Misha Khaliq and Najeeba Ramazan

POST PANDEMIC ARCHITECTURE

What will the post pandemic housing model evolve into?

Thesis:- Post Pandemic Architecture

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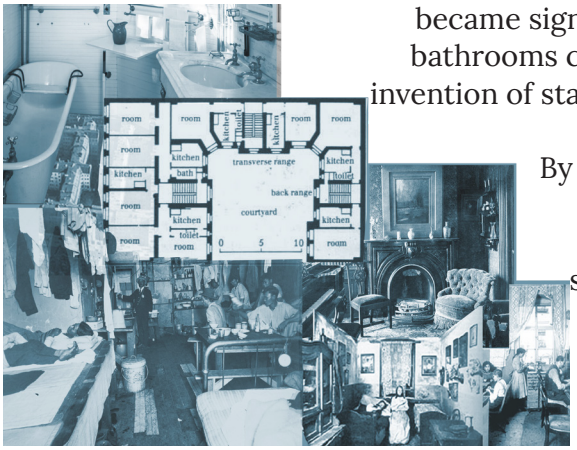
HISTORY TIME-LINE

19TH

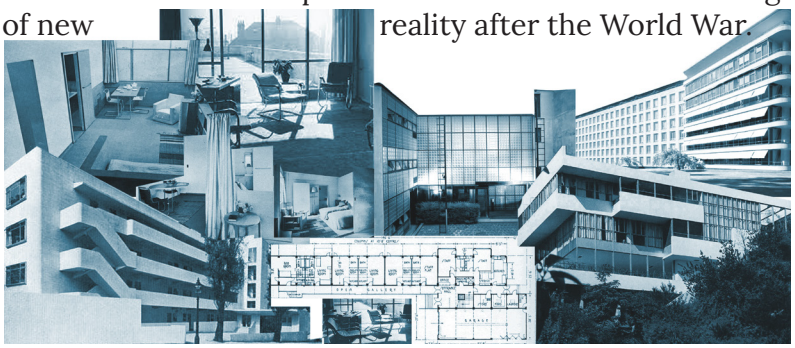
19th Century led to sanitary reform movement, the cities became a real focus and the risk of home making one ill became significant. Modern bathrooms came to life with invention of stationary bathtub and sink.



By the end off 19th century good ventilation and sunlight became the need of each house. Urbanisation led to Tenements for poor.

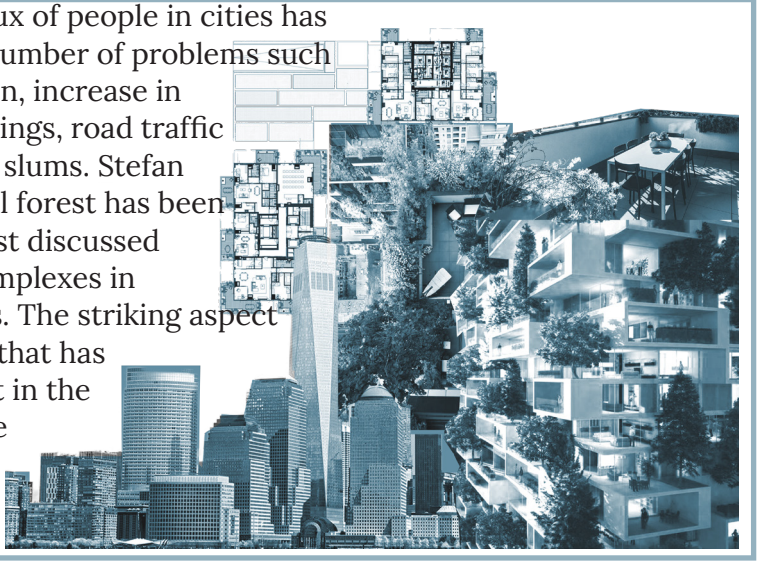
20TH

The first half of the 20th century gave rise to many new typologies of buildings such The modernist movement in the early twentieth century happened at a time when the idea of healing by symbolic association was in practice. Specialist institutions such as sanatorium started appearing until the mid twentieth century. Lawn Road Flats completed in 1934 were an attempt to rethink architecture in the light of new reality after the World War.



21ST

This large influx of people in cities has resulted in a number of problems such as densification, increase in high rise buildings, road traffic and growth of slums. Stefan Boeri's Vertical forest has been one of the most discussed residential complexes in previous years. The striking aspect of the project that has also brought it in the limelight is the increase in biodiversity.



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Abstract

The current situation has propagated changes in human behaviour and the use of conventional spaces. The spaces that were previously not essential have now become a necessity in our homes, forcing architecture to rethink the new housing model. This thesis will begin by exploring past pandemics to better understand their causes, how the architecture shaped in relation to it and the lessons we need to carry forward.

It helps establish the foundation for our research as we will look into the case studies of housing in the 19th and 20th century and apprehend how a crisis leads to innovation.
The research will also shed light on the major challenges the residential architecture faces and review the features that are necessary for creating a resilient environment. The awareness of how diseases spread is vital for creating an environment that counters and prevents the transmissions of microbes.

The spaces we inhabit and work in can have a significant impact on our mental and physical health. The main objective of this thesis is to analyse and explore what post pandemic architectural housing will look like. This will be achieved by carrying out interventions in existing architectural houses (19th, 20th and 21st Century), whilst also proposing new housing models based on the survey and needs of users.

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Introduction

Across the ages, disease outbreaks have wreaked havoc on humanity, sometimes transforming the course of history to ending entire civilizations. Through this experience we have been able to identify their origin and causes but we are incapable of predicting when the next one will come along. Hence, it is important to know the possible sources and work on prevention of future outbreaks.

Diseases have driven change in architecture throughout history. In response to bubonic plague, cities cleared slums and opened public spaces and widened the boulevards. Yellow fever led to indoor plumbing, tuberculosis led to open air sanitariums and other pandemics inspired modernist building and a minimalist future which leaves little to no space for dirt and germs. History has been a great example of bringing to the spotlight the relation architecture has with health. With the help of well designed architecture, we can slow down or even contain the process that helps spread infectious diseases and create environments that are resilient.

It is a cliche that necessity is the mother of invention but a crisis really steps it up and pushes everything up a notch. Looking at the present times, there has been a recent shift in the paradigm and the needs of people are evolving. Architects have started to deinstitutionalize spaces that they were inclined towards institutionalising just a century ago. As compared to previous centuries, we are better informed of what a healthy environment should be and are better equipped to deal with the problems head on but the world we were slowly building towards has been put on halt and we are forced to face the issues altogether.

The question we are faced with is that are our buildings responding to the newly faced issues?

This thesis explores the pre pandemic housing model and analyses in depth to better understand the features that should be retained and how design can adjust to the growing needs of users.

Methodology

The research will be carried out by reading and analysing information from books, journals and reports about past pandemics. The case studies on housing typologies will mainly be from Europe as we direct our research in that particular region. A survey will be conducted to better understand the problems people faced during the current pandemic and how we can overcome them using design interventions. The survey will help us form our personas for whom we will design and revamp those said typologies.

Research question

What will the post pandemic housing model evolve into?

01. PAST PANDEMICS AND THEIR IMPACT ON ARCHITECTURE IN THE 19TH AND 20TH CENTURY

Architectural design and health have a very deep correlation, consequently shaping the places we live in. The solutions that were designed in response to past pandemics are now an important part of our built environment. This chapter will highlight the vital role architecture has played in slowing the spread of diseases over the centuries.

INTRODUCTION

Pandemics can be defined as epidemics of an infectious disease that spreads through the regions affecting a certain number of people. Throughout history, we have seen multiple pandemics that have killed millions of people.[1]

Historically, disease and urban life are intertwined, and together they have had an extreme impact on people, architecture and the design of cities. Epidemic illnesses are not only a product of biology, the social and cultural phenomena also contribute to the problem.[2]

This chapter will highlight the vital role architecture has played in slowing the spread of diseases over the centuries. While the impact of Covid 19 on the urban environment may feel unparalleled, the reality is that modern day cities are in part, the result of history's pandemics. Looking at history can help us better understand how past architects dealt with pandemics, as a way to help us prepare for the future.

The recent virus outbreak has revealed our global vulnerability which is evident by the increase in infections. Our way of living has been rapidly reorganised as a response to the crisis. Already various predictions have come forth that this may be the end of social life and cities as we know it. However, people have been drawn to cities for thousands of years due to their economic and cultural roles, despite countless pandemics and the need to socialise is intrinsic to our nature.

The houses we live in today, the cities we walk through have gone through considerable changes. We will refer to significant examples of 19th century and 20th century housing and public spaces to observe how they evolved in the light of past epidemics.

1. Porta, Miquel, ed. (2008). Dictionary of Epidemiology. Oxford University Press. p. 179.
2. Part 1: Epidemics, Architecture, and Urban Design: Historical and Future Implications

1.1. IMPACTS OF PAST PANDEMICS ON ARCHITECTURE

Throughout history, architecture has been shaped by the health crisis. Pandemics and wars have been catalysts for quantum leaps in medicine and technology.

Disasters wreak havoc and we fight with our all, as if we are in a battle. Desperate responses to a catastrophe also lead to sinister benefits - and architecture is certainly a recipient. The architecture as a result of the health crisis has a form of wicked originality, because the parameters are always new and unknown, and require new solutions to conditions never experienced before. [3] In this chapter, we will outline a few major past pandemics that have affected society and the built environment.

How we design and inhabit spaces has played a vital role as a defense against epidemics, for centuries. As early as 400 BC, Hippocrates hypothesized that poor physical environments such as bad air and water caused illnesses and spread of diseases.[4] Ancient Greeks emphasised social and emotional health in their designs whereas Romans were more concerned about infrastructure and finding ways to deliver clean water and sanitation to its citizens. From Hindu traditions of vastu shastra and Chinese feng shui, every civilization took into account ways of building in relation to health and wealth.

