Japan by Layers and Window Area', *IOP Conference Series: Earth and Environmental Science*, vol 218, 1st January 2019, pp. 4

Figure 29 Slim House, Alma-nac, Interior Width of 2.8 Meters, London, 2012

Moreover, a relationship between space and function is created within the Slim House, where there are common traits associated with Maslow's Hierarchy of needs. The hypothesis of Maslow states that the needs placed at the hierarchies' peak such as self-actualisation, cannot be content until the lower needs such as physiological needs of a dwelling are met.[79] Thus, such attributes were applied to Slim House, where the physiological needs of the user have been incorporated efficiently to then allow the creative, yet necessary functional attributes to fit through. The house still holds a conscious approach to multifunctionality that maximizes the spatial boundaries within a small dwelling. As described by Susan Kent, it "creates boundaries out of otherwise unbounded space". Furthermore, emphasising the applications incorporated into the interior to stimulate the organization of the unbounded footprint.[80]

79 M. Elsevier, '*Mosby s Dental Dictionary*', edt, Margaret J. Fehrenbach, 4th edn, Mosby Publishing, Maryland Heights, Missouri, 1st March 2019, pp. 1-816

80 Susan Kent, '*Domestic Architecture and the Use of Space: An Interdisciplinary Cross-cultural Study*', Cambridge University Press, Cambridge, England, 2nd September 1993, pp. 1-202

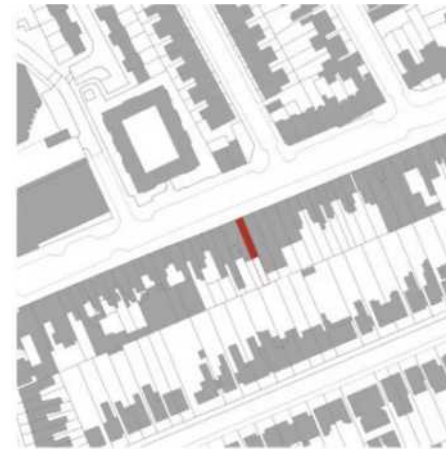


Figure 30 Slim House, Alma-nac, Size comparrison, London, 2012

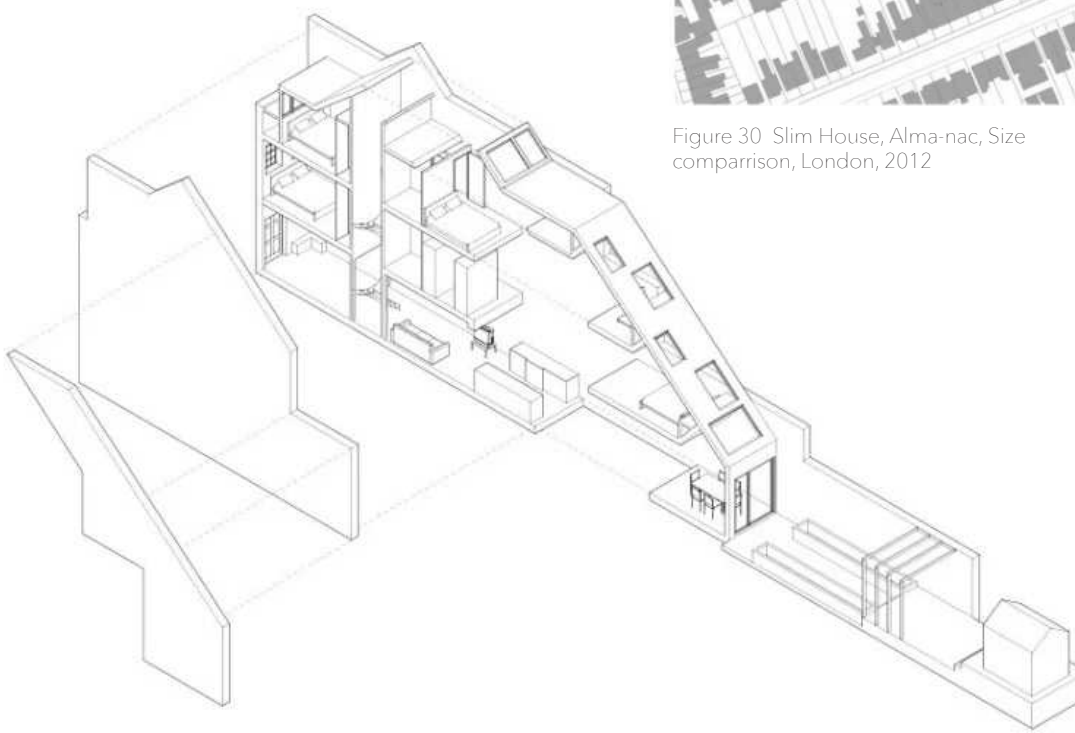


Figure 31 Slim House, Alma-nac,, Spatial utilization elevation, London, 2012

Figure 32 Slim House, Alma-nac, Width and Interior Utilization, London, 2012

Within the interior of the Slim House as presented in figure thirty two, there is a long, narrow yet open plan kitchen with dining room that runs throughout the length of the dwelling, creating the conscious feeling of boundary utilization. The second and third floor of the dwelling has been expanded to maximize storage capabilities. Incorporating a compact loft space over the upstairs bathroom with free standing closets, opens the available footprint whilst not compromising the flood of natural light entering the property. The incorporation of warm and light colours opens the interior up, with the space narrow however now bright and expansive.[81] The re-scoping and multi-functional alterations of the interior, increases the possibility for adaptation and growth within the dwelling on a permanent basis.[82]

81 Mimi Zeiger, '*Tiny Houses in the City*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 20th March 2009, pp. 177

82 Stephanie Brokenshire, 'Tiny Houses, desirable or disruptive?', *Australian Planner*, vol 55, 2nd October 2018, pp. 230

Figure 33, Slim House, Alma-nac, Bedroom, London, 2012

Figure 34, Slim House, Alma-nac, Open plan efficiency, London, 2012

Figure 35, Slim House, Alma-nac, Storage, London, 2012

Figure 36, Slim House, Alma-nac, Natural Light, London, 2012

Furthermore, the alternative approaches to micro-living in the renovation and adaptation of narrow homes, has opened the scope to different methods of being able to live small yet efficiently within a world that has a forever retracting footprint.[83] Whilst the number of micro-homes has proliferated in a substantial number of cities, the notable insight centres around an increased desire to re-develop underutilized land. This resulting in building smaller dwellings like narrow homes that have higher vertical density such as Slim House which has an outlook of producing an improved life in a desired setting.[84] Moreover, the underpinning motives suggested behind the geometric adaptations of urban dwellings, is seemingly to enhance the perceived size of the home with a limited footprint. This is completed through manipulating internal and external factors, such as height and interior entities like multifunctionality to create greater practical efficiency within the home. Slim House, poses a prime example of efficient interior and exterior spatial arrangement to achieve functional efficiency with a reduced footprint yet without major compromise.[85]

Within a broader consciousness and in the grip of an intensifying housing crises, the acceleration of micro-living has posed a possible and viable solution that stimulates efficiency and adaptiveness to the current environmental and social hinderances.[86] Through the adjustment of the forms in which users live, there is a vital junction created where modern dwelling can integrate higher levels sustainability within their design while creating an effective living environment.[87] By maximizing the un-used spaces in urban settings, micro-living navigates towards a feasible solution in combat of the current un-sustainable levels of dwelling sizes. Furthermore, adding creative solutions that simultaneously brings individuality and the utilization of space to a planet running out of resources and footprint.[88]

83 Rikard Sundling, Henrik Szentes, 'Why are we not renovating more? An elaboration of the wicked problem of renovating apartment buildings', *Civil Engineering and Environmental Systems*, vol 38, iss 3, 22nd September 2021, pp. 368

84 Mandy H.M Lau, Xureji Wei, 'Housing size and housing market dynamics: The case of micro-flats in Hong Kong', *Land Use Policy*, vol 78, November 2018, pp. 278

85 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 95

86 Ella Harris, Mel Nowicki, '"GET SMALLER"? Emerging geographics of micro-living', *Area*, vol 52, iss 3, September 2020, pp. 591,596

87 L.A. Steijger, R.A Buswell, V.A Smedley, S.K Firth, P. Rowley, 'Establishing the zero-carbon performance of compact urban dwellings', *Journal of Building Performance Simulation*, vol 6, iss 4, 31st January 2013, pp. 319-334

88 Joshua Wotton, Henry Skates and Leigh Shutter, 'Tiny House, When Size Matters', *Australian Planner,* vol 55, 14th June 2019, pp. 209-220

Figure 37 Slim House, Alma-nac, Nightime, London, 2012

HORIZONTAL

Figure 38 Loftcube, Studio Aisslinger,2016, Locational Adaptability


VERTICAL

The formidable realisation that the planet is sitting within a housing crisis, has called for numerous industries to produce innovative solutions in response alongside functional dwelling formats. Concurrently, construction technology advancements have provided growth to the rapid surge in off-site and automated modular building methods.[89] Progressions in the development of pre-fabrication and modularity within the housing sector has taken a notably rapid increase in the twenty-first century, responding to pressuring notions. The UK government in 2016 targeted the construction of a million new homes before 2020.[90] This action resulted from a necessary response to the structural failures in long term dwelling supply, particularly at an inexpensive rate.

These elements have brought the development in off-site dwelling construction, as associated commonly as the prefab home. This draws on the integration of fabrication and design that surpasses the common assembly and fitting process.[91]

The level of prefabrication in individual dwellings can differ, while the aesthetic and technical field of off-site constructed houses is vast. Elements such as physical steel cores, timber frames and modularised systems culminate the included features in the method.[92] Moreover, the combination in efficiency and rapidity in production of prefabricated units, has led to utilizing them on multiple scales, such as its merge within modularity for dwellings.[93]

89 Gatheeshgar Permpalam, Ross Dobson, 'Modular Building Design: Post Brexit Housing', *Nordic Steel CE Papers*, vol 3, 18th September 2019, pp. 220

90 Homes England, 'Making Homes Happen', Strategic Plan 2018/2019-2022/2023, 2018, pp. 26, < https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/752686/Homes_England_Strategic_Plan_AW_REV_150dpi_REV.pdf >

91 Ornella Iuorio, 'Energy retrofit of tower blocks in UK: Making the case for an integrated approach', *TECHNE: Journal of Technology for Architecture and Environment*, vol 1, July 2018, pp. 45-48

92 E. Harris, M. Nowicki, K. Brickell, 'On-edge in the impasse: Inhabiting the housing crisis as a structure of feeling', *Geoforum*, vol 101, September 2018, pp. 156-164

93 Ornella Iuorio, Andy Wallace, Kate Simpson, 'Prefabs in the North of England: Technological, Environmental and Social Innovations', *Sustainability (Basel, Switzerland)*, vol 11, iss 14, 17th July 2017, pp. 2

With the integration of modularity and pre-fabrication, modular dwellings have become suggestively more expansive in their application amongst urban settings. Modular design refers to a co-ordinated system that makes use of a standardized material units without waste". The term modularity herein, is used to denote a concept of design that features maximum construction efficiency and minimum material waste to benefit the target property.[94]

A form of modular dwelling that integrates the use of prefabrication, takes the form of the growing home. Expandable dwellings, also known as 'grow homes', are specifically designed to allow occupants to expand their personal living space while utilizing footprint. Resultingly, users can reside in the same location for longer rather than moving. A major benefit of the system is being seen in first time buyers, with the pressures of frequent changes in their life stages.[95] The two key methods of forming expandable dwellings include: 'add in and add on'. Specifically, the 'add-on' design centres around expansion through addition with the ability to be added onto. The initial design of these buildings is crucial, such as hallway and bathroom location, thus pre-empting further additions.[96]

94 Frederick Uhlen Hop, '*Modular House Design, The Key to Complete Construction Efficiency*', Prentice Hall Inc, Englewood Cliffs, New Jersey, 1st March 1988, pp. 3

95 Canadian and Mortgage Housing Corporation, 'Building Housing Incrementally', 18th May 2011, (Cross Reference)

96 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 68, 69

There is also the ability to expand vertically, which can be emphasized in The Prefab Lighthouse. With the rises in urban living and the awareness of the growing constraints surrounding the availability of resources, the plea for larger numbers of affordable dwellings has increased. Therefore, greater requirements for new architectural typologies, optimizing resource use and efficiency has amplified.[97] The Prefab Lighthouse has helped tackle this societal issue while integrating modularity, prefabrication and exploring an untapped urban landscape. The solution behind the dwelling, aims at reducing congestion in urban areas while providing a practical and innovative extension to homes using modern prefabrication. With each unit measuring approximately six by four by three meters, these modules can be placed on many existing buildings and commercial structures as displayed in figure thirty nine, while efficiently being erected in two days.[98]

Notably, The Prefab Lighthouse is a residential option, suitable for a variety of dwellers. With the unit pieces being prefabricated in a plant and further delivered on site, a built module can then be formed. Furthermore, the dwelling has all the elements working in a co-ordinated system that has been standardized to make on-site construction simplistic and efficient.[99] In a consistently evolving planet, there are constantly evolving needs, and The Prefab Lighthouse displays an example of how architecture is responding. Through a process of functional conceptualism, the units are designed without needing to be dependent on separate structural systems. This drawing on the combination of modularity and modern prefabrication; designing aspects that work inside a closed system while simultaneously removable yet completely integrated in the dwelling. The development between the prefabrication and the modularity produces a dwelling with dimensional standardisation, meaning the compatibility of all elements is high, irrespective of where the component began.[100]

97 Marielle Ferreira Silva, 'Another way of living: The prefabrication and modularity toward circularity in the architecture', *IOP Conference Series: Earth and Environmental Science*, vol 588, iss 4 1st November 2020, pp.1

98 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 76

99 Frederick Uhlen Hop, '*Modular House Design, The Key to Complete Construction Efficiency*', Prentice Hall Inc, Englewood Cliffs, New Jersey, 1st March 1988, pp. 3

100 Raquel Silva, Ines Campos, 'Advantages of Modularity Applied in Architecture', *IOP Conference Series- Materials Science and Engineering*, vol 603, iss 3, March 2019, pp 1-9

Figure 39 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Add-On Construction

Figure 40 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Vertical View

With the ability to expand, the modules are designed with wall heights and materials that can be easily added onto with benefit to any future additions, which will remain visually proportionate to the original unit. In terms of growth, having the core hallway of the current structure reach an external wall allows for the specific extensions, and separately does not create any unwanted secondary movement between rooms.[101] By adding spaces when they are required, users stand to save resources by not having to maintain extra space while removing expenses of heating and maintenance for un-used space. Designing for flexibility like The Prefab Lighthouse is essential through all expandable dwellings; in an aim of providing an efficient way of re-designating spaces and integrating further modules when necessary for the user.[102] Significantly, The Prefab Lighthouse is seemingly a prime example of bridging the gap between underutilized space and modern dwelling innovation capabilities.[103]

101 Larry Garnett, 'Expandable Designs', Professional Builder Magazine, March 2011, pp. 21-26 < https://www.probuilder.com/sites/probuilder/files/20_HouseReview_0.pdf>

102 Jennifer Sullivan, 'Go Expandable: Homes that Grow with You', Rhode Island Home and Design Magazine, 18th May 2011, < http://www.rhodeislandhomedesign.com/Feature/go-expandable-homes-that-grow-with-you.html>

103 William Riggs, Menka Sethi, Wesley L. Meares, David Batstone, "Prefab Micro Units as a Strategy for Affordable Housing', *Housing Studies*, 14th October 2010, pp. 1

Figure 41 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Street View

Yet despite the need for detailed planning in reference to installation of utilities, the overall process seemingly utilizes the efficiency of applying additional units. Hence, in The Prefab Lighthouse, extending plumbing routes for potential additional toilets and kitchen facilities prevents major changes to the primary structure throughout construction. The inclusion of non-permanent fixtures allows the re-designation of room functions without large scale alterations.[104] The overarching approach of The Prefab Lighthouse, tackles the creation of a standard living unit that defines interior spaces through modular generated systems, Thus, attempting to satisfy users' various living necessities at different life stages.