Dense settlements and connection to the outside world - the features that define cities - can also turn fatal. In 430 BC, Athens was struck with plague, concurrently when it's citizens were avoiding the spartan army and had to live in more closely packed conditions than usual. It was believed to have originated all the way from Ethiopia, killing tens of thousands in Athens, and probably causing their defeat in the Peloponnesian war. One millennium later, another plague hit Constantinople, ending the emperor Justinian's attempt to recondition Rome. Justinian's plague, which also came to be known as the black death, was the first recorded occurrence of the 'Yersinia pestis' bacteria. Cities were always particularly endangered because they served as entry ports, also allowing in diseases that further spread due to urban proximity.[5] This highlights how closely packed settlements and interactions beyond the borders can aggravate the spread of disease leading to disastrous outcomes.

Subsequently, in the 14th century, the bubonic plague wiped out one third of Europe's population killing more than 20 million people. The new concept of quarantine became the only form to escape the plague. Isolation and human distancing changed the urban approach of the 14th century renaissance. Medieval cities expanded as a way to create less cluttered spaces. Slums and overcrowded spaces were cleared out to minimize the spread of disease.

Natural ventilation became significant, buildings and streets were being designed to be less crowded and have more open green spaces for the public. In addition to all of that, a quarantine facility was introduced, which was a form of modern day hospitals.[6] Even before people had scientific knowledge of microorganisms, it seems they knew the

3. "The Architecture Of Crisis" 2021
4. "Design In The Age Of Pandemics". 2020
5. Glaeser, Edward "Cities And Pandemics Have A Long History". 2020. City Journal.
6. Mrad, Joelle. 2020. "Architectural Changes In Europe After Bubonic Plague - RTF | Rethinking The Future". RTF | Rethinking The Future.

significance of creating spaces that prioritised health.

When tackling a lethal outbreak, we instinctively know to separate the infected from the rest of the people. When a medieval city was struck with plague, its response was to shut its gates to mitigate the spread of the disease. In 17th century Europe, people would be restricted to stay in their homes, and made to appear in the windows during inspections to verify their presence.[7]

The term quarantine - originating from the latin word for "forty days" - refers to regulating the movement of people or goods. Such measures are known to be taken in Venice during the middle ages to alleviate the spread of the bubonic plague. They required ships coming from affected areas to anchor for 40 days before the crew could disembark. Quarantine acts as a shield in space for a certain period of time, preventing us from coming up against it immediately. That being said, lockdowns are difficult to maintain for a long period, making it crucial to search for long term solutions.[8]

Humans have looked at physical spaces as a way to cure and treat illnesses for a long time. Architects redesign neighbourhoods, architecture, infrastructure as well as interiors as a way of minimizing the spread of disease. With new diseases like Covid-19 and no vaccines, we are forced to go back to the old ways : social distancing, quarantine, isolation etc. Spaces in relation to epidemics aren't just about distancing yourself, quarantining or putting space between you and whatever the danger is, it is also a design problem.[9] "When you consider a more holistic definition of health—its physical, mental, social, and emotional aspects—you realize how significantly urban designs have been impacted," says Mohammad Gharipour, highlighting Architecture and well-being go hand in hand.[10]

New evidence indicates that epidemics have become a recurring problem only after the inception of agriculture and animal husbandry, around 10,000 years ago. With the prevalence of infectious diseases, hygiene became a key factor considered in design. It transformed urban planning long before it eventually influenced architecture as well.

Looking around most neighbourhoods and cities, there is an evident result of how humans reacted to early diseases and redesigned the physical spaces that we now use. [11]

It is understood that epidemics have come about as a direct consequence of urbanization. The close proximity between people is what enables viruses, bacteria and parasites to propagate.[12] According to Scott Wiener in the article "A Backlash Against Cities Would Be Dangerous", crowding is what increases the spread of contagion, rather than density. Crowding refers to lack of adequate housing where inhabitants are forced to live in tight quarters. This proximity is what is bad for public health, not density in cities, where people can

7. Edelson, Zachary "Plague Architecture: How Designers Have Fought Disease Across The Ages - Architizer Journal". 2014. Journal.
8. Heathcote, Edwin. "The Architecture Of Health: How Buildings Are Designed For Wellbeing". 2018.
9. Carr, Sara Jensen. 2020. The Topography Of Wellness: Health And The American Urban Landscape.
10. "Building Health: The Link Between Architecture And Well-Being -". 2020.
11. Carr, Sara Jensen. 2020. The Topography Of Wellness: Health And The American Urban Landscape.
12. Bagnato,"Microscopic colonialism" 2021

live in uncrowded homes with easy access to services and commercial corridors.

To blame density for the havoc caused by coronavirus is to overlook all the factors that are really causing all the suffering within communities in such crises.[13] For this reason, good, sanitary and uncrowded housing conditions are a critical factor in determining how an epidemic spreads.

In the 19th century, a cholera outbreak was believed to be caused by a lack of fresh air, leading to significant changes. For instance, in London and Paris, modern sewer and sanitation systems were introduced. In New York, Frederick Law Olmsted's central Park was inspired by it. Wider streets, sidewalks, parks and squares came to be. In 1853 when Baron Haussmann was appointed by Napoleon III to renovate Paris, the reimagination brough light and air into the city centre. The neighbourhoods that were unsanitary and overcrowded were demolished.

Following that, hospitals also began to be designed using more rational methods, with long extending wings so that wards could be easily naturally ventilated. The practice of numbering of houses and detailed mapping of every building in urban neighbourhoods started as a result of the outbreak of plague in the 18th and 19th centuries in Paris. As the modern era commenced, rationalism and minimum space standards were established leading to hospitals and all public buildings to be designed according to precise tight-space standards.[14] This marked the conception of health oriented design.

This perspective is not only of the fight against infectious diseases, but of an overall response to the emergence of the social question in the rapidly industrializing society. The first International Hygiene Congress was organized in Paris in 1875. Hygienists and urban planners have a role in the debate on urban organization in the late nineteenth century.

In Italy, the first health law dates back to 1888. In Europe, legislation at the end of the 19th century promotes the development of new types of municipal services and infrastructures for health prevention, such as public toilets and baths, modern sewers and aqueducts, healthy popular residential buildings, hygienic rehabilitation of historic districts.

At the beginning of the twentieth century, architects started incorporating sanitation and hygiene in their design.[15] As Lubell writes "20th century tuberculosis, typhoid, polio and Spanish flu breakouts prompted urban planning, slum clearance, tenement reform, and waste management". It instigated modernism itself, with introducing airy spaces, separating residential and industrial zones, having cleaner surfaces and a great emphasis on sterility. Architectural Modernism (1920-1970s) is often reduced to affirming purity of form, modern materials, strict geometries and a rejection of ornamentation.

The transformation in ideas and innovation in architecture through the times shows how we have historically steered through consecutive waves of hysteria about the well-being of our cities, homes and the future of buildings. Heathcote, writer of The architecture of

13. Scott Wiener, Anthony Iton. 2020. "A Backlash Against Cities Would Be Dangerous". The Atlantic.
14. Wood, Sam, and University Kent. 2020. "Architecture And Pandemics". News Centre - University Of Kent
15. Bagnato,"Microscopic colonialism" 2021.

health says "From panics about plagues and fire through the moral repulsion against the Victorian slums, the history of architecture can seem like a series of reactions to health crises embodied in buildings."

Modernist architects had the viewpoint that clean, hygienic spaces were necessary for treatment. Presence of large windows and balconies- to allow in sunlight and fresh air- are traits commonly observed in buildings from the 1920s and 1930s. The modern movement was a reintroduction of the classical archetype of a healthy city.

Early modernists created domestic architecture that could be comparable to hospitals, with health at the core of the design. Features like merging the interior with the exterior green, white tiles and chrome and glass aesthetic were commonly adapted to create a clinical precision in houses.[16]

Our research has shown us that epidemics have had a strong impact on architecture and people, leading to design changes on smaller and larger scales. It's too early to predict what kind of architectural changes will come from the recent outbreak but we are reminded again of sterility and hygiene being the most important factor. It brings us to the realisation that to counter epidemics we need to identify the real problems with our architectural spaces and way of life, and attempt to solve those.

1.2. THE ROLE OF PAST PANDEMICS IN SHAPING ARCHITECTURE IN EUROPE, UK AND US IN THE 19TH AND 20TH CENTURY

This topic will explore the design interventions through the lens of epidemics, starting from the industrial revolution to date. Due to epidemics like cholera, typhoid and tuberculosis, the burgeoning field of urban planning used health as inspiration for innovative ideas in the 19th century. Architects in the modern 20th century era considered their buildings as a type of medicine.[17]

The 20th century brought pandemics of tuberculosis, influenza and Spanish flu, worsened by the severity of the First World War, leading to a new emphasis on cleanliness in design. Le Corbusier prioritized sunlight and ample circulation of air in buildings. His concept of urban housing, high-rises with balconies set within a park-like landscape influenced the design of public housing for decades.

To further enhance our insight into the context around diseases and their impacts on architecture, we will refer to significant examples of 19th century and 20th century housing and public spaces and observe how they evolved.

1.2.1. Effects of epidemics during the 19th century

The 19th century was the century during which urbanisation, industrialisation and population explosion happened. Society evolved from living in rural communities to urban areas. Before the 19th century, it wasn't widely understood

16. Heathcote, Edwin. "The Architecture Of Health: How Buildings Are Designed For Wellbeing". 2018.
17. Budds, Diana "Design In The Age Of Pandemics". 2020.

how germs pass, habits such as sharing a glass with a stranger and spitting in public among crowds was seen as normal and not unsanitary. After the outbreaks, the behaviour evolved and with that so did the architecture, to some extent. Some of the most important features in the cities and homes as we know now, were designed in response to past epidemics. The cholera outbreak in the 1800s spurred a sanitary reform movement to clear the streets of waste and infected water. This resulted in straighter and wider streets to enable the installation of underground pipe systems for clean drinking water and sewage infrastructure.[18]

In the early 19th century, people believed in a theory called miasma, which hypothesized that diseases floated through the air and water. The fear that this generated only increased with the industrial revolution when cities became densely populated and housing conditions became more crowded. Towards the end of the 19th century there was pressure to design buildings with good ventilation and exposure to sunlight.[19]

For a long period of time in American history, the city was seen as a breeding ground for diseases. New York's central park was proposed by Frederick Law Olmsted to be the 'lungs of the city' during the tuberculosis outbreak. He held the view that green spaces had medicinal qualities, which he reflected in his 1868 master plan for Riverside, Illinois, a green suburb that was regarded as a healthier alternative to urban life.