104 Jennifer Sullivan, 'Go Expandable: Homes that Grow with You', Rhode Island Home and Design Magazine, 18th May 2011, < http://www.rhodeislandhomedesign.com/Feature/go-expandable-homes-that-grow-with-you.html>

Figure 42 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Interior Shaping

Figure 43 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Structural Foundations

Subsequently, this poses as an innovative solution to a reduction in footprint. Herein, by expanding upwards and as coined by Hermann Hertzberg, 'to create the incomplete building', users are allowed to create their individual spaces in relation to their current and future needs. Moreover, keeping an open relationship between rooms and providing the constant ability to repeatedly reconfigure. In doing so, the process offers greater variety in adaptations like in The Prefab Lighthouse, to create a solution to developing sustainable living spaces.[105]

105 Agnes Borsos, Jeno Balogh, Balazs Kokas, Balint Bachman, 'An eco-approach to modularity in Urban Living', *International Journal of Design & Nature and Eco Dynamics*, vol 42, iss 2, June 30th, 2019, pp. 83

Figure 44 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Separate Module Representation

With the embedded relationship between the exterior and interior of The Prefab Lighthouse, its modularity works with characteristics that have a central mechanism of relative independence. However, the integrated ability to adapt each module relative to a new function, as emphasized in figure forty four, creates efficient construction and utilization of adaptive space. Each module has consistent access points that provides structural integrity and successful interchanges when extra units are required.[106] The Prefab Lighthouse's ability to increase its capacity based on user needs, supports the notion that the house should accommodate the occupants rather than the occupants adjusting their needs to the constraints of the dwelling.[107] It's specific interchangeable abilities, in the form of spatial division, draws suggestions that the modular dwelling style breaks the generalization of traditional forms of standardized living, providing new solutions to global footprint reduction.[108]

106 Yu Gu, 'Research on the Innovative Application of Modular Design in University Student Apartment Furniture', I*OP Conference Series- Materials Science and Engineering*, vol 573, iss 1, 1st July 2019, pp. 1,6

107 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 71

108 Yu Gu, 'Research on the Innovative Application of Modular Design in University Student Apartment Furniture',1st July 2019, pp. 6

Figure 45 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Interior Styling and Inclusions

Figure 46 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Expansion Possibilities

User needs are specifically focused through the forms of vertical modular home expansion, as expressed within The Prefab Lighthouse. A conscious combination of prefabrication innovation and modular forms help create a flexible yet functional adjustment to the users living space over time.[109] The innovation of the transformable architecture aids in addressing spatial limitations in the 21st century with footprint deficiency. The transformable features of the dwelling, provides greater ability for the space to adjust to environmental conditions with the capabilities of vertical expansion.[110] Furthermore, in a search for living more efficiently yet with minimal compromise, expandable homes offer a grid style modular system that can be exchanged and enhanced easily through the use of subsystem units.[111]

Moreover, expandable homes such as The Prefab Lighthouse, seemingly could take the form of an archetype for future modular housing projects. Likewise, the foundations of this exploration promote suggestions that growing homes may create a catalyst for cyclical housing expansion and a solution towards more sustainable living. With the benefit targeting ecological, social and economic quality change and a planet running out of potential spatial footprint, modular and expandable dwellings provide an inventive proposition, in an innovative architectural response.[112]

109 Yuli, 'Research on interior space and furniture design of university student apartments', *Art education research*, vol 20, 2014, pp. 87

110 A.N Saputra, D.G Lineker, H.E Hibaturrahim, D.K Nilla, R Sobandi, A.S Ekomadyo, 'Space Utilisation and Transformable Architecture of Peri-Urban Co-Living Concept in Rancaekek, Bandung', vol 328, iss 1, *IOP Conference Series. Earth and Environmental Science*, vol 649, 1st September 2019, pp.2

111 Fazia Nakib, 'Toward an adaptable architecture: Guidelines to Integrate Adaptability in the Building', *World Congress Proceedings: Building a Better World*, 6th October 2010, pp. 14

112 Charlotte Cambier, Waldo Galle, Niels De Temmerman, 'Expandable Houses: An Explorative Life Cycle Cost Analysis', *Sustainability*, vol 13, iss 12, 21st June 2021, pp. 1,18

Figure 47 Prefab Lighthouse, DAAD Architects, Rhenen, Netherlands, Expansion Possibilities


GAZELLE

The development between modularity and modern prefabrication, has seemingly become instrumental in providing viable alternatives to standardized living methods without waste.[113] While expandable dwellings provide routes for continuous change in a fixed location, modularity in modern dwellings has outwardly progressed down further channels. Therefore, designers are exploring the untapped value of moveable micro-living units. The micro-living unit concept has progressed as a result of its junction with modular prefabricated technology. The integration between the typology of micro-units and prefabricated methods of construction offers significant benefits in a housing market crisis, with a consistent reduction in available resources and footprint. Such innovations and availability of this modular technology, presents a distinct opening for utilizing and applying a modern technique in the standardized market to combat the pressuring notions.[114]

Coining this integration under the term plug and play designs, the rapid nature of the unit's installation enhances the moveability and adaptability of the dwelling. Herein, the development demonstrates a suggested movement towards a trend of transportation and mass customization in client focus instead of mass production.[115] Unlike standard prefabrication, plug and play designs require no on-site assembly. Once constructed, they can be moved between location freely. The two overriding factors affecting the modular design of the unit sit within the interior and transportation. With a requirement to be easily transported, weight is an overarching factor in a goal to create maximum wind drag and minimal damage when erected. Regardless of specific weights, it is important to verify roofing allowances before placing on areas such as flat top roofs.[116]

113 Frederick Uhlen Hop, '*Modular House Design, The Key to Complete Construction Efficiency*', Prentice Hall Inc, Englewood Cliffs, New Jersey, 1st March 1988, pp. 3

114 William Riggs, Menka Sethi, Wesley L. Meares, David Batstone, 'Prefab Micro Units as a Strategy for Affordable Housing', *Housing Studies*, 14th October 2010, pp. 1

115 Ornella Iuorio, Andy Wallace, Kate Simpson, 'Prefabs in the North of England: Technological, Environmental and Social Innovations', *Sustainability (Basel, Switzerland)*, vol 11, iss 14, 17th July 2017, pp. 7

116 Studio Aisslinger, 'The Loftcube Project', 16th June 2016, <https://www.aisslinger.de/loftcube/>5

Figure 4.01 Taube, Studio Aisslinger, Berlin, Nature Adaptation, 2016

Figure 49 Loftcube, Studio Aisslinger, Berlin, Landscape Utilization,Berlin, 2016

Loftcube provides a specific example of the application and considerations made to make the design and process viable. The modular dwelling suits users with a nomadic lifestyle, while feasibly allowing temporary stays in dense urban locations. It's pre-compact construction in the form of a moveable dwelling, seemingly re-invents the definition of the housing unit. This notable combination of modular innovation and prefabrication is seemingly bridging the gap between living small and providing urban accessibility that offers single habitation efficiency.[117] With the cube measuring fifty-five meters squared, the unit has been strategically designed out of timber and steel. As displayed in figure forty nine, this making the micro dwelling transportable from rooftops to terrain such as forests and mountains. The weight of Loftcube has been calculated to allow transportation by helicopter and positioning by crane; while its structural integrity allows the unit to withstand heavy wind forces.[118]

117 William Riggs, Menka Sethi, Wesley L. Meares, David Batstone, "Prefab Micro Units as a Strategy for Affordable Housing', *Housing Studies*, 14th October 2010, pp. 1

118 Avi Friedman, *Innovative Houses, Concepts for Sustainable Living*, ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 108

Figure 50 Loftcube, Studio Aisslinger, Berlin, Adaptability, Chatau Poste, Belgium, 2014

Figure 51 Loftcube, Studio Aisslinger, Prefabrication Utilization, Hotel Daniel, Austria, 2014

The digital and fabrication advances incorporated into the unit are helping degrade the previous views placed under modular dwellings. Where once seen as monotonous and technical inferiority are now seen as conventionally constructed units.[119] This rising trend, as presented in Loftcube, can be attributed to the units financial, structural, and time-saving advantages.[120] As a subsystem of modern prefabrication, integrating transportable modular features within Loftcube, presents a complete system package that can be produced as an assembled unit in less than a week.[121] In direct result of these developments, users are becoming increasingly aware of the significance of temporariness in today's cultural context. Seemingly, the progresses have shown a movement away from a static generation and a transition towards a dynamic dimension of spatial consumption. Using a hybrid infrastructure, Loftcube presents an innovative and outward expression of modern modularity in a quest to solve spatial limitation and the disproportionate use of unnecessary permanent foundations.[122]

119 James Trulove, Ray Cha, '*Prefab Now* , 1st edn, Harper Design- Harper Collins Publishers, New York City, New York, USA, 4th September 2007, pp. 1-192

120 Luis De Garrido, essay within: Sergi Costa Duran, '*New Prefab: Architecture Prefbriquee*', Loft Publications, Barcelona, Spain, 2nd April 2009, pp. 1-191

121 Monica Elliot, 'Adaptable Architecture: lean techniques are a solid foundation for industrial engineers in home manufacturing', *Industrial Engineer*, vol 37, iss 9, September 2005, pp. 28

122 De Beradinis, P. Marchionni, C. Capannolo, 'MO:BOM: a multi-functional prefabricated and flexible module', *International Journal of Computational Methods and Experimental Methods*, vol 5, iss 4, 1st June 2017, pp. 522

Figure 52 Loftcube, Studio Aisslinger, Installation, Hotel Daniel, Austria, 2014

The modular and prefabricated construction of Loftcube highlights the effective approach in overcoming the shortage of transportable spaces. Furthermore, providing benefits such as enhanced productivity, increased safety and enhanced optimization of the unit's footprint and interior amenities.[123] From initial installation, full living access can be completed in less than two days regardless of the desired location. Therefore, a large quantity of urban buildings are able to accommodate the cube due to its optimization benefits in ease of installation. The exterior façade of the unit can be clad with a wide selection of materials.

123 Hosang Hyun, Inseok Yoon, Hyun-Soo Lee, Monseeo Park, Jeonghoon Lee, 'Multiobjective optimization for modular unit production lines focusing on crew allocation and production performance', *Automation in Construction*, vol 125, May 2021, pp. 1

Figure 53 Loftcube, Studio Aisslinger, Exterior Facade Cladding at Night, Berlin, 2016

Figure 54 Loftcube, Studio Aisslinger, Exterior Facade Cladding in the Day, Graz, Austria, 2014

With materials ranging from transparent glass panels for views and timber louvers that retains privacy, users can select individual preferences regarding lifestyle and location.[124] Moreover, Loftcube's moveable structure seemingly underpins the benefits of modularity in modern dwellings.

With the unit's soft connections between urban foundations, the dwelling can adapt to environmental and user changing needs. The unit builds on existing notions of living in motion while presenting a new ability for homes to respond to external change.[125]

124 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 108, 110

125 Alkhansari Maryam Gharavi, 'Towards a convergent model of Flexibility in Architecture', *Journal of Architecture and Urbanism*, vol 42, iss 2, 14th November 2018, pp. 120,122

Figure 55 Loftcube, Studio Aisslinger, Independence Feel, Maillen, Belgium, 2016

Sustainability is the ruling guideline throughout the entire volume, with a common characteristic of transportable units surrounding how lightly profiles sit on land. Loftcube establishes a dialogue with the land instead of the occupation yet illustrates its own way of implementing completely new and transportable spatial solutions.[126] These formulations using distant building techniques previously used and integrated into modern innovations to create a developed and transportable living system. Loftcube seemingly presents an independent yet still functional unit in a closed system that maximizes this adaptability.[127]

126 Jacobo Krauel, '*New Houses, Compact and Prefab*', ed. by William George and Jay Noden, 1st edn, Links Books, 16th September 2010, pp. 7

127 Raquel Silva, Ines Campos, 'Advantages of Modularity Applied in Architecture', *IOP Conference Series- Materials Science and Engineering*, vol 603, iss 3, March 2019, pp 1

Figure 56. Loftcube, Studio Aisslinger, Maximizing Remaining Footprint, Maillen, Belgium, 2016.