London's streetscape shows the evident remains of its previous battles with the epidemics. The odd patches of open land and car parks in packed areas of a city were believed to be plague pits. Similarly, the victoria embankment (spacious boulevards) that runs along the River Thames is also a result of how London's urban area was revised to prevent the threat and spread of disease.

In the midst of the 19th century, there were deadly outbreaks of cholera that killed thousands and the deaths were reasoned to be due to the untreated stench of human waste and the industrial fumes that were choking the city's environment. By the mid of the 19th century the connection between waste and health had been understood and the municipalities of the world - London, Paris and New York began to build sewer systems to flush the wastes from the city. Hence, urban intervention was demanded and as a result the sewage system was refurbished.

a. Housing in 19th century

Housing ranged from large homes that accommodated single family and several servants down to small working class houses which were shared by large families. After the industrial revolution, he population boomed across Britain, which led to congested houses.

"The 19th century is when the city became the real focus of infectious disease, for many people living in any industrial center, the risk of your home making you ill was very significantindeed." says Emily Sargent.

18. Arnsten, Emily "Six Epidemics From American History Show How Urban Design Affects Our Health". 2021.
19. Carr, Sara Jensen. 2020. The Topography Of Wellness: Health And The American Urban Landscape.

a.a. Victorian houses

Early Victorian houses became popular in the middle of the 19th century when Queen Victoria came to throne. In deprived areas, houses were built back to back and in the narrow courts. They suffered from overcrowding and had limited sanitation. Access to water as well as the living conditions were terrible which led to spread of diseases such as cholera.[20] Later these areas became slums and were cleared.[21] They were an object of significant transformations since the Second World War.

While on the other side there were increases in streets and carefully wrapped houses that were an epitome of comfortability for the middle and upper class. The houses for the middle class and upwards had a place for servants, employed for the considerable labour required to keep the house clean and well stocked.

The properties featured internal decoration, flushing water closet and gas lighting. Mass production at that time resulted in more furniture and furnishing.

Ground floor plan

First floor plan

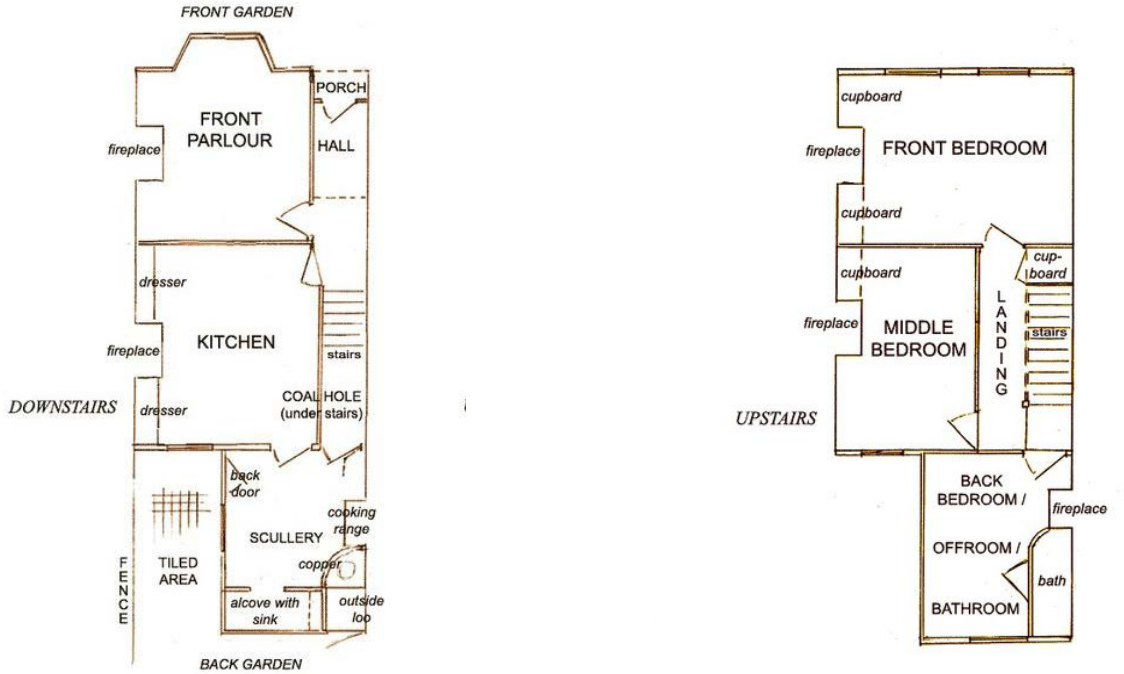


Fig 1. Typical Floor plan of downstairs rooms of a terraced house on a Victorian housing estate as it was in the early 1900s.[22]

20. Modern, General. 2021. "The Evolution Of The British Home: From The Georgian Era To The Present Day". Historyextra.
21. Marshall, John; Willox, Ian (1986). The Victorian House. London: Sidgwick and Jackson Limited
22. "Floor Plans For A House On A Victorian Housing Estate". 2021

The floor plans of Victorian houses reflect the standard of living and the new technologies that were introduced throughout the periods. Victorian houses had rear extensions that were attached to the back of the house which contained rooms and separated it from the main living quarters. The houses were generally built in terraces or as detached houses. Small gardens were included as a form of nature by suburban domestic ideals. Private porches of the houses have existed long before the 19th century for sleeping as a way to escape summer heat but they became common towards the end of 19th century, when countries were hit by tuberculosis epidemics. Sunlight and fresh air were known to be the best cure for these diseases, before antibiotics.

Interior architectral features

• Bathrooms

Before the 1850s, the three parts of bathrooms were divided into separate rooms. By the mid 1800s knowledge and technology advanced, thanks to the industrial age that supplied both the problem (overcrowding due to lack of space leading to waste) and the solution (modern plumbing and flush toilets).

By the late 1800s the modern bathrooms came to life with the invention of stationary bathtub and sink, flush toilets, indoor plumbing and pipes. In wealthier homes, the toilet was often in a room by itself or in a corner. Unfortunately, that wasn't the case for the cities with smaller spaces such as Brooklyn. Very few houses in Brooklyn row houses had the luxury of a separate toilet closet.

The bathroom usually had wainscoting made of tiles or board which was then later replaced with white tiles, which were the best sanitary materials available. The glazed surfaces were perfect for frequent and easy cleaning. The Victorians were very particular about their privacy, so bathrooms had stained glass windows. [23]

Fig 2. Late 19th century bathroom at the Codman House.

23. Morris, Suzanne. 2016. "From Pakistan To Brooklyn: A Quick History Of The Bathroom". Brownstoner.

• Living Rooms

In western architecture living rooms were named differently, each serving a slightly different purpose. The earliest name we know was 'parlour' which was by definition a reception room and public space found in large formal homes across different historical periods. Evolution of parlour was a relatively new invention as most of history, humans lived in tight-knit family groups which led to a shared lifestyle. This communal lifestyle manifested as large rooms where people came together to socialize.

First parlour or now known as living rooms started appearing in domestic English homes. Some parlour rooms were considered to be a symbol of social status as it proved that a person had enough wealth to devote an entire room for nothing but entertainment of guests. The room became a receiving room for guests and it was decorated with the finest furniture and ornaments. [24]

By the end of the 19th century, people moved to cities rather than houses. Only few people had the luxury to afford an apartment with private rooms for formal usage. Gradual changes overcame women as well, access to education and job opportunities opened due to WWI, most women didn't have the time to be occupied in parlours appearance.[25]

Towards the late 19th century, public health concerns that had initially concentrated on clean water and sanitation shifted their attention to the substandard state of working-class urban housing that correlated with a high number of tuberculosis and respiratory disease cases. In 1878, a paper presented by French architect Emile Trelat emphasized on the need to improve the housing standards for the fast growing french urban working class. His paper referred to tuberculosis statistics to demonstrate and prove that a lower rate of infection was observed among the population that had been rehoused in upgraded 'hygienic' dwellings.

These efforts by public health to improve social housing were taking place around the same time when there was the emergence of architectural modernism. Both were as a result of competitive industrialisation in European and American societies.[26] However, social housing, in Italy and in many European countries, often had the toilet outside the house until the Second World War, on the balcony or in the courtyard, shared with several families.

Fig 3. A look inside 1800s Victorian Living room

24. Room, 20. 2018. "A History Of The Living Room". Fella Design.
25. "Rancho Los Cerritos Historic Site". 2021.
26. Campbell, Margaret. 2005. "What Tuberculosis Did For Modernism: The Influence Of A Curative Environment On Modernist Design And Architecture". Medical History 49 (4): 463-488.

a.b. Tenement housing

The term "tenement house" first came about in America around the mid nineteenth century. Tenement referred to large buildings that contained many small spaces, homes equipped with the minimum standards of safety, sanitation, and comfort that could be rented out.

With the growth of cities in the nineteenth century, the disparity between the social classes of the rich and poor also grew. There was also an increase in immigration, leading to overcrowded housing with poor sanitary conditions to accommodate the growing population. Eventually the tenements gained a reputation as slums due to their poor living conditions. [27]

According to Wright in his book ' a social history of housing in America' he explains that the term tenement in English means " an abode for a person or for the soul, when someone else owned the property."[28] On the other hand, at the beginning of the 19th century, slum was actually used as a slang word for a room, however by the mid 19th century it had evolved into a word referring to dwelling occupied by members of the lowest class of society.