The importance of integrating modularity and prefabrication in modern dwellings as presented in Loftcube has been routinely dismissed previously. However, this periodically celebrated building technique is now presenting a viable alternative to living flexibly. With urban footprint rapidly reducing, modular living is seemingly revolutionizing the functional and aesthetic make-up of the standard dwelling.[128] The contemporary new adaptation of such techniques in the form of Loftcube, is captivating the use of modularity to create an uncluttered, outdoor oriented construction unit. This in an attempt to reinvent the way modern homes can be used to maximize interior dimension and reach new collective aspirations.[129] Similarly, the unit has major internal benefits, with the interior providing a 360-degree panoramic view.

128 Joseph Tanney and Robert Luntz, '*Modern Modular, The Prefab Houses of Resolution*', 1st edn, Preston Architectural Press, East Seventh Street, New York, 1st October 2013

129 Michelle Kaufmann, Catherine Remick, '*Prefab Green*', 1st edn, Gibbs Smith, Layton, Utah, 1st April 2009, pp. 13; Alessandra De Cesaris, Domizia Mandolesi, 'Modular Sustainable and Customized: Projects for the Contemporary Dwelling', *Open House International: Gateshead*, vol 38, iss 3, September 2013, pp. 40

Figure 57 Loftcube, Studio Aisslinger, Panoramic Interior View, Berlin, 2016

Figure 58 Loftcube, Studio Aisslinger, Interior Bedroom, Berlin, 2016

With four general living spaces, as shown in figure fifty nine, partitioning is included for multifunctional usage, providing an efficient distribution of all basic dwelling amenities. Notably, both bathroom and kitchen sinks share a common manoeuvrable tap. Portable furniture and sliding tracks can be constantly adjusted, meaning the indoor view is not obscured.[130] Moreover, by presenting a contemporary and functional living space in a transportable form, a more conscious approach is being taken to the entire life-cycle of the dwelling, reducing its dependencies on a fixed footprint.[131]

130 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 110

131 Isaac Shabtai, Thomas Bock, Yaniv Stoliar, 'A New Approach to Building Design Modularization', *Procedia Engineering*, vol 85, 2014, pp. 275,281

Figure 59 Loftcube, Studio Aisslinger, Open Plan Interior, Berlin, 2016

Furthermore, Loftcube's use of new plug and play architectural typology, creates a flexible unit with exterior transportability and transformable interior functions. Therefore, creating a seemingly efficient and innovative response to the excessive use of a fixed spatial footprint in standard dwelling designs.[132] The cube draws on the need for temporariness in living, maximizing the ability to use separate locations in response to evolving contexts. Similarly, Loftcube follows the statement from Le Corbusier in, "the house is a machine for living", with its attempts to rationalize and remodel the way a dwelling can be manipulated and manoeuvred externally and internally in unit form.[133] By plugging modular an prefabricated modules in and out of changing environments, occupants are able to own a flexible living space in the form of a non-concrete skeleton that can be moved in relation to external factors and personal requirements.[134] Moreover, the concept is beginning to remodel the way people can live on and occupy limited urban footprints.[135] With a flexible method of transporting the unit, the space's definition sits in accordance with the personal, urban and environmental context.[136]

132 De Beradinis, P. Marchionni, C. Capannolo, 'MO:BOM: a multi-functional prefabricated and flexible module', *International Journal of Computational Methods and Experimental Methods*, vol 5, iss 4, 1st June 2017, pp. 522,528

133 Ryan E. Smith, *Pre-Fab Design: A Guide to Modular Design and Construction* , Wiley Publishing, Hobocken, New Jersy, USA, 11th January 2011, pp. 30

134 Hanno-Walter Kruft, '*A History of Architectural Theory: From Vitruvius to the Present* , Princeton Architectural Press, Hudson, New York, 16th August 2004, pp. 276, 348

135 Marielle Ferreira Silva, 'Another way of living: The Prefabrication and modularity toward circularity in the architecture', *IOP Conference Series: Earth and Environmental Science*, vol 588, iss 4 1st November 2020, pp. 3

136 Alessandra De Cesaris, Domizia Mandolesi, 'Modular Sustainable and Customized: Projects for the Contemporary Dwelling', vol 38, iss 3, *Open House International*, 1st September 2013, pp. 39

Figure 60 Loftcube, Studio Aisslinger, Berlin, Separate Location, Forest Use, Berlin, 2016

Thus, with the inclusion of plug and play method in the design process, as enveloped in Loftcube, it presents a new type of modular dwelling that is shaped for optimal spatial footprint use and transportation in response to changing environments.[137] Furthermore, the innovative concept seemingly presents a viable solution that allows users to take control of their home and adapt to consistently changing user needs, urban landscapes, reducing footprints and decreasing resources.[138]

137 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 104

138 Agnes Borsos, Jeno Balogh, Balazs Kokas, Balint Bachman, 'An eco-approach to modularity in Urban Living', *International Journal of Design & Nature and Eco Dynamics*, vol 42, iss 2, June 30th, 2019, pp. 84

Figure 61 Loftcube, Studio Aisslinger, Interior Control in Open Plan Style, Berlin, 2016

Figure 62 Loftcube, Studio Aisslinger, Self-Contained Living Unit Presentation, Berlin, 2016

Figure 64 Fincube, Studio Aisslinger, Ritten, Italy, 2010


ISOLATE

Trailing the United States' housing crisis and the global recession, the single-family home, once an emblem of domestic success, has transformed seemingly not into a celebratory representation of expression and pride but prison of economic precariousness. With even commonplace language surrounding the situation being bleak, stunned homeowners are having to adapt towards a more sustainable outlook in living smaller and greener.[139] Now that the green imperative has become more pervasive and necessary in modern living, most newly built dwellings are including energy conscious strategies in structure and utility design. As a result, the coined 'micro-green' homes, are not weighed down by their energy efficient remit but uplifted by the challenge. The commitment to the principle of energy conservation, prompts a more creative approach to all aspects of the structure, allowing functional inclusions to make a credible difference in saving energy.[140] The 'micro-green' dwellings in the form of homes, huts and cabins, are part of this critical re-assessment of creating sustainable living environments. These environments involve the re-thinking of materials, passive energy systems, active energy systems and the synthesis of the design into a carefully crafted environmental experience. Furthermore, reshaping how users can live sustainably with a smaller footprint and remaining

139 Mimi Zeiger, '*Micro Green, Tiny Houses in Nature*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 22nd March 2011, pp. 7

140 Phyllis Richardson, '*Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 137

141 Lori Ryker, '*Off The Grid, Modern Homes and Alternative Energy*', 1st edn, Gibbs Smith, Layton, Utah, 28th October 2005, pp. 16

resource efficient.[141]

The 'micro-green' dwelling's active commitment towards living sustainably seemingly fuses the new moralities surrounding the consumption of energy and the interaction with technical innovations of building structures. Moreover, this provides an enhanced control over the space's overall energy consumption and presenting a new relationship between environment and space that never remains static.[142] Notably, the integration of micro-living and sustainability has progressed down numerous channels. Yet seemingly, a sector of prominent development sits amongst the utilization of solar energy within the home, making an effort to capture the natural energy flows while consciously maximizing interior and exterior footprint.[143] The Silo House, developed by Cornell University, resembles the 'micro-green' dwelling's materiality, while maximizing the impact technological change can have towards living sustainably and maximizing solar energy.[144]

142 Michelle Gabriel, Philippa Watson, 'From Modern Housing to Sustainable Suburbia: How Occupants and their Dwellings are Adapting to Reduce Home Energy Consumption', *Housing, Theory and Society*, vol 30, iss 3, 1st September 2019, pp. 223, 232

143 Angela M. Dean, '*Green by Design, Creating a Home for Sustainable Living*', 1st edn, edt. Jennifer Grillone, Gibbs Smith Publisher, Layton Utah, 15th September 2003, pp. 100

144 Dan Hicks, edt. Mary C. Beaudry, '*The Oxford Handbook of Material Cultural Studies*', Oxford University Press, Oxford, England, September 2010, pp. 77

Figure 65 Silo House, Cornell University, Exterior Facade, Ithaca, New York, 2009

Designed for the 2002 US Solar Decathlon competition, the innovative concept presents a real-life working iteration of creating a green building while utilizing solar power. Fundamentally the dwelling takes the form of a conscious and modern exterior that maximizes interior potential. By extracting the materials and forms of the grain silos of the American Midwest, the tripartite scheme provides three silos with each unit housing a separate function. As displayed in figure sixty five, the form is comprised of three cylinders, one each for housing areas persisting of sleeping, eating and living. The corten corrugated steel shell aids in energy retention, which is captured through a 'skin integrated solar thermal system that preheats water into the house'.[145]

145 Phyllis Richardson, '*Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 147,148

Figure 66 Silo House, Cornell University, One of the Three Living Silos, Ithaca, New York, 2009

Figure 67 Silo House, Cornell University, Solar Panel Emphasis, Ithaca, New York, 2009

In essence, the heat captured by the steel is transferred through to running pipes behind the cladding. The Silo House seemingly moves against the norm of urban consumption and intensive resource use, exploring alternative perceptions of how a dwelling can be sustainable beyond the present norm. A subtle and humbling approach is taken in the house's construction, ceasing the current dependences on the consumption of fossil fuels.[146] The utilization of solar energy within The Silo House, seeks to adhere to a new age of living where a high quality of life can be matched with a reduced level of consumption.[147]

An important aspect of an active solar system is the harvesting method. They can be separated into two categories: those that produce electrical power and those that produce thermal energy. The Silo House potential and passive solar gain of energy potential throughout the house. incorporates both methods in the harvesting and storing of generated energy effectively.[148] The dwellings design considers maximizing energy output through proper orientation of solar components. This utilizes the energy potential and passive solar gain of energy potential throughout the house.[149] Each cylindrical silo has openable skylights for ventilation and diffuses natural light beneath the canopy of the photovoltaic sheets. Electricity is supplied by the sheets that hover above the silos and the porch. The forty panels are angled slightly for rainwater run-off and can produce 38 kilowatt hours of energy on a sunny autumn day.[150] A smart distribution panel helps keep track of consumption, with a circuit breaker that monitors and closes off the house's circuits when out of use. Furthermore, refining and housing innovative properties that hold a fixed demand on energy consumption values throughout the dwelling.

146 Pernilla Hagbert, Karin Bradley, 'Transitions on the home from: A story beyond sustainable living beyond eco-efficiency', *Energy Research and Social Science,* vol 31, September 2017, pp. 242,244

147 Samuel Alexander, Simon Usher, 'The Voluntary Simplicity Movement: A multi-national survey analysis in theoretical context', *Journal of Consumer Culture*, vol 12, iss 1, 13th April 2012, pp. 68; Maria Hakansson, Phoebe Sengers, 'Beyond Being Green: Simple families and ICT', *CHI13: SIGHI Conference on Human Factors in Computing Systems*, 27th April 2013, pp. 2732

148 Cathy Strongman, '*The Sustainable Home: The Essential Guide to Eco Building, Renovation and Decoration*', Merrell Publishers Ltd, London, England, 13th January 2010, pp. 1-205; Sengers, 'Beyond Being Green: Simple families and ICT', *CHI13: SIGHI Conference on Human Factors in Computing Systems*, 27th April 2013, pp. 2732

149 Paola Sassi, '*Strategies for Sustainable Architecture*', Taylor & Francis Ltd, Oxfordshire, England, 19th June 2006, pp. 1-312

150 Phyllis Richardson, '*Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 148

Figure 68 Silo House, Cornell University, Off-Grid Panel Use, New York, 2009

Seemingly, the importance of creating a 'micro-green' unit is presented by John Papiewski, who argues the need for a sustainable environment that is a product of both a structure and an application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle".[151] Hereto, The Silo House embodies these notions in an effective and formulaic structure which is resilient and adheres to sustainable housing strategies.[152] The current built dwelling systems seemingly places society under increasingly uncharted pressure.[153] With materials being the main foundation of space, decreasing the damaging environmental impacts through the rational use of resources is paramount. The Silo House's re-claimed material structure

151 Ali Basin Alfuraty, 'Sustainable Environment in Interior Design: Design by Choosing Sustainable Materials', I*OP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 5; John Paiewski, 'What is the Meaning of Sustainable Materials?', *bizfluent*, 6th September 2019, < https://bizfluent.com/about-6398478-meaning-sustainable-materials-.html>w

152 Kumaraswamy Basavapatna, J. Brennen, 'Significance of boundary conditions towards sustainable housing strategies', *IAFOR Journal of Sustainability, Energy and Environment*, 10th February 2015, pp.22

153 Eva van Genuvhten, Alicia Calderon Gonzalez, Ingrid Mulder, 'Open Innovation Strategies for Sustainable Urban Living', *Sustainability, Basel*, vol 11, iss 12, 15th June 2019, pp. 1

follows this groundwork with an emphasis on reformulating and integrating natural resources for positive impact.[154] While previously, some attempts to effectively create 'micro-green' homes and true sustainable living have failed due to inadequate infrastructure. However, there now remains a unilateral attention to integrating modern technology and environmental techniques to create built environments that are sustainable internally and externally such as The Silo House.[155]

154 Ali Basin Alfuraty, 'Sustainable Environment in Interior Design: Design by Choosing Sustainable Materials', 1st July 2020, pp. 6,7; Chuck Yu, '*Healthy Indoor Environments for Sustainable Buildings: Design and Construction*', Taylor & Francis Ltd, Oxfordshire, England, 14th December 2015, pp. 1-356

155 Paula Femenias, Pernilla Hagbert, 'The Habitation Lab: Using a Design Approach to Foster Innovation for Sustainable Living', *Technology Innovation Management Review 3*, November 2013, pp. 17

Figure 69 Silo House, Cornell University, Sustainable Exterior Emphasis at Night, Ithaca, New York, 2009

Figure 70 Silo House, Cornell University,Interior , New York, 2009

With each of the three cylindrical silos representing a housing area in sleeping, eating and living, there is efficient use of spatial footprint throughout the dwelling. The kitchen space includes inclusive energy efficient appliances with a great deal of storage possibilities. A bathroom is carefully concealed in the next bedroom in which the bed, on a counter-pully system, as displayed in figure seventy, can be drawn into a concealed ceiling box. The cautious arrangement of amenities opens up a desirable footprint for the users. With the two living room chairs made from reclaimed bourbon barrels, zero off grassing materials are used to finish throughout. With an attention to sustainability, sustainably forested black locust, ash and beech hardwoods were used for the interior throughout.[156] Furthermore, the centralised and sophisticated solar gain alongside a consciously sustainable interior, allows the dwelling to work in harmony. This drawing encouraging results in the expansion and adaptation towards net-zero energy homes.[157]