The emergence of tenement houses in the 1830s came about as a result of the conversion of warehouses into low cost housing meant to accommodate Irish and black workers. Furthermore, existing large homes were subdivided with new structures to create rear houses. These rear houses replaced the traditional backyards and gardens and were no healthier than the front house as they often housed several families at once. However, this strategy was still insufficient to meet the housing demands, leading to the period of the tenements.

Despite the unpopularity of tenement housing, it continued to grow. By 1850, in New York and Boston, each tenement accommodated approximately 65 people. Around this time the 'railroad tenement' was introduced which consisted of a solid, rectangular block with a narrow alley in the back. These blocks contained 12 to 16 rooms, each about 6 feet by 6 feet, that would house around four people.

The rooms were generally in poor condition with no exposure to direct light and proper ventilation except for those that faced the street. The occupants lacked any privacy. The hygiene conditions were very poor as they would typically have open sewers, uncollected garbage and only a single toilet at the back of the building.

27. Mauch, Jason, 2018. "Industrialism." Infobase Publishing. Archived from the original on 14 May 2018 – via Google Books.
28. Wright G. Building the dream—a social history of housing in America. Cambridge, MA/London: The MIT Press; 1998.

Additionally, fire was a major threat in these settlements as wood construction was common, and heating was done with coal and wood. Due to the series of tenement fires in 1860 in New York, terms such as death-trap and fire-trap were used to describe the housing.Fig 4. Sleeping quarters

- Houses that were once for a single family were often divided up to pack in as many people as possible, as this 1905 photo shows.

Jacob Riis/Bettmann archive

Towards the end of the 19th century, 'dumbbell tenements' were introduced. These consisted of a front and rear building connected by a long hall. They typically had five stories with a basement and no elevator. Similar to the rest of the tenements, these were also unaesthetic and of poor quality. Garbage was often thrown down the air shafts, and natural light only reached the first floor hallway. They had one or two public toilets and a sink causing very unsanitary conditions as the buildings housed a large number of families.[29]

Tenement housing can be observed in several other cities in history such as Edinburgh, Glasgow, Berlin, Dublin, Buenos Aires, Poland and even Mumbai. Similar models are developed in industrial cities in Italy, where the corridor is often replaced by an open continuous balcony, the so-called "railing houses"

In this case study we will look at the tenement housing in Berlin in more detail. The term used in German is "Mietskaserne" which means rental barracks, especially known to be present in the city of Berlin. In 1930, Werner Hegemann referred to the city as the largest tenement city in the world.[30] Between the period 1860 to 1914, and particularly after the german unification of 1871, there was a great increase in population which led to the development of tenements of about five stories high, arranged in a broad ring encircling the old city center known as the wilhelmian ring.[31]

29. "Chapter 1: Housing History And Purpose" 2021.
30. Hegemann, Werner "Das steinerne Berlin"1930
31. Girouard, Mark. 'Cities and People: A Social and Architectural History' 1985,

The buildings had front, rear and cross blocks creating several courtyards that were large enough to allow a fire truck to turn around within them. They were built in the industrial location of Berlin, and were therefore affected by noise and other nuisances.[32]

Among the infamous tenements in Berlin was the Gesundbrunnen[33] which at times accommodated 2000 people and required its own police officer to maintain order.[34] Between 1901 and 1920, a clinic in Berlin carried out an investigation on the living conditions of its patients. The photographs documented revealed that many of them lived in small dwellings such as damp basements, spaces under stairs and apartments with poor light and ventilation.

The apartments in the Wilhelmian Ring were very small and consisted of only one room and a kitchen. A common internal corridor was used to access each of the rooms directly, which even the Berlin Architects' Association deemed as unsanitary and detrimental to family life. A survey done in one area in 1962, showed the inadequacy of sanitation whereby only 15% of apartments had both a toilet and a bath, 19% contained only a toilet and 66% used shared toilets.[35]

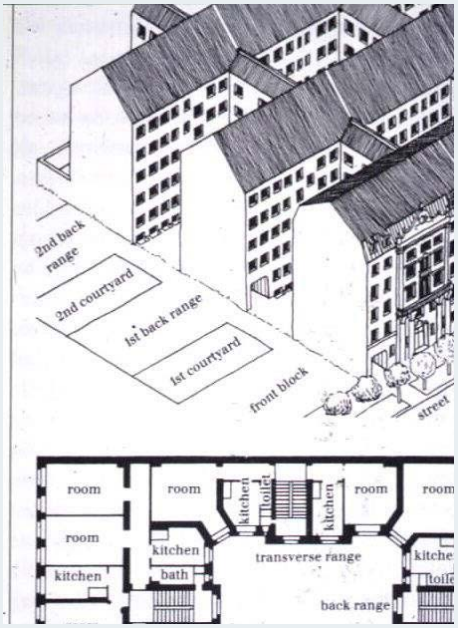


Fig 5. Tenement houses of the Grunderzeit, circa 1880, Berlin

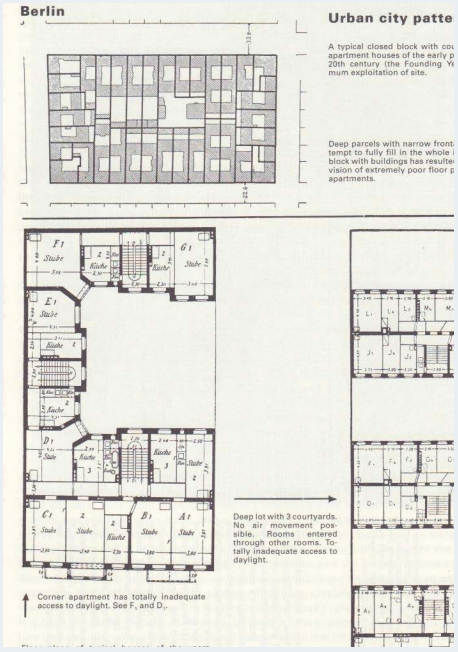


Fig 6. "Berlin Tenement Early 20Th Century". 2013. Misfits' Architecture. https://misfitsarchitecture.com/2013/07/20/

This case study will be referred to in chapter 5 as a model for typical 19th century apartments.

32. Elkins, T. H. with Hofmeister, B. "Berlin: The Spatial Structure of a Divided City,"198
33. Hake, Sabine. "Topographies of Class: Modern Architecture and Mass Society in Weimar Berlin," 2008
34. Reese, Dagmar. Growing Up Female in Nazi Germany, 2006.
35. Elkins, T. H. with Hofmeister, B. Berlin: The Spatial Structure of a Divided City, London/New York: Methuen, 1988, ISBN 0-416-92220-1

1.2.2. Effects of epidemics during the 20th century

The first half of the 20th century gave rise to many new typologies of buildings such as open-air schools, vacation residences, social housing, hotels and gyms. This new architecture embodied the modern environmental ideals of well being that utilised sunlight, air, water and nature in design.[36] This shift in design was prompted by outbreaks of spanish flu and tuberculosis.[37]

Statistics on the spanish flu of 1918 reveal that the difference in socioeconomic status of the populations was a crucial factor in determining those who were more susceptible to the disease. In Connecticut, US, it was found that the newest immigrant group - the Italians - were most affected, while in Rio de Janeiro, it was the occupants of the shanty settlements around the city's edge that experienced the worst losses. Paris presented a conflicting result at first because the numbers showed that the highest mortalities were occurring in some of the wealthiest neighbourhoods. However, statisticians soon came to the realisation that the deaths were not of the owners of the grand apartments, but of their overworked maids who slept in the cold attic rooms. Globally, it was seen that the groups that were hardest hit were also the ones most likely living in poor crowded conditions, with poor access to health care and proper diet.[38]

As mentioned earlier, another epidemic which had a profound impact on architecture was Tuberculosis. After the first world war, illnesses were a driving factor in transforming architecture. Designers started integrating form with social and curative purposes.[39]

Historian Margaret Campbell observed that many of the new buildings had features such as expansive windows and open terraces. These features were originally inspired from sanatoria that were created to treat illnesses like tuberculosis.

The modernist movement in the early twentieth century happened at a time when the idea of healing by symbolic association was in practice rather than the use of scientific methods. Modernism was based on meeting practical needs and exploring new materials and technologies such as reinforced concrete and steel, which were suitable for a more hygienic lifestyle. [40] Following the epidemic outbreaks, the new homes designed consisted of good quality spaces with indoor bathrooms and toilets, in addition to fitted kitchens.

The private homes had larger rooms, in Great Britain after the Parker Morris report which highlighted the significance of spaces. This period also introduced an L shaped living arrangement, where the kitchen became integrated with dining space. Fireplaces were removed and more appliances were introduced.

a. Sanatorium movement in the 20th century

Specialist institutions such as sanatoria

36. Borasi, Giovanna, and Mirko Zardini. 2012. "Demedicalize Architecture". Places Journal, no. 2012.
37. Simon, Stephanie "Architects Of The City Planned Ahead For More Pandemics Long Ago". 2021.
38. Spinney, Laura. 2021. "The Flu That Transformed The 20Th Century"
39. Blumberg, Shirley "Epidemics, Architecture And City-Building". Canadian Architect.
40. Campbell, Margaret. 2005. "What Tuberculosis Did For Modernism: The Influence Of A Curative Environment On Modernist Design And Architecture". Medical History 49 (4): 463-488

and asylums started appearing up until the mid twentieth century. They were intended for isolating people from the rest of the community where they could be treated under special settings for medical conditions such as tuberculosis and lunacy.

Although the different institutions followed different systems of treatment, certain architectural features were common across most sanatorium designs. These were deep verandas, balconies, covered corridors and garden shelters that were fit out with reclining seats for the mandatory two hour rest period in the open air.[41]

The Purkersdorf Sanatorium, built in the wooded areas in the outskirts of Austria, was Josef Hoffmann's first major architectural work. He was influenced by Kraft-Ebing's interest in the healing power of light, air, nature, simplicity and rationality. The facilities had very minimum ornamentation and were aimed to be used for new diseases such as nervousness or hysteria.[42]

On the other hand, Otto Wagner's chapel for the hospital am Steinhof, merged minimalist 'hygiene' design with subtle decorative elements. Alvar Aalto's Paimio Sanatorium (Figure 4) located in Finland was a pioneer design with it's technical innovations, optimal use of daylight, heating and natural ventilation. Aalto also structured the patient's social interactions and the design details of the wards that facilitated cleaning. The functions of the sanatorium were addressed with great rigour, as Aalto's intention was for the building to function as a medical instrument in itself.[43]

Meanwhile in the UK, Finsbury Health Center, designed by Berthold Lubetkin's gave a similar impression of hygiene with white tiles and an elevated structure symbolising an idea of freely accessible healthcare.[44]

Fig 7. Federico Covre, Alvar Aalto, Paimio

Sanatorium, 2021. Accessed 27 April, Divisare.

b. Housing in 20th century

Eventually, architects started applying these concepts in the domestic as well. Some of the signature features of modernism such as flat roofs, balconies and terraces can be observed in these houses. In the early twentieth century, it was recommended to acquire the health benefits of sunbathing. While it was a popular architectural demand to have such outdoor spaces for people to acquire fashionable tans, the less glamorous purpose was for the treatment of rickets and tuberculosis and for improved general well being.[45]

41. Campbell, Margaret. 2005. "What Tuberculosis Did For Modernism: The Influence Of A Curative Environment On Modernist Design And Architecture". Medical History 49 (4): 463-488
42. Topp, Leslie. "An Architecture for Modern Nerves: Josef Hoffmann's Purkersdorf Sanatorium." Journal of the Society of Architectural Historians 56, no. 4 (1997): 414-37. Accessed April 26, 2021.
43. Ellis Woodman, Tom Wilkinson, Christine Murray, AR Editors, AR Editors, and Lili Carr. 2016. "Revisit: 'Aalto'S Paimio Sanatorium Continues To Radiate A Profound Sense Of Human Empathy' - Architectural Review". Architectural Review.
44. Heathcote, Edwin. "The Architecture Of Health: How Buildings Are Designed For Wellbeing". 2018
45. Campbell, Margaret. 2005. "What Tuberculosis Did For Modernism: The Influence Of A Curative Environment On Modernist Design And Architecture". Medical History 49 (4): 463-488

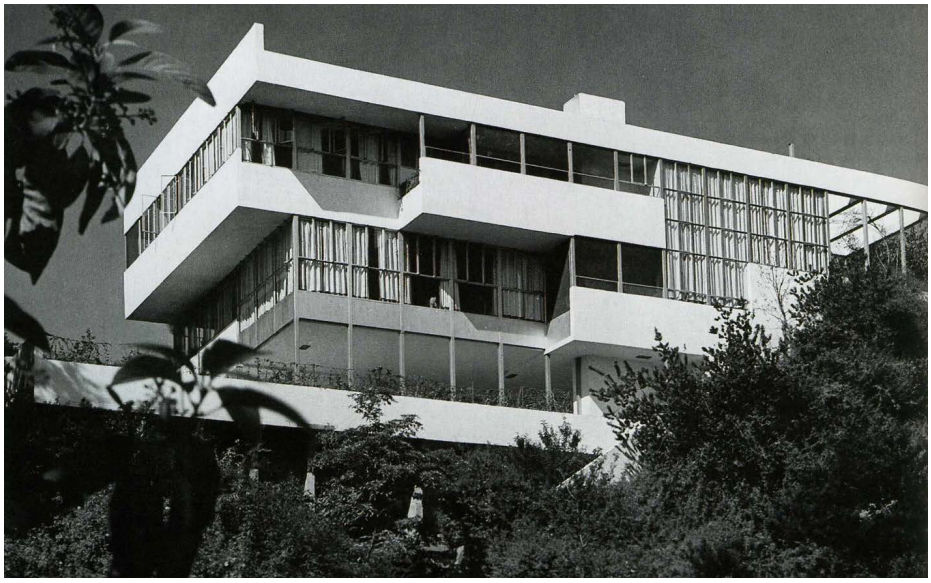
b.a. Lovell Health House, by Richard Neutra

This project had a significant impact on the advancement of modern residential design. The residence was designed to specifically cater for the active, health conscious Lovell family in the hills of Los Angeles.

The house features pools and panoramic terraces with views of the city. The terraces are used for sunbathing and outdoor sleeping and there are dedicated areas for outdoor gym, optimised diet kitchens and therapy spaces.

Neutra's inspiration from Le Corbusier is evident in the style and aesthetic of the building that has stark white walls and ribbon windows that allow natural light into the interior spaces.[46]

Fig 8. "Gallery Of AD Classics: AD Classics: Lovell House / Richard Neutra - 2". 2021. Archdaily.



b.b. Maison de Verre, Paris

Around the same time, Pierre Chareau's Maison de Verre in Paris, played a pivotal role in modernist architecture. The residence was built for a gynaecologist, and contained consulting rooms as well as a private apartment.[47]

The interior spaces are separated by movable screens that can slide, fold or rotate. The main facade is made up of glass blocks that allow in sufficient natural light, and it has movable traps for ventilation. Both these houses are important examples of application of health consciousness in the design of homes

46. Kroll, Andrew "AD Classics: AD Classics: Lovell House / Richard Neutra". 2011. Archdaily.
47. Heathcote, Edwin. "The Architecture Of Health: How Buildings Are Designed For Wellbeing". 2018

Fig 9. Maison de Verre, Parigi, 1928 “Il Modernismo Senza Tempo Della Maison De Verre”. 2020. La Citta Immaginaria.

Interior architectural features

• Bathrooms

By the beginning of the 20th century, bathrooms were all about cleanliness and privacy. The New Tenement law of 1901 in the U.S.A. stated that all new apartments must include indoor toilets and bathtubs. Since sanitary facilities were not easily available for poor people, especially after thousands of immigrants flocked to these cities, public baths were established.

By the end of world war I, the average bathroom in most American homes became what they look like in the present day. White tile bathrooms were considered to be highly sanitary but by 1920, it became popular to start having wallpapers and patterns in bathrooms to give it a more feminine look.

With time, when automobiles became common and people started moving out in the suburbs, commutes became longer which also meant rushed ablutions and hence showers came into use by the 1930s.[48]

After the housing boom post World War II, it was no longer acceptable to have only one bathroom in the middle-class American home, powder rooms became the need of the hour, for guests, mostly located downstairs in the entrance. Powder rooms or commonly known as half baths on the ground floor were a result to prevent the spread of diseases.

48. Morris, Suzanne. 2016. “From Pakistan To Brooklyn: A Quick History Of The Bathroom”. Brownstoner.

In the early 20th century, it was common to have someone delivering either coal or ice on a daily basis. This meant, everyday, at least one delivery person would enter inside your home, after being inside many other homes, some probably with sick patients. For this reason, it made perfect sense to have a half bath for visitors only, with an attached sink to wash hands at the entrance, as it was very crucial for health and hygiene.[49]

• Living rooms

After World War I, when the influenza epidemic took the lives of millions, the parlour (living room) became a death room.[50] As people did not have the means to bury the bodies immediately, bodies were stacked in unused parts of the house - mostly the parlour. When things started looking better after the influenza, the term was changed to the living room, once the days of socialization and happiness were back.[51]

When the understanding of microorganisms became prevalent, it had an effect on domestic activities as well. Victorian style furnishing, carpets and draperies were discouraged as they collected a lot of dust and in turn, germs too. Up until the 20th century, bathrooms were decorated with carpets and wooden cabinetry just like other rooms, however they were eventually removed for better hygiene. Companies selling flooring and wall covering materials such as porcelain, tile and linoleum capitalized on the belief that smooth and impermeable materials were healthier.[52]

Although Closets have been around for centuries, what we find in our households are in fact a much more recent innovation. Up until the 20th century, clothing items were stored in stand-alone furniture. As Lloyd Alter writes "When you look at the plans from the turn of the century, the closets are tiny, tiny, tiny—if they exist at all."[53] The transformation that caused the switch from armories to closets was due to hygiene and cleanliness, as it made it easier to clean rooms, old armories (closets) were heavy to move and would collect dust. Le Cobusier was an advocate for the importance of minimalism, cleanliness and hygiene in home design and eventually it became a norm.

49. Yuko, Elizabeth. 2020. "How Previous Epidemics Impacted Home Design". Architectural Digest.
50. Room 20. 2018. "A History Of The Living Room". Fella Design.
51. Adrienne Brookbanks. 2015. "The Fascinating History Of The Living Room". Builddirect Blog: Life At Home.
52. Budds, Diana "Design In The Age Of Pandemics". 2020.
53. Yuko, Elizabeth. 2020. "How Previous Epidemics Impacted Home Design". Architectural Digest

b.c. Lawn Road Flats Hampstead 1934 (UK)

Lawn Road Flats also famously known as Isokon flats situated in the district of London Borough of Camden was completed in 1934 by a Canadian engineer Wells Coates.[54] The project was an attempt to rethink architecture in the light of new reality after the World War. The existing flats had small kitchens as communal kitchens for preparation of meals were presented on site with other services such as laundry and shoe polishing.

Clients and Architects sat together to create a rigorously planned environment for people who were unable to 'feel at home' now had the chance to.[55] The design was an experiment in minimalist urban living, providing simple accommodation that focuses on maximum comfort using minimum materials.

The building served as a great example of Wells' belief of a minimalist setting in comparison to the ornamentation of Victorian houses. It proposed small flats that were clean, furnished and centrally heated. The furniture was built in each apartment providing them with all basic necessities. Wells' idea of minimalist living consisted of occupants only taking their personal belongings and finding everything needed to start their life.[56] The use of space, materials and forms and their adaptation into a new language of architecture made it a turning point in development of English Modernism. Its structure was graded I in 1999 making it a significant historic building in England.[57]

The building consists of four storey blocks that houses thirty four flats and two penthouse apartments. The materials used for the construction of this building was reinforced concrete with a cement wash render, the main elevation featured a cantilevered staircase that gave access to cantilevered balconies that were stretched throughout the elevation. In the exterior walls terminations were performed that waterproofed and dyed cement and applied directly to concrete formwork.