156 Phyllis Richardson, '*Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 147,148

157 Yeganeh Baghi, Zhenjun Ma, Duane Robinson, Tillmann Boehme, 'Innovation in Sustainable Solar Powered Net-Zero Energy Solar Decathlon Houses: A Review and Showcase', *Buildings, Basel*, vol 11, iss 4, 1st January 2021, pp. 2

Figure 71 Silo House, Cornell University, Bathroom Space, New York, 2009

Figure 72 Silo House, Cornell University, Material Use, New York, 2009

The Silo House represents a new age of morals when considering how dwellings should function and how they are able to function sustainably. By using materials in the construction and use that are sustainable, a built environment is created that considers a harmonious progression of multiple sides.[158] The dwelling's new principles sit around creating a minimal environmental impact while forming a comfortable living space. Ecologically, a positive affect can be placed on people's lives and dwellings through utilizing the sustainable processes which can additionally be applied to modern houses.[159] By minimizing the consequences on nature through exploiting natural elements like sunlight and thoroughly integrating the possible gains throughout the dwelling with modern technology, properties like The Silo House can move towards posing viable alternatives to living functionally and sustainably.[160]

158 S.B Yazyeva, L A Seferyan, L A Oparina, A Y Golubeva, 'Greening Technology Organization of Multi-Story Buildings, in the Reconstruction of Architectural and Planning Solutions with the use of Modern Building Materials', Materials Science Forum, vol 931, 20th September 2018, pp. 883-888

159 S.B Yazyeva, I.A Mayatskaya, 'Eco-sustainable architecture and comfortable living environment', IOP Conference Series. Materials, Science and Engineering, vol 1031, iss 1, February 2021, pp. 6

160 H.C Leindecker and D R Kugfarth, 'Mobile Tiny Houses, Sustainable and Affordable', IOP Conference Series: Earth and Environmental Science, vol 323, 1st August 2019, pp. 7; S.B Yazyeva, I.A Mayatskaya, 'Eco-sustainable architecture and comfortable living environment', February 2021, pp. 6

Figure 73 Silo House, Cornell University,Exterior Material and Process Benefits, New York, 2009

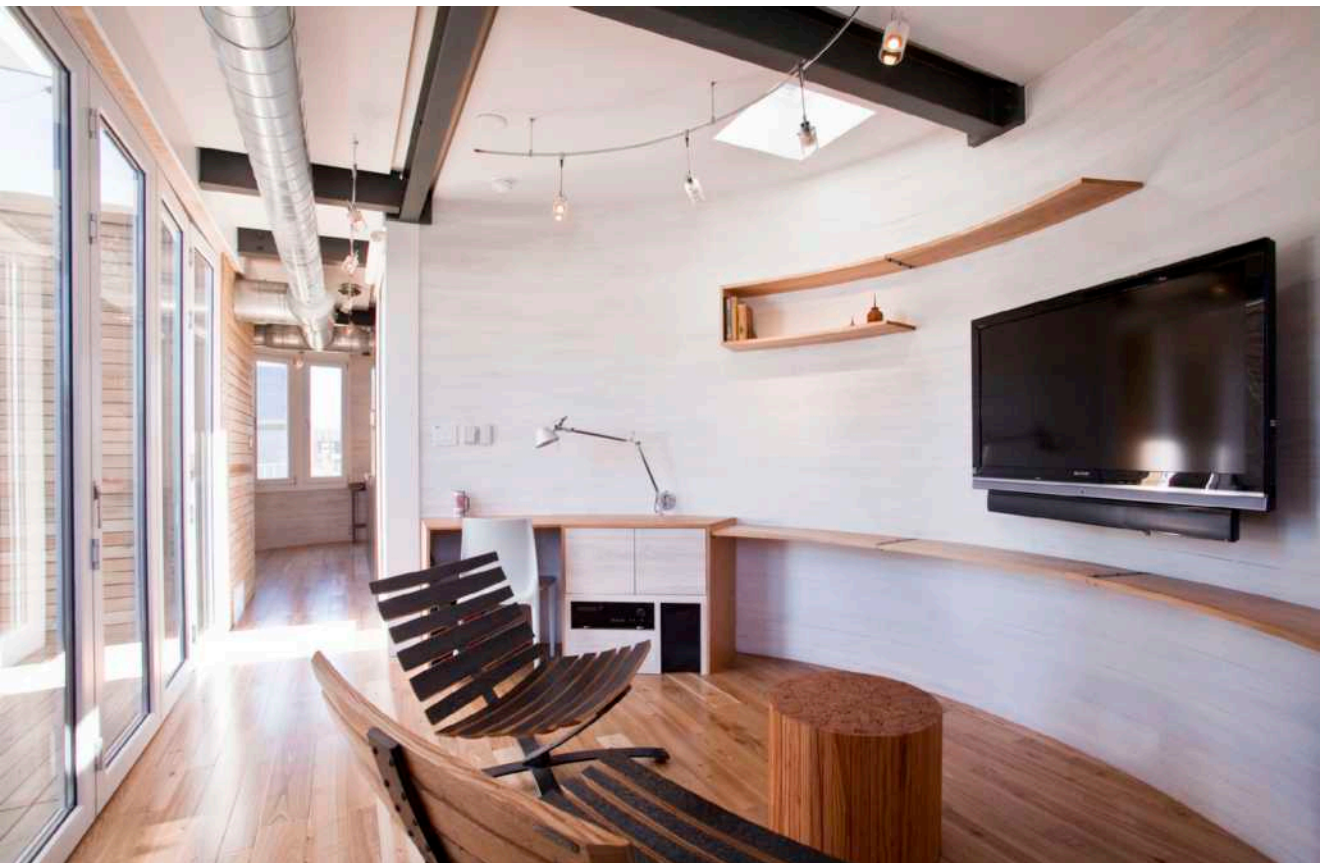


Figure 74 Silo House, Cornell University, Reclaimed Material Integration, New York, 2009

Figure 75 Silo House, Cornell University, Integration of Sustainable Materials, Open Entrance, New York, 2009

Figure 76 Silo House, Cornell University, Night Use, Full Integration and Use of Technologies, Ithaca, New York, 2009

Furthermore, The Silo House's adoption and utilization of energy efficient technologies, significantly contributes to the security that the dwelling is environmentally sustainable. By stimulating the sustainable incorporations alongside the operational impact, the dwelling sits as a seemingly feasible and innovative alternative in representation of a 'micro-green' property.[161] The dwelling presents an eco-conscious response which celebrates material choice, energy conservation, awareness of site conditions and ability to live functionally and sustainably.

Moreover, The Silo House presents a forward and holistic approach to integrating modern technology and the environment together, rejecting the damaging past of overconsumption. It proposes a form of 'micro-green' unit that does not simply retreat into the woods but creates positive and effective change in the wake of a planet running out of footprint and resources. It proposes a form of 'micro-green' unit that does not simply retreat into the woods but creates positive and effective change in the wake of a planet running out of footprint and resources.[162]

161 Ahmed Sodiq Ahmer Baloch, Shoukat Alim Kahn, Nurettin Sezer, Seif Mahmoud, Ali Abdelaal, 'Towards modern sustainable cities: Review of sustainability principles and trends', *Journal of cleaner production*, vol 227, 1st August 2019, pp. 978, 983

162 Mimi Zeiger, '*Micro Green, Tiny Houses in Nature*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 22nd March 2011, pp. 8,9,10

Figure 77 Silo House, Cornell University, Atmospheric Visual, Ithaca, New York, 2009

With attempts to adapt towards a smaller and sustainable lifestyle, 'micro-green' dwelling designs are tentatively laced with critique. Yet, the conscious and concerted effort to move away from the norm of the 'suburban sprawl' has furthermore developed an off-grid style of living.[163] Living off the grid is a term that best describes strategies and technologies of using alternative energy systems, while utilizing the surrounding environment and utility connections when needed.[164] The concept of a twenty-first century self-sufficient home provides the opportunity to break away from traditional networks, breaching the dependence on standard utility services. The opportunity for complete immersion and escapism is met with reality of not disbanding standard utilities, however utilizing them to create a conserved transition towards modern self-sufficiency.[165] Fincube presents a practical adaptation to this form of 'micro-green' living, however with a more conscious focus on the adaptable requirements of living in an unconventional environment.[166]

163 Mimi Zeiger, '*Tiny House*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 24th March 2009, pp. 7

164 Lori Ryker, '*Off The Grid, Modern Homes and Alternative Energy*', 1st edn, Gibbs Smith, Layton, Utah, 28th October 2005, pp. 24

165 Dominic Bradbury, *Off the Grid: Houses for Escape*' 1st edn, Thames and Hudson Ltd, London, England, 21st February 2019, pp. 7

166 Ali Basin Alfuraty, 'Sustainable Environment in Interior Design: Design by Choosing Sustainable Materials', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 5

Figure 79 Fincube, Studio Aisslinger, Large Wood Caging Emphasis, Ritten, Italy, 2010

Designed and developed by Werner Aisslinger, Fincube incorporates a smart use of natural resources and positive potential of human innovation. The self-contained living unit explores the possibilities of marrying modern nomadic tendencies with responsible and efficient design, while being made from natural resources. Larch-wood caging envelops the living block into an organic form, as shown in figure seventy nine, that is akin to a woodland mushroom; wrapping the structure in a warm timber web while providing solar protection.[167] The glass façade triple-glazed windows with low U-value, allows the almost transparent house to infuse sunlight throughout the dwelling. With the custom-made wood furnishings taking on the natural warmth, every aspect of the design is energy conscious. For instance, the roof can be equipped with photovoltaic solar array cells, to take the entire residence off grid.[168] Seemingly, Fincube provides new potential for structural expansion in un-common environments, with a self-sufficient yet more sustainable approach joint with a reduction in footprint.[169] As a transportable prefab product, the unit sits nearly nine feet above the ground on a small foundation, making it moveable. Yet, it requires minimum soil sealing, meaning the natural soil is only lightly displaced on installation. Furthermore, maximizing the benefits to nature while harmoniously merging the dwelling within the desired territory.[170]

167 Phyllis Richardson, '*Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 68

168 Mimi Zeiger, '*Micro Green, Tiny Houses in Nature*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 22nd March 2011, pp. 105

169 H.C Leindecker and D.R Kugfarth, 'Mobile Tiny Houses, Sustainable and Affordable', *IOP Conference Series: Earth and Environmental Science*, vol 323, 1st August 2019, pp. 2,7

170 S.B Yazyeva, I.A Mayatskaya, 'Eco-sustainable architecture and comfortable living environment', *IOP Conference Series. Materials, Science and Engineering*, vol 1031, iss 1, February 2021, pp. 6

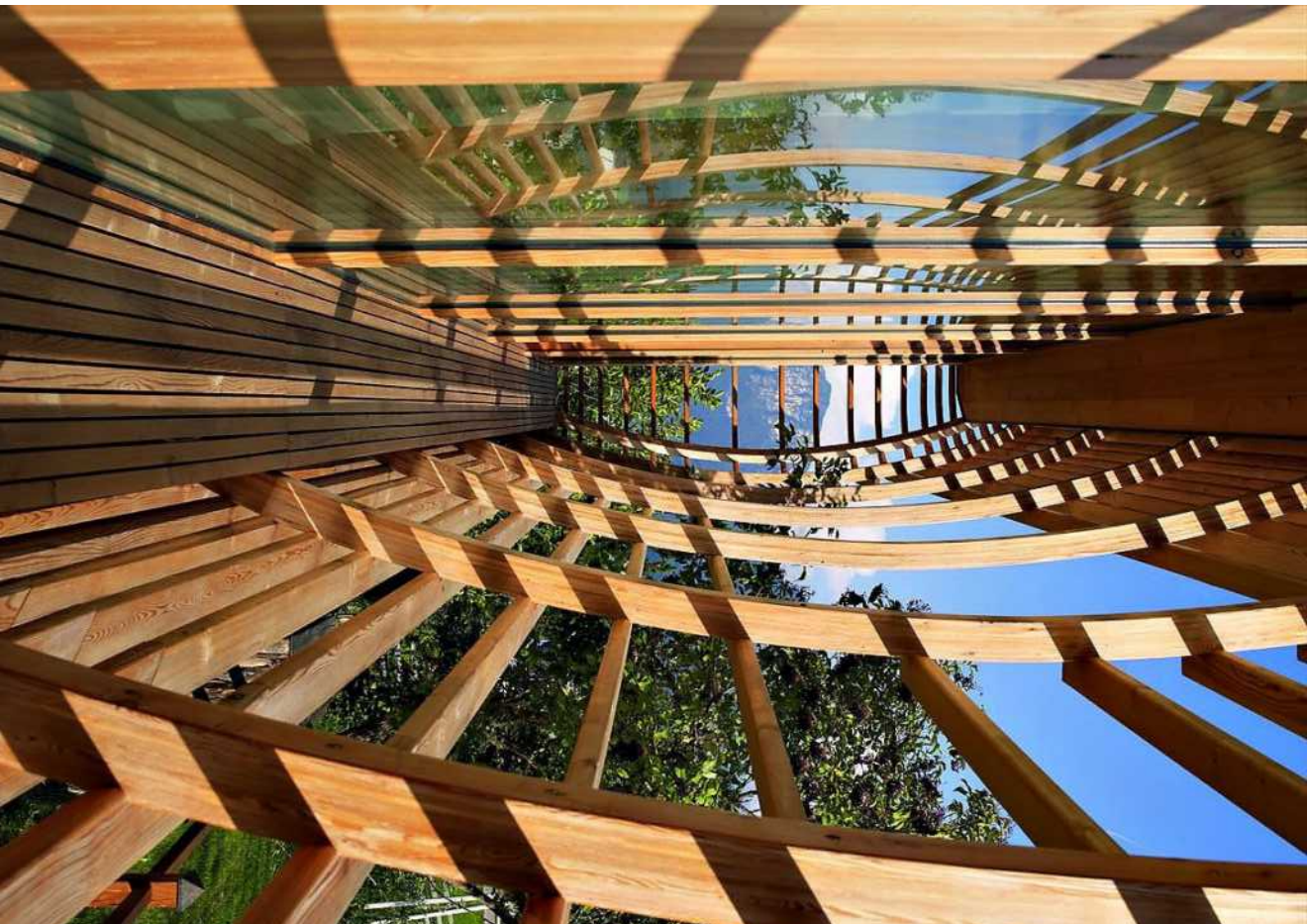


Figure 80 Fincube, Studio Aisslinger, Woven Wooden Web Skirting, Ritten, Italy, 2010