Fig 10. Elevation of Lawn Road Flats.

54. Burke, David. P.9 . 2014. The Lawn Road Flats
55. "1934: Lawn Road Flats, London – The Twentieth Century Society". 2021
56. Burke, David. 2014. The Lawn Road Flats
57. "1934: Lawn Road Flats, London – The Twentieth Century Society". 2021

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• Minimal flats

The 22 'minimal flats' had small kitchenettes equipped for a single or couple without children. The images highlight how the space was designed to be simpler by providing comfort with using least materials.

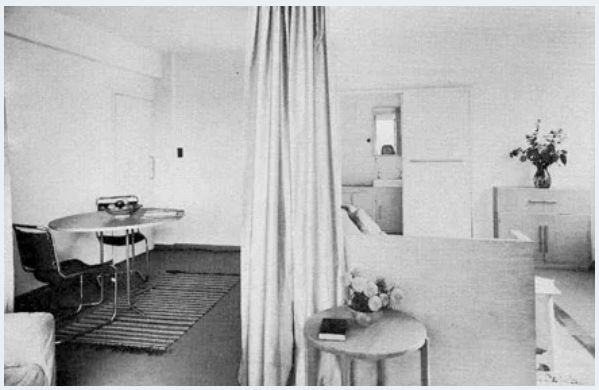


Fig 11. Images of interior of flat

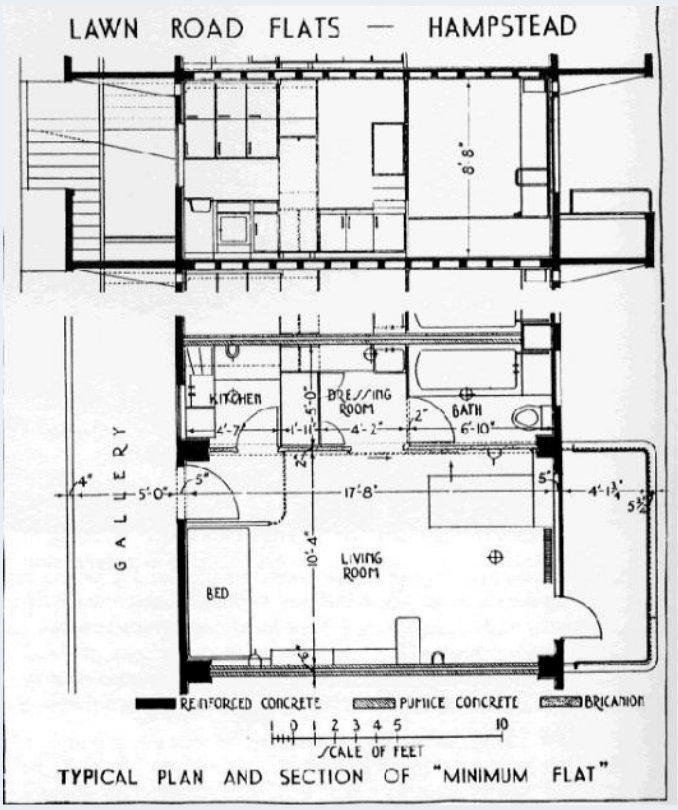


Fig 12. Typical Plan and Section of minimal Flat

• Apartments

In the building there are four double apartments that are divided by sliding panels to create bigger spaces, located at the south end.[59]

• Studies

In the far North side of the building, three studies exist which consist of large windows and

58. Burke, David. 2014. The Lawn Road Flats
59. Burke, David. 2014. The Lawn Road Flats

balconies (north to southwest). The main kitchen and rooms for staff are on the ground floor.

• Attic

The attic was located on the top of the building, on the roof that consisted an apartment for Pritchards who was also the owner of the Lawn Road Flats. It consisted of two units, one was inhabited by him and his wife while the other independent from their unit was inhabited by their two young girls.[60]

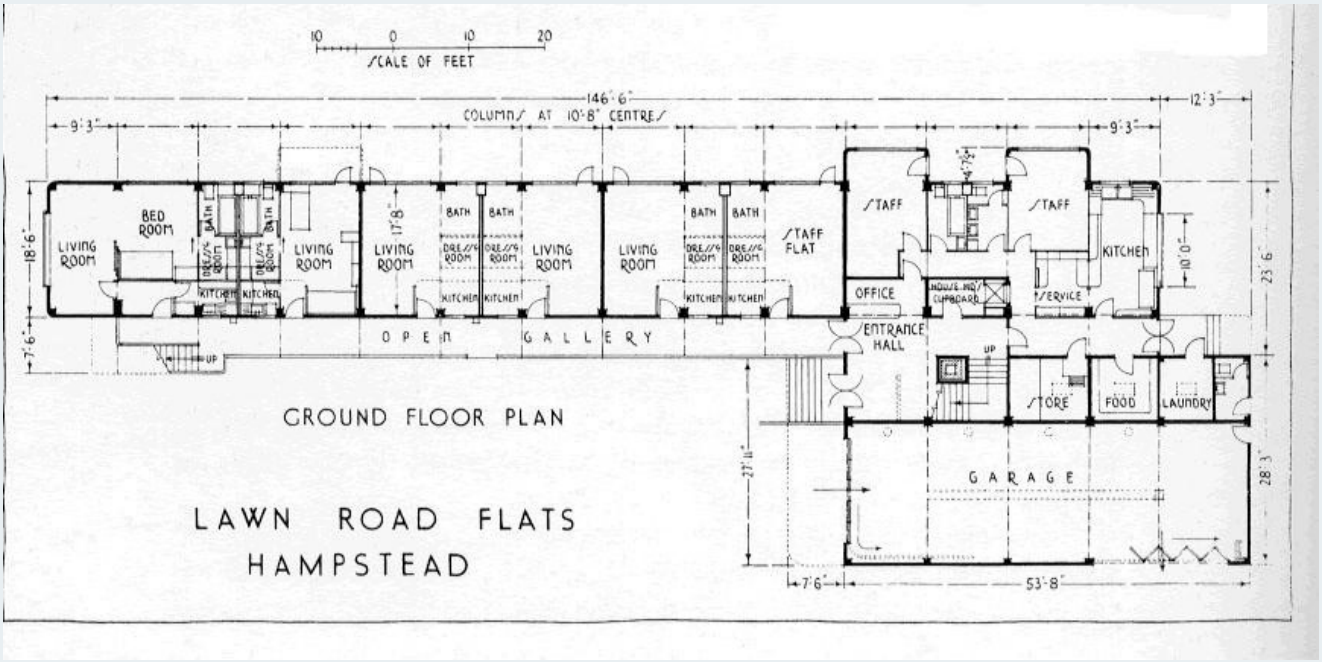


Fig 13. Lawn Road Flats Ground Floor Plan

This case study will be referred to in chapter 5 as an example of a typical apartment of the 20th century.

60. Burke, David. 2014. The Lawn Road Flats

02. CHALLENGES FACING THE 21st CENTURY PRE PANDEMIC HOUSING MODEL

This chapter explores the factors involved in determining the quality of living, both external and internal. External factors such as urbanisation and neighbourhood planning affect the immediate environment of homes and add limitations in the design of residential buildings. We spend a lot of our times indoors, therefore factors such as materials and indoor air quality play a significant role in the well being of the ocucpants.

INTRODUCTION

Undoubtedly, housing and health has garnered a lot of interest by the public health community in recent times and is now considered a significant factor affecting population health. Not only environmental factors but also indoor emissions have become a rising concern and are seen as a public health risk.

As discussed in the first chapter, during the 19th century there were several large-scale public health interventions that were carried out, especially in European countries, in response to the inadequate housing conditions and poor hygiene and sanitation.[61]

Poor housing conditions are linked to a wide range of health conditions that include respiratory infections, poisoning by toxic metals and mental health. Tackling these issues offers public health officials a chance to 'address an important social determinant of health'.

Today, there are multiple strategies at the disposal of public health departments that can help improve housing by enforcing housing guidelines and codes and implementing healthy, affordable housing.[62]

Traditional issues such as crowding, hygiene and sanitation are still persistent in current housing. Furthermore, indoor pollutants and chemical emissions are also problems that have started being addressed more recently.[63]

In this chapter we will discuss the challenges facing health and architecture and how the situation has been made worse by various external and internal factors in our cities, neighbourhoods and living units.

2.1. EXTERNAL FACTORS AFFECTING THE QUALITY OF LIVING IN RESIDENTIAL UNITS

Within a short time, we have transitioned from a world in which emerging infectious diseases posed a great health challenge to one that now has to face multiple chronic illnesses and new viral and bacterial pandemics. This has had a massive effect on our health systems that are not only alarmingly unprepared to take on the challenge, but also lack enough information on

61. Braubach, Matthias. "Key Challenges Of Housing And Health From WHO Perspective". 2011
62. Krieger, James, and Donna L. Higgins. "Housing And Health" 2002
63. Braubach, Matthias. "Key Challenges Of Housing And Health From WHO Perspective". 2011

how they need to be adapted.[64]

Sanitation and overcrowding is an ongoing problem in growing settlements and cities, particularly in developing countries. Furthermore, developing as well as developed countries face problems such as noise pollution, poor thermal conditions and home safety among others. Housing and health is always affected by a range of factors, making it a challenging subject to assess.

As Ranson states " housing and health is not and never will be an exact science".

The quality of housing conditions plays an important part in determining the health status of the occupants. Many health problems are traced back directly or indirectly to the buildings that we occupy and their conditions. Additionally, the home has a great influence on the psychological and mental well being of an individual as it serves as a place of attachment and identity, and it is where the people go to seek a last refuge from their daily lives.[65]

This subchapter discusses some of the external factors that affect the quality of living in residential spaces.

2.1.1. Urbanisation

Urbanization refers to the movement of people from rural to urban areas and the physical changes that occur in urban areas as a result of this migration. It has been related with human development and progression, but recent evidence has shown that this shift in urban settings can also lead to social inequalities and health repercussions.