Figure 81 Fincube, Studio Aisslinger, Rising from the Landscape, Ritten, Italy, 2010

An important factor in 'micro-green' units, surrounds creating a built environment persisting of technical strategies that can decrease environmental impact and energy consumption yet excel the dwelling's performance.[171] The benefit to both the user and nature can be emphasised in Fincube, through the form of a shelter that is both substantial and transient. The level of visible minimalism encompassed in Fincube adds to the specific reduction in use of resources and carbon footprint.[172] With a smaller interior footprint and large wooden skeleton, the cube evades further material production which helps it in achieving an off-grid green building status.[173] Notably, Fincube's exterior timber shell springs up from the natural landscape without a huge environmental impact through a careful selection of alternative sustainable materials. The sustainable, material-orientated design brings the dwelling in close touch with nature. Moreover, a transition is generated within the small timber shell that addresses and seemingly resolves the current limitations seen in previous off-grid 'micro-green' dwellings.[174]

171 Lee.S Young, 'Sustainable Design Re-Examined: Integrated Approach to Knowledge Creation for Sustainable Interior Design', *The International Journal of Art & Design Education*, vol 33, February 2014, pp.159; Barbera G. Anderson, 'Transforming the interior design profession for leadership in an ecologically-benign future', *Proceedings for the IDEC 2010 Annual Conference*, 2010, pp. 2-6

172 R. Adams, 'The Comfort Zone- How small can it be? Homeowners in Search of Doing More with Less', *Sci Spirit*, vol 19, iss 2, pp. 32-39

173 Wei Wu, Brad Hyatt, 'Experiential and Project-based learning in BIM for sustainable Living with Tiny Houses', *Procedia Engineering- International Conference on Sustainable Design, Engineering and Construction*, vol 145, 2016, pp. 580

174 Pernilla Hagbert, Karin Bradley, 'Transitions on the home from: A story beyond sustainable living beyond eco-efficiency', *Energy Research and Social Science*, vol 31, September 2017, pp. 246

Figure 82. Fincube, Studio Aisslinger, Off-Grid Electricity Use, Ritten, Italy, 2010

While its construction fuses both renewable and recyclable materials together, Fincube's embodiment of the sustainable living variable" externally and internally, is a result of searching for the complete off-grid form.[175] The use of alternative construction materials and the innovations of spatial efficiency within modern dwelling interiors, allows Fincube a footprint layout of twenty-three square feet and a viable off-grid design.[176] Furthermore, the effect and benefits of living in a consciously designed building yet changed environment, are emphasized by Winston Churchill whom argued, "we shape our buildings, there after they shape us".[177] Hereto, previously users were central in the design process.

175 Inka Anggraeni, Herlily, 'Investigation "Tiny House" in urban kampung: sustainable living or responding to scarcity?', *IOP Conference Series. Earth and Environmental Science*, vol 452, iss 1, 1st April 2020, pp.6

176 Nareswarananindya, S.H Laksono, A.N. Ramadhani, A. Budianto, I. Komara, A.I.D Syafiarti, 'The design concept of bamboo in micro housing as a sustainable self-building material', *IOP Conference Series: Materials Science and Engineering*, vol 1010, 1st January 2021, pp. 1

177 Paula Femenias, Pernilla Hagbert, 'The Habitation Lab: Using a Design Approach to Foster Innovation for Sustainable Living', *Technology Innovation Management Review 3*, November 2013, pp. 15

Figure 83 Fincube, Studio Aisslinger, Conscious Integration into the Landscape, Ritten, Italy, 2010

Figure 84 Fincube, Studio Aissinger, Consious Functional Interior Application, Ritten, Italy, 2010

However, by de-centring the user as the nucleus of the dwelling design and placing focus on a sustainable location and property outlook, environments can be protected while providing functional and green housing solutions that last.[178] Moreover, Fincube emphasizes this perception with its incorporation of fewer resource consumption and the recycling of others in the fabrication process. Likewise, as placed by Kersty Hobson, with the "problematizing discourses of sustainable consumption", the focus transitions to the relocation and development of previous dwelling design strategies.[179] This, in replacement of complete design for self-actualisation and a press instead towards internalising environmental care within modern dwellings to reach a level of sustainable consumption externally and internally.[180]

178 Michelle Gabriel, Philippa Watson, 'From Modern Housing to Sustainable Suburbia: How Occupants and their Dwellings are Adapting to Reduce Home Energy Consumption', *Housing, Theory and Society*, vol 30, iss 3, 1st September 2019, pp. 220l; M. Gabriel, K. Jacobs, 'The Post-Social Turn: Challenges for Housing Research', *Housing Studies*, vol 23, iss 4, 1st July 2008, pp. 527

179 Kersty Hobson, 'Competing discourses of sustainable consumption: does the 'rationalization of lifestyles' make sense?', *Environmental Politics*, vol 24, iss 6, 8th September 2010, pp. 103

180 Pernilla Hagbert, Karin Bradley, 'Transitions on the home from: A story beyond sustainable living beyond eco-efficiency', *Energy Research and Social Science*, vol 31, September 2017, pp. 241

Figure 85 Fincube, Studio Aisslinger, Merging of Timber Shell to Glass Panel Circumference, Ritten, Italy, 2010

With the interior shell enveloped around a larch wood web, the organic form protects and houses an almost transparent interior. A horizontal ledge surrounds the unit, helping screen the 360 degrees of triple-glazed windows. Internally, as shown emphasized in figure eighty six, the living, sleeping and dining spaces have been finished to an elevated modern standard. A high attention to sustainability is followed, using recycled and locally sourced European larch to finish the interior walls, cabinetry and built-in furniture.[181] Reached by the stairs in the base of Fincube, the kitchen, living area, bedroom and bathroom radiate around a central core in a helical arrangement.[182] Left untreated,

181 Phyllis Richardson, '*Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 68,72,73

182 Mimi Zeiger, '*Micro Green, Tiny Houses in Nature*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 22nd March 2011, pp. 105

the light-coloured timbers add to the off-grid unit's natural, airy and feel with alternate building materials advancing the feasibility towards sustainable solutions in off-grid dwellings.[183] Moreover, the careful combination of sustainable interior and exterior considerations seemingly channel how the materials and environmental inclusions should now shape the space. Hereto, focusing on the search for reduced fossil fuel consumption and reduction yet utilization of available footprint.[184]

183 Nareswarananindya, S.H Laksono, A.N. Ramadhani, A. Budianto, I. Komara, A.I.D Syafiarti, 'The design concept of bamboo in micro housing as a sustainable self-building material', *IOP Conference Series: Materials Science and Engineering*, vol 1010, 1st January 2021, pp. 1

184 Ali Basin Alfuraty, 'Sustainable Environment in Interior Design: Design by Choosing Sustainable Materials', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 6,16

Figure 86 Fincube, Studio Aisslinger, Sustainable Material Integration while Spacious and Airy Feel, Ritten, Italy, 2010

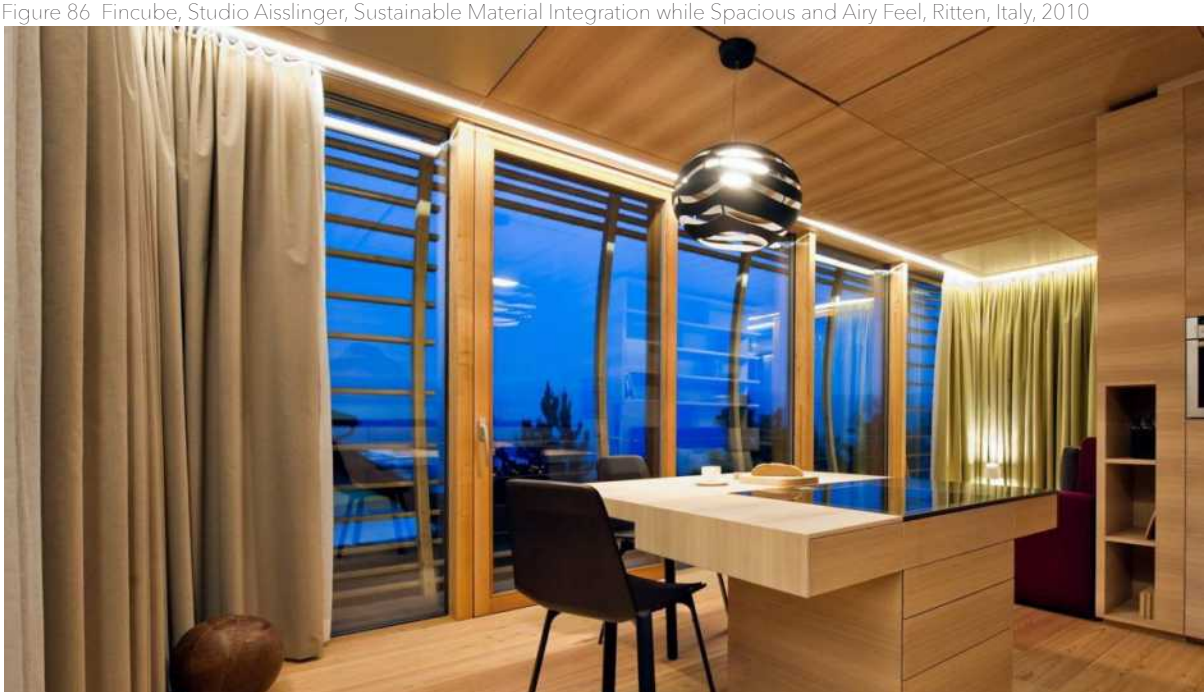


Figure 87 Fincube, Studio Aisslinger, Modern Interior Shaping, Ritten, Italy, 2010

Figure 88 Fincube, Studio Aisslinger, Atmospheric Interior Viewpoint, Ritten, Italy, 2010

Figure 89 Fincube, Studio Aisslinger, Emphasis on a New Wave of Dwelling, Ritten, Italy, 2010

Previously, the traditional design approach in modern dwellings seemingly concerned a 'one-dimensional practice'. They delivered functional and aesthetic enhancements in condensed urban settings.[185] However, a recent shift has seen society recognise the interconnectedness of dwellings in response to a sustainable built environment.[186] Resultingly, a new holistic approach has driven an integration of both environment and occupant to deliver new dwellings like Fincube. These dwellings, seemingly challenging the constrained and current tendencies of unsustainable dwellings, while rebelling against the norm to where dwellings can now be situated to optimise the planets remaining footprint.[187]

Furthermore, in an attempt to reduce the extreme consumption of natural resources, the introduction of 'micro-green' dwellings in different forms, seemingly challenges how users can live and the locations that can be used to live efficiently, safely and sustainably.[188] As expressed by Fincube and The Silo House, in a conscious yet critical presentation of the alternative relationships design and the environment can fuse together to create new and sustainable futures for dwellings.[189] In a brace away from nomadic habits, the transition to 'micro-green' living, seemingly attacks the overarching fixation of standardized dwellings.[190] Rather than succumbing to a stereotype, 'micro-green' dwellings press not for status, but host an assault on the need to transition to a lifestyle of living sustainably and efficiently to protect a planet running out resources and footprint.[191]

185 Carolyn S. Hayles, 'Environmentally sustainable interior design: A snapshot of current supply of and demand for green, sustainable or Fair-Trade products for interior design practice', International Journal of Sustainable Built Environment, vol 4, iss 1, June 2015, pp. 101

186 Frances Mazarella, Jennifer Lipner, 'Interior Design. Whole building design guide: A program of the National Institute of Building Sciences', Whole Building Design Guide, 11th March 2016, < https://www.wbdg.org/design-disciplines/interior-design>

187 M. Kang, D.A. Guerin, 'The Characteristics of Interior Designers Who Practise Environmentally Friendly Interior Design', Environment and Behaviour, vol 41, iss 2, 23rd September 2008, pp. 171

188 Ali Basin Alfuraty, 'Sustainable Environment in Interior Design: Design by Choosing Sustainable Materials', IOP Conference Series: Materials Science and Engineering, vol 881, 1st July 2020, pp. 6

189 Michelle Gabriel, Philippa Watson, 'From Modern Housing to Sustainable Suburbia: How Occupants and their Dwellings are Adapting to Reduce Home Energy Consumption', Housing, Theory and Society, vol 30, iss 3, 1st September 2019, pp. 221

190 Phyllis Richardson, 'Nano House, Innovations for Small Dwellings', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 57

191 Mimi Zeiger, 'Micro Green, Tiny Houses in Nature', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 22nd March 2011, pp. 8

Figure 90 Fincube, Studio Aisslinger, Main Atmospheric Visual, Ritten, Italy, 2010

Figure 91 5 to 1 Apartment, Michael K Chen Architects, New York, 2018

STATIC


MOBILE

When Le Corbusier introduced his Dom-Ino house in 1914, it was seen as turning point of expression for dwelling design. This with the houses revolutionary slab-and-column construction, proving to be the ultimate bookcase and blank canvas for interior and exterior expression.[192] Moving onwards, in the midst's of a twenty-first century housing crisis and increasing population density, the innovative shaping of the interior in supporting, containing and rendering the accessible third-vertical dimension of space has been paramount.[193] In the realm of this budding residential genre, the focus has filtered to creating within finite quarters, refining the small abode into an effective blend of innovation and functionality.[194] The evolution of the open plan home and the empty interior, has seen a less fragmented version itself, where the emergence of intricate systems and rigid partitions reconcile with the current demand for articulated and intimate living spaces.[195] Thus, in a critical re-assessment of the populations untapped footprint, the stereotypical domestic interiors are becoming innovated into adaptive, multi-purpose and flexible systems to combat pressuring notions.[196] Hereto, with a planet evidently collapsing in available spatial footprint, the innovations of the compact interior are seemingly articulating a new sense of purpose and importance in a bid to sculpt maximum