This large influx of people in cities can result in a number of problems such as circulation of communicable diseases, pollution, poor nutrition and road traffic. In most cases, these problems hit the poor the hardest as they live in urban slums that are unregulated and congested. They are also usually located in geographically dangerous areas such as hillsides, riverbanks and water basins that are prone to landslides, flooding or industrial pollution. Eventually, in the absence of effective planning, the negative effects also spillover to the rest of the city dwellers, and as urbanization keeps on increasing, this effect increases and takes on a global dimension.[66]

The uncontrolled growth of cities and industries has led to a rise in human exposure to biological, chemical, physical and psychological health hazards. Furthermore, environmental problems such as air pollution from vehicles and industrial emissions, water pollution, inadequate solid and water waste management and noise pollution pose a serious risk to the health of city dwellers.[67]

Another consequence of the growing population in cities has been a significant increase in the demand for housing. During the financial crisis, many major cities faced a complete standstill in the housing market. The gap in supply and demand of housing intensified due to the sudden inflow of people. When construction was resumed, it was unable to match the growth in demand. Consequently,

64. "The Biggest Health Challenge Of The 21St Century — And How Little We Know About It". 2018
65. Bonnefoy, X. (2007) 'Inadequate housing and health: an overview', Int. J. Environment and Pollution, Vol. 30, Nos. 3/4, pp.411–429
66. Kuddus, Md Abdul, Elizabeth Tynan, and Emma McBryde. 2020. "Urbanization: A Problem For The Rich And The Poor?"
67. Goldstein, G. "Urbanization, Health and Well-Being: A Global Perspective."

prices of houses and the overall cost of living has increased significantly and quickly in many cities while decreasing the quality of living.[68]

2.1.2. Affordability

Most of the world's wealthy cities like London, New York City, San Francisco and Paris, share a common problem of housing shortage. They are unable to support their growing population, and rents and property prices have shot up consequently. This has pushed the lower income groups out of their homes and forced the working class into congested and smaller accommodations. The shortage of housing has majorly come about as a product of the post industrial economy. All the high income jobs are saturated in a handful of metropolitan areas, concentrating the population and wealth while worsening the inequalities among different groups in terms of economy and geographic location.[69]

The lack of affordable housing options in cities has been a major cause of informal urbanization such as the growth of slums and unplanned settlements. Therefore, cities are not expanding according to the plans and land-use laws set but rather based on informal housing and land subdivision. Problems such as slums, poor housing, overcrowding and spatial segregation are strongly linked to lack of affordable housing.[70]

Research shows that lack of secure, affordable housing can have a negative impact on health. It has been seen that the chances of having frequent and severe mental and physical ailments are higher among the homeless, or individuals who go without healthy food or medicine so that they can pay for housing costs.[71]

2.1.3. Neighbourhood planning

The site and location of the home is a determining factor of health. The effects on health at a neighbourhood level in low socioeconomic areas have been documented and they show an increase in the rates of illnesses such as cardiovascular disease, HIV, gonorrhea and tuberculosis. They also show elevated rates of poor birth outcomes, physical inactivity and depression cases.[72]

According to past research, four main factors have been identified as determinants of the impact of neighbourhoods on the dwellers. The first one is related to the social processes such as the extent of social networks and collective socialization in the neighbourhood. It also takes into consideration the contesting for resources between groups.

The second is environmental factors such as exposure to risk or violence, the physical disposition of the area and environmental pollutants. Geographical placement is also a key point as it determines the distance of the neighbourhood to tertiary and industrial activity poles, as well as important resources such as jobs, schools, hospitals and supermarkets.

The most evident effect of neighbourhoods is

68. van Doorn L., Arnold A., Rapoport E. (2019) In the Age of Cities
69. Jake B."Why Is There A Housing Shortage? - City Monitor". 2020.
70. "Why The Provision Of Affordable Housing Is Necessary For The Realization Of Human Rights In Cities In The 21St Century - Newcities". 2019.
71. "Integrating Housing And Health | HUD USER". 2021.
72. Krieger, James, and Donna L. Higgins. 2002. "Housing And Health: Time Again For Public Health Action"

on the health of the people living there. A direct link is seen from the exposure to violence and pollutants to poor health. The type of residential areas that people live in have an influence on their health and social behaviours. [73]

Neighbourhoods also play a role in the habits and behaviours people pick such as smoking and alcohol consumption or physical activity which could either be beneficial or detrimental to their health.[74] Lack of sidewalks, bicycle lanes and recreational areas discourage physical activity among people in the area and can contribute to obesity.

Substantial evidence has shown that ethnic minority groups and low-income communities are particularly affected; they have greater rates of disease and limited access to health care. They also happen to live in the poorest built environment conditions which just amplify the already distressing conditions.[75]

Neighbourhoods in close proximity to sources of exhaust emissions such as major roads, bus garages and airports tend to have poor air quality. These places are also a source of considerable noise exposure which is linked to a range of health related problems. Waste dump sites that are not correctly managed, such as near food markets, can harbor pests which can be hazardous for the homes located near them.[76]

2.1.4. High rise buildings

The increase in urbanisation in the past years has led to an increase in the construction of high rise buildings across the globe and particularly in upcoming economies. The key reason for this growth of tall buildings is the lack of space in congested and tightly packed urban areas. It has therefore become a necessity for residential developments to be able to accommodate more people, and with the growing population, mixed-use buildings are also gaining importance to manage the rising number of city dwellers.[77]

One of the main concerns with high rise buildings is the negative impact it has on the biosphere and human health. According to standards regulating the exposure of buildings to solar radiation, tall buildings are required to have at least 100 meters between each other. This spacing is to ensure that lower floors do not get completely shaded and blocked from sunlight. The apartments located on lower floors tend to be uncomfortable and are even positioned lower on the economic quality and market value.

In line with modern building practice, ground floors are usually allocated for shops or offices. The second and third floors are also not very conducive for comfortable living as they usually lack natural light. The presence of tall buildings affects the neighbouring properties' exposure to a reasonable amount of natural light as well as their visual quality. Street users in neighbourhoods with many high rise buildings

73. Galster, George. 2014. "How Neighborhoods Affect Health, Well-Being, And Young People'S Futures".
74. Airaksinen, Jaakko, 2015. "Neighbourhood Effects In Health Behaviours: A Test Of Social Causation With Repeat-Measurement Longitudinal Data"
75. Hood, Ernie. 2005. "Dwelling Disparities: How Poor Housing Leads To Poor Health".
76. Krieger, James, and Donna L. Higgins. 2002. "Housing And Health: Time Again For Public Health Action".
77. Wray, Sarah. 2018. "'Mini Cities': The Rise Of Tall Buildings".

may feel psychological pressure and create a sense of threat.

Studies have shown that people prefer low-rise residential buildings as living on higher floors in high rise buildings is not very ideal. According to safety standards, glazing of balconies is a must. However, without any railing, glass is not enough to create a sense of security and psychological comfort. Floors above the 20th and 22nd usually cannot have outdoor spaces such as balconies or terraces, which also reduces the circulation of fresh air in these apartments.[78] Even though high rise buildings appear to be a practical solution for congestion, particulary in American and Asian cities, they create a new set of problems that are harder to solve.

2.2. INTERNAL FACTORS AFFECTING THE QUALITY OF LIVING IN RESIDENTIAL UNITS

"We shape our buildings; thereafter, they shape us." - Churchill, 1943

For decades, the housing environment has been linked to human health. Living and housing conditions contribute to many factors that affect the quality of our living. Indoor air quality, home safety, noise, humidity , usage of materials (lead, radon , volatile organic compounds) and crowding are a few factors that affect our health and living conditions.

Individuals spend most of their lives inside buildings built by people. These built spaces shape our lives, choices, emotion, mental and physical health as well as our behaviours. Every person has a tendency to perceive and respond in a way different to the other.[79] Spaces continue to influence and change us during our entire lives. A room that is warm can make people feel uncomfortable, sweaty or hard to focus. A dark room can make people afraid, alert or restless. A well lit room can help people concentrate better. The environment that we inhabit plays a vital role in how we feel.

This topic will highlight what factors affect indoor quality of living in today's housing model.

2.2.1. Open Plans

In the previous chapter we discussed how interiors such as kitchen, bedroom and bathrooms evolved over the course of centuries. The kitchens, as highlighted previously, were placed at the back of the house as they were considered to be service areas and not a space to socialize.

As the name suggests, open plan homes were designed for a continuous circulation and flow between the living and kitchen with minimum to no barrier between functional spaces. The need to include the kitchen with the living room offered flexibility to arrange space according to the needs of individuals/family.[80]

The open floor plans became more practical as it provided the capacity to accommodate a large population of people in the same space and it answered to the evolution of living models. They were a response to the closed floor plans pre world war 2 and and 60s, with the separation between 'day and night space',

78. Michael Eichner, Zinaida Ivanova, 2018 "Socio Ecological Aspects of High-rise Construction
79. Andréa de Paiva, and Richard Jedon. 2019. "Short- And Long-Term Effects Of Architecture On The Brain: Toward Theoretical Formalization". Frontiers Of Architectural Research 8 (4): 564-571
80. "The Open Floor Plan: History, Pros And Cons". 2021. The Spruce.

its advantages still remain as it helps improve traffic flow, access to shared light and flexibility that allows for multifunctionality.

Unfortunately, Covid has killed the open-plan, as work and school (and almost every other activity) has been pushed to the domestic sphere with everyone being in each other's way all the time. Pre Pandemic, the space was occupied differently as different members of the household occupied home at different times throughout the day but post pandemic, in most cases all members of the household started occupying the home at the same time leading to open plans being 'occasional annoyance' to a 'privacy killer'.[81]

The concurrent pattern of occupying space doesn't only highlight privacy as the main concern, energy efficiency also becomes a topic of discussion. More people working from home automatically results in more usage of heating to maintain a comfortable environment.[82] This can be harder to achieve in open plans, as both large spaces and greater internal height are not the most efficient solution from the point of view of energy saving, and because different uses of space also require modularity and flexibility in the air conditioning, ensuring sanitation.