192 Anna Yudina, '*Furnitecture, Furniture That Transforms Space*', Thames and Hudson Ltd, London, England, 23rd February 2015, pp. 7

193 E. Harris, M. Nowicki, K. Brickell, 'On-edge in the impasse: Inhabiting the housing crisis as a structure of feeling', *Geoforum*, vol 101, September 2018, pp. 156

194 Azby Brown, '*The Very Small Home, Japanese Ideas for Living Well in Limited Space*', Kodansha America Inc, New York, USA, 15th October 2012, pp. 7, 9

195 Anna Yudina, '*Home Work, Design Solutions for Working From Home*', Thames and Hudson Ltd, London, England, 8th March 2018, pp. 114

196 Gestalen, ed. Tessa Pearson, '*Petite Places, Clever Interiors for Humble Homes*', 1st edn, Die Gestalten Verlag, Berlin, Germany, 25th September 2018, pp. 6

flexibility and simultaneously functionality.[197]

The adaptive interior seemingly fuses the need for flexibility in a compact space alongside the ability to transform a static environment into a visual and physically permeable entity. The development of modern spatial layout evidently is transitioning away from fixed designs and integrating flexible incorporations to create optimal capacity for users' needs.[198] Spatial adaptability refers to the conversion of available space and adopts forthcoming scenarios of room functions. Thus, the incorporation of flexibility into the interior seemingly provides users with configurations, choices and customizations that are integrated to cover the everyday demands of the dweller within a static footprint.[199] Yet, the interiors form doesn't need to change. By plugging innovative and adaptable features into the interior, the spaces configuration need not alter but embrace the various functions into the footprint to provide ease of use.[200] Compact Living, developed by Spacon and X Architects, fuses the principles of flexible living to provide a comfortable, optimized, and compact domestic interior environment.[201]

197 Simona Canepa, 'Living in a Flexible Space', *IOP Conference Series: Materials Science and Engineering*, vol 245, iss 5, 1st October 2017, pp. 7,10

198 Sura Aziz, Alobaydi Dhirgham, Amna BM. Salih, 'Studying Flexibility and Adaptability as Key Sustainable Measures for Spaces in Dwelling Units: A Case Study in Baghdad', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 11

199 Andrew Rabenek, David Sheppard, Peter Town, 'Housing Flexibility', *Architectural Design*, vol 43, iss 11, 1973 pp. 698-727; Steven Groak, '*The Idea of Building, Thought and Action in the Design and Production of Buildings*', Taylor & Francis Ltd, Oxfordshire, England, 2nd July 1992, pp. 1-32

200 Herman Hertzburger, '*Space and Learning: Lessons in Architecture*', 010 Publishers, Rotterdam, Netherlands, 1st August 2007, pp. 32,142

201 Yu Gu, 'Research on the Innovative Application of Modular Design in University Student Apartment Furniture', *IOP Conference Series- Materials Science and Engineering*, vol 573, iss 1, 1st July 2019, pp. 6

Figure 92 Compact Living, SPACON AND X Architects, Merging of Two Flats, Copenhagen, Denmark, 2014

Designed from re-thinking static to flexible, the modest flat was developed to suit the family's evolving needs. The scheme of the home merges two small apartments, breaking the boundaries between the two spaces to integrate one another, creating an optimal living environment. The boundaries are broken between room and furniture to utilize the available footprint, while maintaining the specific functions and intimacy in each room. Furthermore, the design is centred around transformation, with light and bright materials enveloping the rooms.[202] As displayed in figure ninety two, multifunctionality is consciously embedded into the room's functional strategies.

With a centrally located staircase including integrated storage, not only does it adjacently connect the two flats together but paves way for the thematical inclusions in the upstairs rooms.[203] Each room, guest and standard living space considers the importance of spatial occupation. With housing footprint becoming volatile and subject to a variety of tendency changes, Compact Living uses new architectural solutions in multifunctionality to promote a new type of home which is inevitably dynamic yet within the same footprint.[204] Seemingly, the home has tendencies physically and visually to be framed as immobile, with now pressuring notions surrounding continual transformation.[205] Yet, Compact Living's incorporation of adaptable features such as hidden bedding, integrated storage and cleverly concealed partitioning, re-defines the environment of domesticity and the utilization of a dense footprint.[206]

202 SPACON and X, 'Compact Living', SPACON and X, 2014, <https://spaconandx.com/COMPACT-LIVING>

203 Hosseini Raviz, Seyed Reza, Nik Eteghad Ali, Ezequiel Uson Guardiola, Antonio Armesto Airo, 'Flexible Housing: The Role of Spatial Organization In Achieving Functional Efficiency', *ArchNet-IJAR: International Journal of Architectural Research*, vol 9, iss 2, 13th July 2015, pp. 74

204 Tatjana Schneider and Jeremy Till, '*Flexible Housing*', 1st edn, Elsevier Inc/Ltd, Amsterdam, Netherlands, 30th July 2007, pp. 47

205 Simona Canepa, 'Living in a Flexible Space', *IOP Conference Series: Materials Science and Engineering*, vol 245, iss 5, 1st October 2017, pp. 3

206 Gerhard Bruyns, 'Tactical interiority; Hong Kong's "lived" Interiors as Praxis for Tactical Living in High-Density Landscapes', *Interiors*, vol 9, iss 32nd September 2019, pp. 347

Figure 93 Compact Living, SPACON AND X Architects, Multifunctional Bed Conversion Open, Copenhagen, Denmark, 2014

Figure 94 Compact Living, SPACON AND X Architects, Multifunctional Bed Conversion Closed, Copenhagen, Denmark, 2014

Figure 95 Compact Living, SPACON AND X Architects,Progressive Adaptations, Copenhagen, Denmark, 2014

Yet while there are questions on the feasibility of compact homes, now seemingly what was dismissed by a previous generation is notably embraced by the current.[207] Re-using footprint to suit the altering needs of users as exemplified in Compact Living, pursues re-framing the outcomes of reduced housing to create progressive adaptations that excel and utilize the living experience.[208] In addition, Compact Living incorporates the two dominant types of flexibility. This is persistent of a multi-use space system and an open plan system, that merges and embraces living spaces together to create a dwelling that can significantly contribute to the quality of life and functionality of user experience.[209]

207 Jenny Preece, Kim McKee, John Flint, David Robinson, 'Living in a small home: expectations, impression management and compensation practices', *Housing Studies*, 11th October 2021, pp. 2

208 Lauren Berlant, '*Cruel Optimism*', Duke University Press Books, Durham, North Carolina, 20th December 2011, pp. 1-352

209 Sura Aziz, Alobaydi Dhirgham, Amna BM. Salih, 'Studying Flexibility and Adaptability as Key Sustainable Measures for Spaces in Dwelling Units: A Case Study in Baghdad', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 4; Peter Howley, 'Attitudes towards compact city living: Towards a greater understanding of residential behaviour', *Land Use Policy*, vol 26, iss 3, 2009, pp. 796

Figure 96 Compact Living, SPACON AND X Architects, Integrated Stair Storage, Copenhagen, Denmark, 2014

Figure 97 Compact Living, SPACON AND X Architects, Subtle Multifunctional Inclusions, Copenhagen, Denmark, 2014

Furthermore, Compact Living follows the perception of transiency in its design, crafting a conscious dimension of temporariness throughout the space in search of the diminishment of standardized and non-efficient living methods.[210] Moreover, with configuration representing the crucial connection of space and form, Compact Living includes subtle incorporations of multifunctionality in it's dwelling layout.[211] This therefore, providing the foundations for continually over time, accommodating its inhabitants' diverse requirements in the same dense spatial footfall.[212]

210 De Beradinis, P. Marchionni, C. Capannolo, 'MO: BOM: a multi-functional prefabricated and flexible module', *International Journal of Computational Methods and Experimental Methods*, vol 5, iss 4, 1st June 2017, pp. 522

211 Abdul Rahim, Abu Hassan, 'Study on Space Configuration and Its Effect on Privacy Prevision in Traditional Malay and Iranian Courtyard House', *International Proceedings of Economics Development & Research*, vol 42, 2012, pp. 115-119

212 Hosseini Raviz, Seyed Reza, Nik Eteghad Ali, Ezequiel Uson Guardiola, Antonio Armesto Airo, 'Flexible Housing: The Role of Spatial Organization in Achieving Functional Efficiency', *ArchNet-IJAR: International Journal of Architectural Research*, vol 9, iss 2, 13th July 2015, pp. 74,75

Figure 98 Compact Living, SPACON AND X Architects, Efficient Integration of Flats, Copenhagen, Denmark, 2014

In a refusal to abide by the conventional norms', the aspirational yet seemingly detrimental shift towards the utilization of compact space shown in Compact Living aims to tap and embrace the empty interior.[213] The integration of spaces alongside it's space saving innovations, seemingly deviate from standardized living methods.[214] Spacon and X recalibrates the seeming expectations of how to live efficiently, accepting the "realities of the system" in modern spatial consumption, pressing a focus on making use of their existing internal footprint while eliminating the need to move.[215]

213 Anonymous, 'Living Small: Home and Garden Books 2018', *Publishers Weekly*, vol 265, iss 7, 9th February 2019, pp. 2

214 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living*', ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 71

215 Elinor Chisolm, Philpia Howden-Chapman, Geoff Fougere, 'Tenants' Responses to Substandard Housing: Hidden and Invisible Power and the Failure of Rental Housing Regulation', *Housing, Theory and Society*, vol 37, iss 2, 29th October 2018, pp. 139-161; Jenny Preece, Kim McKee, John Flint, David Robinson, 'Living in a small home: expectations, impression management and compensation practices', Housing Studies, 11th October 2021, pp. 4

Figure 99 Compact Living, SPACON AND X Architects, Utilizing Existing Internal Footprint, Copenhagen, Denmark, 2014

Figure 100 Compact Living, SPACON AND X Architects, Fully Integrated Storage, Copenhagen, Denmark, 2014

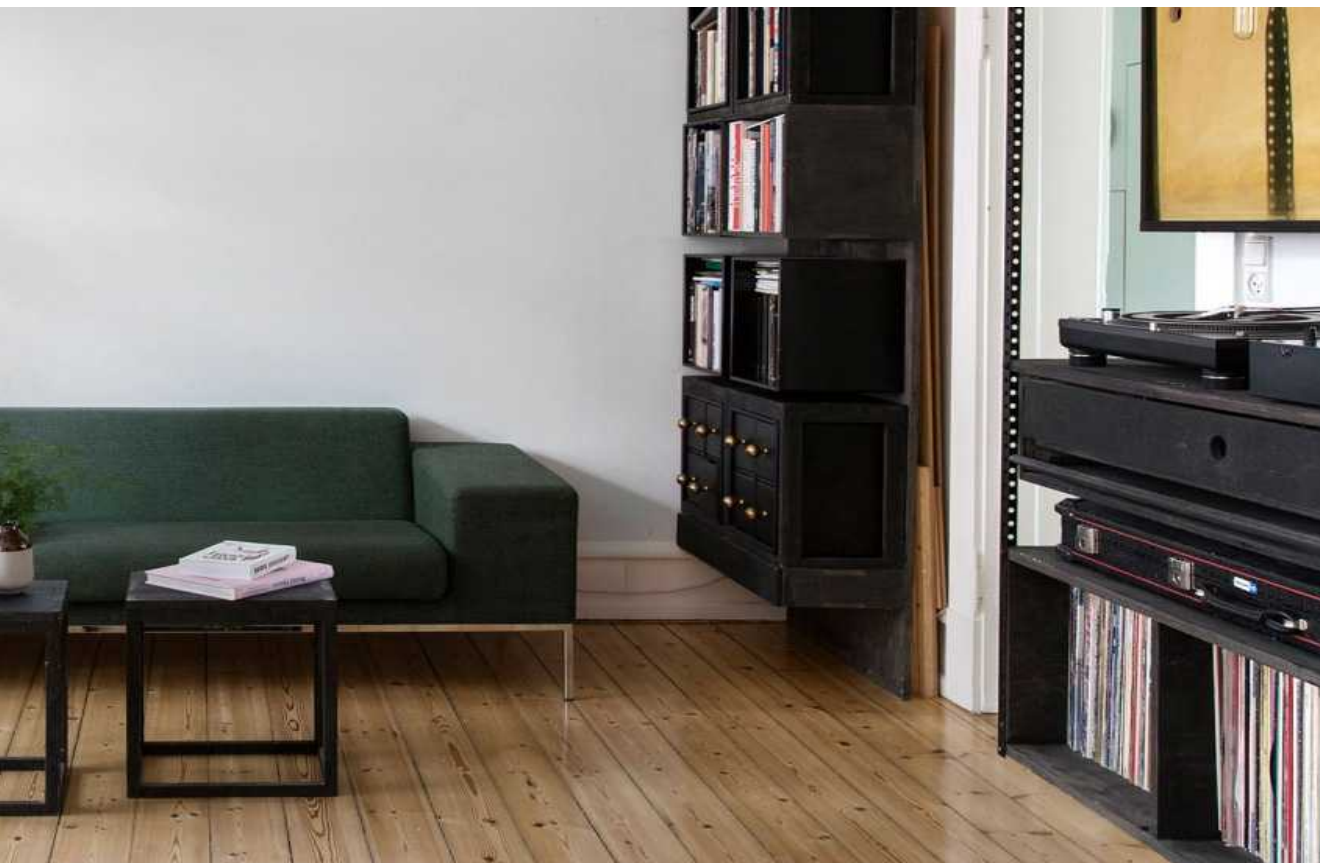


Figure 101 Compact Living, SPACON AND X Architects, Sophisticated yet Efficient, Copenhagen, Denmark, 2014

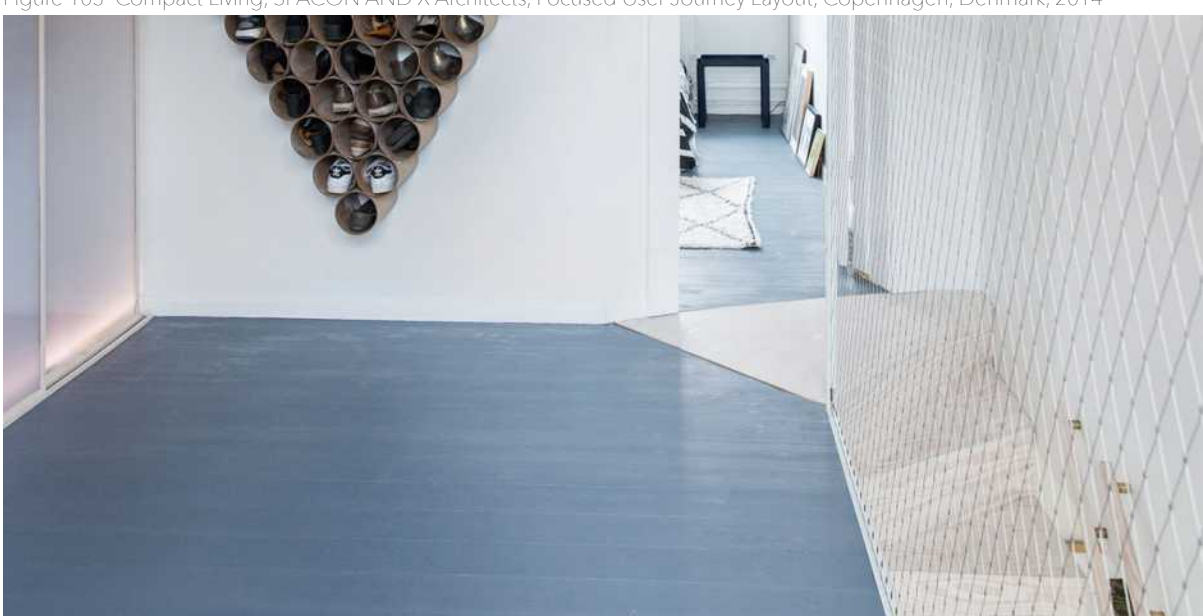
Figure 102 Compact Living, SPACON AND X Architects, Integrated Storage Stairway, Copenhagen, Denmark, 2014

Seemingly, Compact Living engulfs the evolution of open-plan living, creating a harmonious combination of optimizing storage and strategies that eliminates the under-utilized space in a concealing façade. The flexibility incorporated into the design, as worded by French Architect Arsne-Henri, "is not about designing allegedly 'good' or 'correct' layouts but provide a space which can accommodate the vicissitudes of everyday use over the long term".[216] Thus, while the evolution of the compact, private habitat enforces limitations, new architectural solutions as presented in Compact Livings interior developments, have simultaneously opened opportunities to incorporate flexibility and adapt to changing domestic needs.[217]

216 Tatjana Schneider and Jeremy Till, 'Flexible Housing', 1st edn, Elsevier Inc/Ltd, Amsterdam, Netherlands, 30th July 2007, pp. 159; Andrew Rabenek, David Sheppard, Peter Town, 'Housing Flexibility', *Architectural Design*, vol 43, iss 11, 1973 pp. 698-727

217 Hosseini Raviz, Seyed Reza, Nik Eteghad Ali, Ezequiel Uson Guardiola, Antonio Armesto Airo, 'Flexible Housing: The Role of Spatial Organization In Achieving Functional Efficiency', *ArchNet-IJAR: International Journal of Architectural Research*, vol 9, iss 2, 13th July 2015, pp. 68

Figure 103 Compact Living, SPACON AND X Architects, Focused User Journey Layout, Copenhagen, Denmark, 2014



A key internal component incorporated into Compact Living includes a home office, as shown in figure one hundred and four, slotted between the children's territory and the living space. Concealed within the parting wall, the homeowners 'office cabinet' includes plug-in stools, integrated shelving, and a collapsible table. The unit can store the required technology for work such as a computer and printer while its opposing side, pairs as a whiteboard for collaborative working and doubles to a letter drop for efficiency.[218] Integrating the unit into the wall helps separate the open footprint into detached niches, with no hinderance of submitting empty space to the environment.[219] The adaptable unit highlights the refreshing pertinence of temporariness within the dense interior with the innovative ability to now be self-contained amongst a compact atmosphere.[220] Yet, Compact Living's comprehensive attention to efficiency is fluidly adhered to throughout the merged spaces. The inclusion of multi-functional elements such as the collapsible furniture and the cleverly fitted storage, opens the possibility for numerous configurations and in turn shows the effective response to re-utilizing the available footfall.[221]

218 Anna Yudina, '*Home Work, Design Solutions for Working From Home*', Thames and Hudson Ltd, London, England, 8th March 2018, pp. 155

219 Simona Canepa, 'Living in a Flexible Space', *IOP Conference Series: Materials Science and Engineering*, vol 245, iss 5, 1st October 2017, pp. 2

220 De Beradinis, P. Marchionni, C. Capannolo, 'MO: BOM: a multi-functional prefabricated and flexible module', *International Journal of Computational Methods and Experimental Methods*, vol 5, iss 4, 1st June 2017, pp. 522

221 Jose Amarillo Barbosa, 'Smart Interior Design of buildings and its Relationship to Land use', *Architectural Engineering and Design Management*, vol 12, iss 2, 14th December 2015, pp. 3

Figure 104 Compact Living, SPACON AND X Architects, Multifunctional Working Unit, Copenhagen, Denmark, 2014

Figure 105 Compact Living, SPACON AND X Architects, Multifunctional Working Unit, Copenhagen, Denmark, 2014

Figure 106 Compact Living, SPACON AND X Architects, Working Unit Set-Up, Copenhagen, Denmark, 2014

Figure 107 Compact Living, SPACON AND X Architects, Multifunctional Entrance, Copenhagen, Denmark, 2014

Notably, the recent shift in the modern interior design of dwellings has transitioned away from the 'one dimensional practise'.[222] In turn, the acceptance of an interconnected interior as presented in Compact Living, displays a seemingly conscious response from society in creating a utilized and efficient, built environment.[223] The copious adaptation to the principles of a non-static layout, attempts to combat the pressuring notions of collapsing housing potential. Embracing the potential plurality in possible configurations of the static interior is not a seemingly merged practise of re-using, yet promotes an critical attitude towards the need for change in utilizing a compact space.[224] Furthermore, the adaptive reuse of the interior as presented in Compact Living, combats the seemingly pervasive housing crisis through the innovative incorporations of multifunctional and flexible considerations within the existing property.[225] The new interactions between form and user as presented within flexible dwellings like Compact Living, seemingly re-evaluate how the static interior is pieced together.[226] The innovations of 'spaces within space' sees the removal of solid, monofunctional, occasionally used interior zones and a revival of the compact interior. Moreover, this adaptive reuse sets a fresh outlook in a quest to break the designated norm of static spatial consumption in coveted urban dwellings and a strive towards functional efficiency in the wake of a planet running out of footprint and resources.[227]

222 Carolyn S. Hayles, 'Environmentally sustainable interior design: A snapshot of current supply of and demand for green, sustainable or Fair-Trade products for interior design practice', *International Journal of Sustainable Built Environment*, vol 4, iss 1, June 2015, pp. 101

223 Frances Mazarella, Jennifer Lipner, 'Interior Design. Whole building design guide: A program of the National Institute of Building Sciences', Whole Building Design Guide, 11th March 2016, < https://www.wbdg.org/design-disciplines/interior-design>

224 Sura Aziz, Alobaydi Dhirgham, Amna BM. Salih, 'Studying Flexibility and Adaptability as Key Sustainable Measures for Spaces in Dwelling Units: A Case Study in Baghdad', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 3

225 Nick Gallent, *'Whose Housing Crisis: Assets and Homes in a Changing Economy'*, Policy Press, Bristol, England, 24th April 2019, pp. 1-191; Francesca Lanz, 'Re-Inhabiting. Thoughts on the Contribution of Interior Architecture to Adaptive Intervention: People, Places and Identities', *Journal of Interior Design*, vol 43, iss 2, 6th April 2018, pp. 6

226 Frances Mazarella, Jennifer Lipner, 'Interior Design. Whole building design guide: A program of the National Institute of Building Sciences', 11th March 2016, < https://www.wbdg.org/design-disciplines/interior-design>

227 Anna Yudina, 'Home Work, Design Solutions for Working From Home', Thames and Hudson Ltd, London, England, 8th March 2018, pp. 7,8,9

Figure 108. Compact Living, SPACON AND X Architects, Atmospheric Visual, Copenhagen, Denmark, 2014

With attempts to transition towards a more flexible and utilized lifestyle, the adaptable interior has seemingly become instrumental in providing sustainable alternatives to standardized living methods without waste.[228] The adaptive reuse of space, emphasized in Compact Living, provides routes for continuous change in a larger property with greater scope.[229] However, modularity and flexibility in small lot developments focuses beyond the proceeding obsession of dimension and more towards combating the compounding social inequity within the seemingly invisible sphere of class. Drawn from minute dwelling developments that add density to an existing area, these compact abodes utilize the constraints of minimal footprints. Thus, in a collision between the rampant demand and limited supply of footprint in the great metropolises of urban cities; these modern principles look to leverage the previous clinches of compact space and embrace the untapped, minute interior.[230] Five to One Apartment, designed by Michael Chen Architects, seeks to mimic these principles in creating a concrete system that allows the home to contract, expand and adapt in relation to the user's needs.[231]

228 Frederick Uhlen Hop, '*Modular House Design, The Key to Complete Construction Efficiency*', Prentice Hall Inc, Englewood Cliffs, New Jersey, 1st March 1988, pp. 3

229 William Riggs, Menka Sethi, Wesley L. Meares, David Batstone, 'Prefab Micro Units as a Strategy for Affordable Housing', *Housing Studies*, 14th October 2010, pp. 1

230 Mimi Zeiger, '*Tiny Houses in the City*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 20th March 2009, pp. 8,9

231 Marielle Ferreira Silva, 'Another way of living: The Prefabrication and modularity toward circularity in the architecture', *IOP Conference Series: Earth and Environmental Science*, vol 588, iss 4 1st November 2020, pp. 5; Hanno-Walter Kruft, '*A History of Architectural Theory: From Vitruvius to the Present*', Princeton Architectural Press, Hudson, New York, 16th August 2004, pp. 276, 348

Figure 109 5 to 1 Apartment, Michael K Chen Architects, Contracting and Expanding Unit New York, 2018

Figure 110 5 to 1 Apartment, Michael K Chen Architects, Multifunctional and Modular System, New York, 2018

With their ongoing research into ultra-functional urban micro housing, architect Michael K Chen and his New York based studio MKCA have developed expertise in moving and transforming architecture. The apartment makes possible in what Chen bids, "a transactional exchange of space" between night and day zones. The 36.2 meters squared apartment mirrors this action, integrating through a motorized partition the spatial and practical components for sleeping, changing, living, and entertaining with dining, kitchen and washing facilities within the minute footprint.[232] The motorized partition, as shown in figure one hundred and ten, slides between two walls, which switches the room's functions and additionally houses a pivoting television set. In day functions, commonly housed as a living room, this function can be closed off to reveal behind the sliding doors a fully fitted home office with built-in storage systems. Alternatively, the office can be closed off to enable dressing or lounge configurations.[233] The design is seemingly driven by efficiency, with the simple idea of flexibly changing the interior layout quickly to uniquely alter the apartment's function and façade.[234] Furthermore, through a multifunctional and modular system, the apartment reduces unused space to meet the householders demands while maximizing the internal amenity in "lieu of reduced floor space".[235]

232 MKCA, 'Five To One Apartment', MKCA, <https://mkca.com/projects/five-one-apartment/>

233 Anna Yudina, *Home Work, Design Solutions for Working From Home*', Thames and Hudson Ltd, London, England, 8th March 2018, pp. 52

234 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living* , ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 64,65

235 Emma Clinton, 'Micro Living: why occupants chose to live in very small dwellings', *Australian Planner*, vol 55, 23rd June 2019, pp. 191

Figure 111 5 to 1 Apartment, Michael K Chen Architects, Standard Living Room Space, New York, 2018

Figure 112 5 to 1 Apartment, Michael K Chen Architects, Office Conversion Through Sliding Doors, New York, 2018

Figure 113 5 to 1 Apartment, Michael K Chen Architects, Modular Technology Integration Overview, New York, 2018

Notably, Five to One Apartment's inclusion of innovative modular technology seemingly fuses ingenuity and modern technological concepts to generate an astute utilization of a compact environment.[236] It's fundamental core, the motorized partition, uses the concept of kinetic architecture to which is designed to permit elements of the structures fabric to move. Hereto, embedded within the form is a dynamic kinetic composition that creates spatial entities which can "physically re-configure themselves", to fulfil the occupants altering needs. As displayed in Five to One Apartment, the application of the sub-group "sliding kinetic", defines the footprint by the preference of the user.[237]

236 Sura Aziz, Alobaydi Dhirgham, Amna BM. Salih, 'Studying Flexibility and Adaptability as Key Sustainable Measures for Spaces in Dwelling Units: A Case Study in Baghdad', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 1

237 Hala Hassanein, 'Utilization of "Multiple Kinetic Technology KT" in Interior Architecture Design as Concept of Futuristic Innovation', The Academic Research Community Journal, vol 2, iss 4, 1st January 2019, pp. 306,308

Figure 114 5 to 1 Apartment, Michael K Chen Architects, Office Space Opened Through Sliding Kinetic, New York, 2018

Figure 115 5 to 1 Apartment, Michael K Chen Architects, Manipulating The Footprint To Suit The User, New York, 2018

Hereto, this attribute allows the occupant to manage the dimension and functions of the footprint whether through maximizing or minimizing the plot. Therefore, in the form of a spatial response, the application supports the occupant's immediate domestic requirements, utilizing the available compact interior.[238] Moreover, Five to One Apartment's manipulation of a dense footprint, seemingly reconceptualizes the shaping of the static interior in response to a need for circularity and functional efficiency to sufficiently accommodate users in a compact space.[239]

238 Mai. M. Youssef, 'Kinetic Behaviour, The Dynamic Potential Through Architecture and Design', *International Journal of Computational Methods and Experimental Measures*, vol 5, iss 4, 2017, pp. 616

239 Martin Tenpierik, Peter Luscuere, 'Circular and Flexible Indoor Partitioning- A Design Conceptualization of Innovative Materials and Value Chains', *Buildings, Basel*, vol 9, iss 1, 26th August 2019, pp. 1,2

Figure 116 5 to 1 Apartment, Michael K Chen Architects,Motorized Unit In Static Form, New York, 2018

The absence and presence of the diverse functions integrated into the motorized unit within the compact footprint of Five to One Apartment, represents a new form of freedom and clarity encompassed within a condensed space.[240] It caters to the point that instead of escalating the size of a dwelling, the emphasis should turn to an increased function. Instead of enshrouding in the oppressive side of the definition of small, re-utilizing the compact interior through flexibility and multifunctionality seemingly pursues a reversal in overconsumption.[241] Yet, in the midst of spatial constraint, the growing utilization of the planets remaining footprint as shown in Five to One Apartment, is reiterated through Frank Llyod whom regarded "man built most notably when

240 Pamela Salen, 'Piecing Together the Empty Interior', *Journal of Interior Design*, vol 43, iss 1, 14th February 2018, pp. 9

241 Li Zeting, Wu Jiahao, 'Research on the design of small interior space', *E3S Web Conferences,* vol 308, 2021, pp.1,4

limitations were at their greatest".[242] Moreover, with the globe seemingly having it's back against the wall in terms of available space, Five to One Apartment parallels Castell's concept of the "space of flows", where spaces are now organised for the continuous movement of people.[243] Castell promotes "disordering the sequence", where the norm of spatial composition is detached and recalibrated to where dynamic movement replaces the static interior.[244]

242 Deborah Schneiderman, 'With Limitation Comes Inspiration: The Case for Interior Prefabrication', *Journal of Interior Design*, vol 39, iss 2, 6th June 2014, pp. 5

243 Tara Chitten, 'When Is a Bedroom Not a Bedroom? Bringing a Space of Flows to the Design of Apartment Interiors in YO! Home', *Journal of Interior Design*, vol 40, iss 4, 15th May 2015, pp. 4

244 Manuel Castells, '*The Rise Of The Network Society*', Blackwell Publishing, Oxford, England, 1996, pp. 467; Felix Stalder, 'The Network Paradigm: Social Formations in the Age of Information', *The Information Society: An International Journal*, volume 14, iss 4, 1998, pp. 2

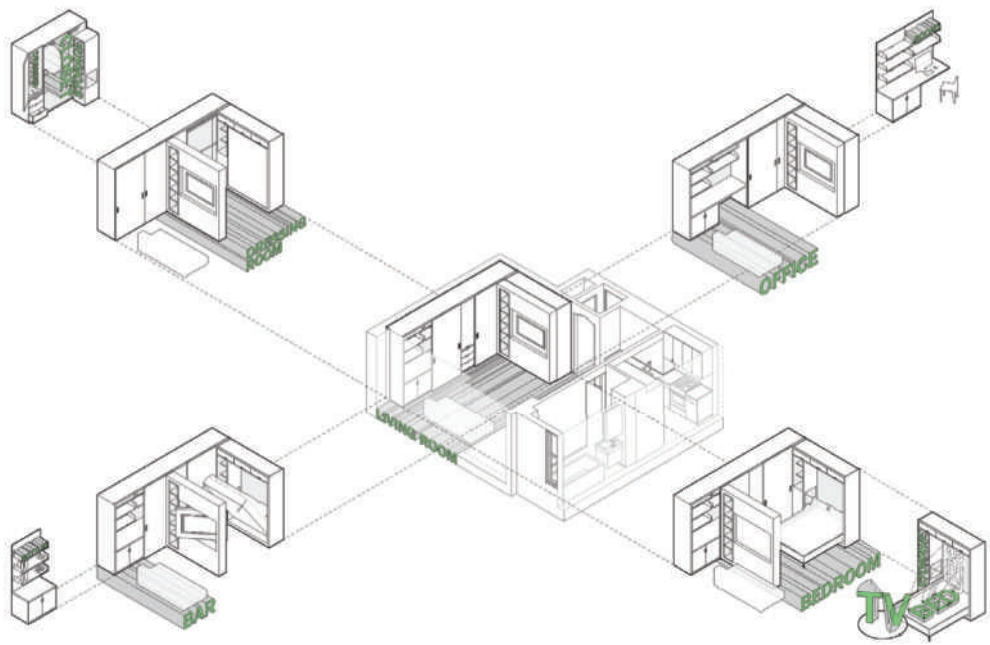


Figure 117 5 to 1 Apartment, Michael K Chen Architects, Full Explosion Of All Functions, New York, 2018

Figure 118 5 to 1 Apartment, Michael K Chen Architects, Bedroom Conversion Process Part 1, New York, 2018

Figure 119 5 to 1 Apartment, Michael K Chen Architects, Bedroom Conversion Process Part 2, New York, 2018

Figure 120 5 to 1 Apartment, Michael K Chen Architects, Bedroom Perspective View , New York, 2018

Five to One Apartment's scope in transitions from one mortised component, seemingly adheres to the modern dynamic movement of space.[245] By day, the conversions alternate around a living space and office. Yet by night, as presented in figure one hundred and twenty, the sliding partitions pull to one side to make space for a fold down bed, with an opposite bar space created through removable components to encompass the evening atmosphere. In the morning, this function retracts in a return to daytime activities with washing and dining facilities available. In the morning, this function retracts in a return to daytime activities with washing and dining facilities available.

245 Tara Chitten, 'When Is a Bedroom Not a Bedroom? Bringing a Space of Flows to the Design of Apartment Interiors in YO! Home', *Journal of Interior Design*, vol 40, iss 4, 15th May 2015, pp. 3

Figure 121 5 to 1 Apartment, Michael K Chen Architects, Bedroom Front Elevation View , New York, 2018

Figure 122 5 to 1 Apartment, Michael K Chen Architects, New York, 2015

While the opened living space houses the built-in office with storage system, alternatively the living space can be slightly compromised to enable a dressing configuration.[246] Thus, by efficiently compiling all living amenities into one, Five to One Apartment seemingly embraces the modern relationship between user and environment, where both work cohesively to utilize the planets retracting footprint. In a removal of the leverage the façade of an interior holds, Five to One Apartment resets the combination of blending aesthetic and function to create a utilized, compact, and domestic dwelling.[247]

246 Anna Yudina, 'Home Work, Design Solutions for Working From Home', Thames and Hudson Ltd, London, England, 8th March 2018, pp. 52

247 Hosseini Raviz, Seyed Reza, Nik Eteghad Ali, Ezequiel Uson Guardiola, Antonio Armesto Airo, 'Flexible Housing: The Role of Spatial Organization In Achieving Functional Efficiency', *ArchNet-IJAR: International Journal of Architectural Research*, vol 9, iss 2, 13th July 2015, pp. 65; Barbara Miller Lane, '*Housing and Dwelling: Perspectives on Modern Domestic Architecture*', Taylor and Francis, Oxfordshire, England, 2007, pp. 467

Figure 123 5 to 1 Apartment, Michael K Chen Architects, Changing Space Conversion, New York, 2018

Figure 124 5 to 1 Apartment, Michael K Chen Architects, Humble Seating View and Dining Space, New York, 2018

Moreover, with configuration sitting as a primary element between the modern relationship of space and form, Five to One Apartment seemingly eliminates the submission of un-utilized space to the environment. In turn, the solution of integrating architecture and furniture together in search of optimizing the dwellings compact footprint, provides a new dimensional independence within a dense space.[248] Through maximizing the process of flexibility and multi-functionality, Five to One Apartment takes the form of an adaptive response to the shifting circumstances surrounding spatial availability across dense urban landscapes and the globe.[249] The integration of customizable configurations, aims to optimize the potential of a compact environment which retains the sentiment of a habitable and comfortable home.[250] Yet, in seemingly different make-up to the standardized dwellings façade, Five to One Apartment encapsulates the tiny ethos for efficiency and mobility within a compact space.[251] It also presents a modern, refreshing and seemingly sought-after application of change in the domestic housing market, where the previous norm of living large is slowly filtering into an unattractive and seemingly unpractical sphere with no return.[252] Therefore, the incorporation of modular and multifunctional interior innovations seemingly provides a renewed solution; a fresh answer towards utilizing compact spaces, while helping adapt and optimize dwellings within a world running out of resources and footprint.[253]

248 Simona Canepa, 'Living in a Flexible Space', *IOP Conference Series: Materials Science and Engineering*, vol 245, iss 5, 1st October 2017, pp. 2,3

249 Sura Aziz, Alobaydi Dhirgham, Amna BM. Salih, 'Studying Flexibility and Adaptability as Key Sustainable Measures for Spaces in Dwelling Units: A Case Study in Baghdad', *IOP Conference Series: Materials Science and Engineering*, vol 881, 1st July 2020, pp. 2,7,11

250 Steven Groak, '*The Idea of Building, Thought and Action in the Design and Production of Buildings* , Taylor & Francis Ltd, Oxfordshire, England, 2nd July 1992, pp. 1-32

251 Mimi Zeiger, '*Tiny Houses in the City*', 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 20th March 2009, pp. 11

252 Azby Brown, '*The Very Small Home, Japanese Ideas for Living Well in Limited Space* , Kodansha America Inc, New York, USA, 15th October 2012, pp. 7, 9

253 Anna Yudina, '*Home Work, Design Solutions for Working From Home*', Thames and Hudson Ltd, London, England, 8th March 2018, pp. 7,8,9

Figure 125 5 to 1 Apartment, Michael K Chen Architects, Atmospheric Visual and Full Apartment View , New York, 2018

CONCLUSION

While the seeming reality is that the modern house remains an anomaly, a tiny portion of the masses of dwellings constructed each year. Such houses are departing from the unheard of and moving to the sought after. The properties analysed in this dissertation envelop the seeding of an influence of dwellings departing radically from the established pattern of domestic form-making. While smaller in stature, the uncompromised barrage of new dwellings illustrates methods to build homes that are reductive in scale but not scope.[254] Yet, these dwellings are not a fashionable, grandiose façade. Opposingly, they are a seeming representative of a seismic and ecstatic demonstration of a new statement in homes. Though the battle for novelty remains, the emergence of the modern dwelling poses a total realignment of the perception towards how we live. While living small has not recently entered the invisible architectural arena, the contemporary update of resource and footprint limitations have resulted in technological and material innovations melded into a new physical make-up and wave of homes.[255]

The notions of living small need not succumb to stripping down to the bare essentials in a feeling of dispossession but reassess the scope of how to utilize minimal space to both the occupant and spatial benefit.[256] Yet with most accustomed to a less rugged daily existence, instincts seemingly propel users to eschew the plunge into a more compact and efficient form of occupation.[257]

However, the harsh reality is poised with the planet seemingly having its back pressed against the wall in the pressing

254 Mimi Zeiger, '*Tiny House* , 1st edn, Rizzoli International Publications INC, 300 Park Avenue South, New York, 24th March 2009, pp. 9

255 Jonathan Bell, '*21st Century House*',edt by Jonathan Bell, 1st edn, , Laurence King Publishing Ltd, London, England, 1st April 2006 , pp. 25, 26

256 Phyllis Richardson, '*Nano House, Innovations for Small Dwellings*', ed. by Peter Dawson, 1st edn, Thames and Hudson Ltd, London, England, 12th September 2011, pp. 10

257 Phyllis Richardson, 'Nano House, Innovations for Small Dwellings', ed. by Peter Dawson, 12th September 2011, pp. 10

rates of consumption both in space and resource. Therefore, in reaction, the twenty-first century has launched a seemingly 'perfect storm' of responses. This in the form of humble, adaptable, and sustainable abodes that compel against the generic norm, searching for small, empty, unconventional locations and pockets to lay comfortable and domestic living foundations with content.[258] As exemplified in properties such as Loftcube or The Macy Miller House, there is no location or concept too daring or unconventional. While considerably, The Prefab Lighthouse exposes through modularity that seemingly the 'sky is the limit' in terms of how dwellings can be designed to expand and adapt to the altering needs of occupants.[259] This remodel of the role flexibility plays in housing and the interior is shaped throughout the dissertation, exemplified within Five to One Apartment, that uses flexibility within a compact space in a press away from the static.[260]

Yet, what was once a solitary object, has transitioned into a captivating and desired form. In a press away from the standardized norm of houses, the modern dwelling now takes an expansive array of forms yet with one primary focus, to integrate amongst, explore and utilize the untapped value of the planets retracting footprint.[261] In a very contemporary tradition of deliberate juxtaposition, modern dwellings are part of a transition that is seemingly unavoidable. The result is the creation of new variations of an 'essential object', a self-contained statement of intent for the future of housing in a bid to protect, propel and utilize the relationship between architecture and nature.[262]

258 Avi Friedman, '*Innovative Houses, Concepts for Sustainable Living* , ed. by Gaynor Sermon, 1st edn, Laurence King Publishing Ltd, London, England, 7th October 2013, pp. 7

259 Agnes Borsos, Jeno Balogh, Balazs Kokas, Balint Bachman, 'An eco-approach to modularity in Urban Living', *International Journal of Design & Nature and Eco dynamics*, vol 42, iss 2, June 30th, 2019, pp. 84

260 Marielle Ferreira Silva, 'Another way of living: The Prefabrication and modularity toward circularity in the architecture', *IOP Conference Series: Earth and Environmental Science*, vol 588, iss 4 1st November 2020, pp. 3; Hosseini Raviz, Seyed Reza, Nik Eteghad Ali, Ezequiel Uson Guardiola, Antonio Armesto Airo , 'Flexible Housing: The Role of Spatial Organization In Achieving Functional Efficiency', *ArchNet-IJAR: International Journal of Architectural Research*, vol 9, iss 2, 13th July 2015, pp. 70

261 De Beradinis, P. Marchionni, C. Capannolo, 'MO: BOM: a multi-functional prefabricated and flexible module', *International Journal of Computational Methods and Experimental Methods*, vol 5, iss 4, 1st June 2017, pp. 522-531

262 Jonathan Bell, '*21st Century House*', 1st April 2006 , pp. 22, 25, 26

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