2.2.2. Indoor Air Quality (IAQ)

Indoor air quality (IAQ) refers to the quality of air inside our buildings and its relation to the health and comfort of the occupants. As individuals end up spending most of their time indoors, throughout the day, that is why it is important to understand and control the pollutants inside our homes to reduce risk of health problems.[83]

Many factors contribute to indoor air quality such as release of gases into the air contribute to the quality of air, poor ventilation can increase the pollutant levels by not filtering air effectively. The main factors are discussed below in detail.

• Materials

There has been growing evidence of the effect indoor materials have on our health.

The poor microclimate can lead to SBS (sick building syndrome) which results in affecting people's activities and wellbeing. Building materials can affect the exposure of volatile compounds by absorption. The release of the absorbed Volatile Organic Compounds (VOCs) elevates their concentration in the air for months or years.

There are quite a few household products that are linked to the sources of VOC such as the paints, cleansers, disinfectants, air freshener, furnishing of our furniture, adhesives, aerosol sprays etc.[84] The Exposure to major air pollutants from indoor sources have a great impact on an individual's health.

• Ventilation

The modern 21st century house has become overly energy conscious. In order to save energy

81. "The End Of Open-Plan Living? How Covid-19 Is Changing Our Homes". 2020.
82. "The End Of Open-Plan Living? How Covid-19 Is Changing Our Homes". 2020.
83. Bonnefoy, X. (2007) 'Inadequate housing and health: an overview', Int. J. Environment and Pollution, Vol. 30, Nos. 3/4, pp.411–429.
84. Tomčík, Tomáš, and Ingrid Šenitková. 2013. "Interior Materials Impact To Indoor Air Quality". Advanced Science Letters 19 (3): 955-959.

we have blocked the chimneys, insulated our walls, double glazed our windows and sealed our houses from fresh air. This has resulted in homes feeling 'stuffy'.[85]

Ventilation serves as one of the major contributing factors to the IAQ as inadequate ventilation can increase the concentration of CO2 and high indoor humidity and moisture which leads to the growth of mould indoors.[86]

2.2.3 Balconies and Outdoor space.

From a small balcony to a home garden or just access to an outdoor space has long been considered a luxury for many in the 21st century and this pandemic brought this to the limelight. In many cities, private outdoor space or parks in general comes at a premium. The ones who can afford to have an outdoor space end up with small, impractical spaces.[87]

> People view nature as an amenity, not as an essential – Lorien Nesbitt[88]

From faux balconies big enough for one person to small balconies that don't have enough depth to put a reasonable set of chairs without putting your feet on the railing.

Small balconies are mostly a result of zoning laws that discourage developers from building bigger balconies as there is a maximum amount of space that developers can essentially get for free. It's a choice between having bigger balconies or more internal space. A multi unit building can only have a limited amount of outdoor space according to city laws.[89]

> Studies have shown that lack of access to outdoor spaces can increase our stress and anger levels, making us more anxious.[90]

Covid has highlighted the numerous inequalities we face as a society with access to balconies, or private outdoor spaces being one. People have been trapped inside their homes with no to little access to outdoor spaces, the need for bigger balconies and outdoor spaces is now more than ever.

Balconies have a lot of benefits from livability, lovability and mental health. They symbolize a different kind of freedom, a way to embrace isolation from outside without having to feel trapped and breathing fresh air without having to fear the virus.[91]

2.2.4 Flexible spaces

> Flexibility in architecture can be defined as the ability of a building to continuously adapt its space layout and structure to evolving needs.

The term stems from the 60's Modernist movement in Japan which focuses on three main aspirations, need for an efficient built environment,densification of urban centers and an adaptable city. In contrast to this nature of use, the developers/real estate industry

85. Ltd, EnviroVent. 2021. "Indoor Air Quality | Why Ventilate | Envirovent". Envirovent Ltd
86. "Ventilation And Indoor Air Quality". 2021. NCHH.
87. Lufkin, Bryan."What Outdoor Space Tells Us About Inequality" 2021.
88. Lorien Nesbitt, 2021 "What Outdoor Space Tells Us About Inequality"
89. Brent Toderian, 2020 'A Lesson from Social Distancing: Build Better Balconies'
90. Interior Architectural Elements that Affect Human Psychology and Behavior, 2020
91. Brent Toderian, 2020 'A Lesson from Social Distancing: Build Better Balconies'

is stuck with creating rigid spaces which has resulted in spaces that aren't used efficiently.[92]

There has been a change in social and economic structures leading to a process of individualisation where individuals are confronted with rapid changes of social and economic environment. As population increases in cities, housing flexibility becomes a significant feature required in our lives. 21st century housing needs to respond to the changing needs of our living.[93]

All the above mentioned challenges are frequently highlighted and are well documented to encourage designers and architects to come up with sustainable solutions to tackle them. To better understand the changes that have been applied to housing models in the present 21st century, we have selected a case study that can be representatitve of sustainable technologies that are now being applied to apartments.

2.3. THE VERTICAL FOREST TOWERS, MILAN, BY BOERI STUDIO

For the 21st century case study we decided to take Stefan Boeri's Vertical forest in Milan as it has been one of the most discussed residential complexes in previous years. The Bosco Verticale consists of two residential towers which are 26 and 18 floors high.

The striking aspect of the project that has also brought it in the limelight is the increase in biodiversity and accommodate vertical densification. More than 700 trees and 5000 bushes across the balconies make up the building facade. The trees weren't placed merely for the reason of providing an ecosystem but also a step towards improving the quality of environment and microclimate.As the trees were expected to absorb the pollutants from air, better the air temperature and sequester carbon.[94]

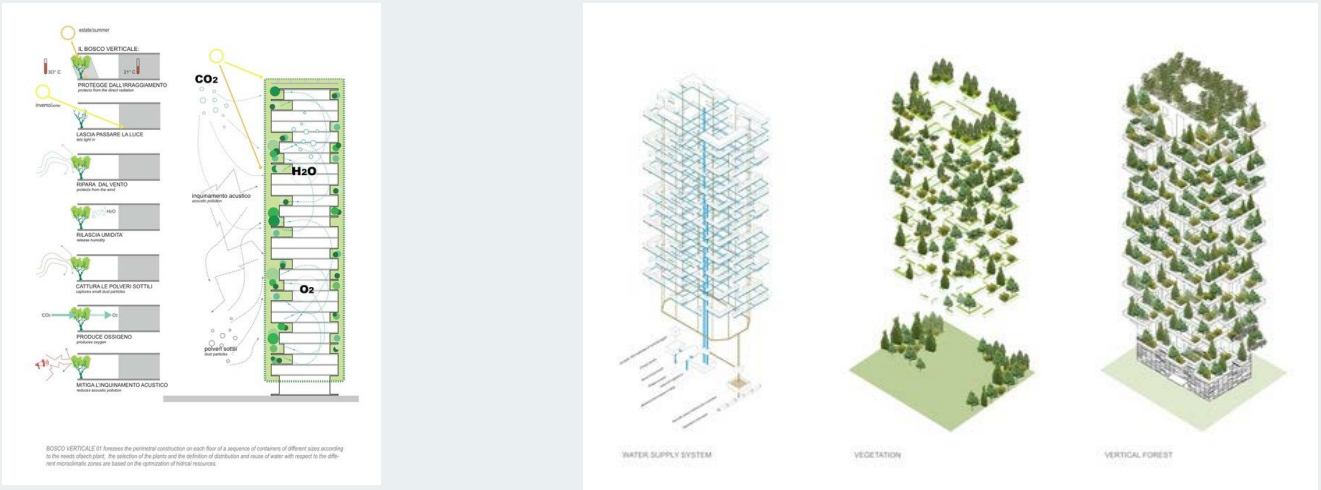


Fig 14 & 15. Bosco Verticale energy consumption and vegetation

92. "Metabolism(S) Flexibility In The 21St Century - Kooza/Rch". 2021.
93. "We Need More Flexible Housing For 21St-Century Lives". 2018.
94. BIANCHINI, RICCARDO. 2021. "The Vertical Forest Towers In Milan By Boeri. Phenomenon Or Archetype? | Inexhibit". Inexhibit.

Architectural Features of the apartment

• Green Balconies.

Bosco Verticale has green balconies cantilevered 3.3 meters from the facade of the building and supports trees that are almost 3 to 9 meter high. The trees were pre cultivated and planted in a substrate container of 1.1 meter in depth. The container is lined with waterproofing materials, followed by a protective sheer to prevent the penetration of roots.[95] A synthetic filter that sits on the top supports the outflow of water by working as a drainage.

The impact bigger and greener balconies had on the energy consumption of buildings was quite significant. Configuration of balconies with trees reduces the summer cooling by 68% but increases the winter heating demand by 37% but configuration without trees, based on the bigger balconies and use of materials, the summer heating can be reduced to 42% and Heating demand is reduced to 10%.[96]

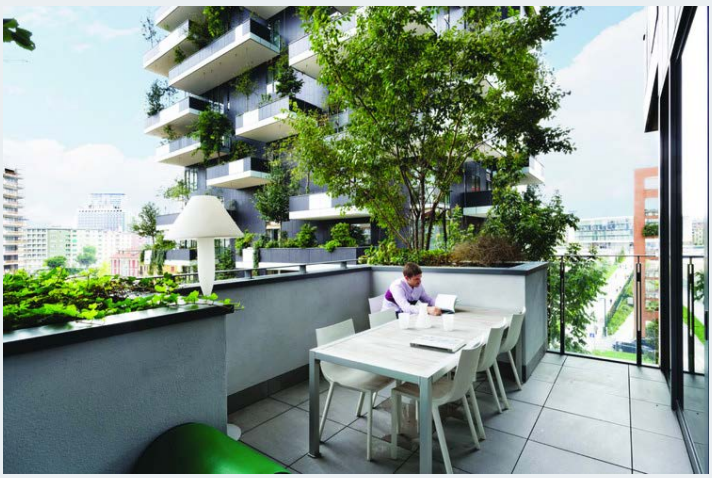


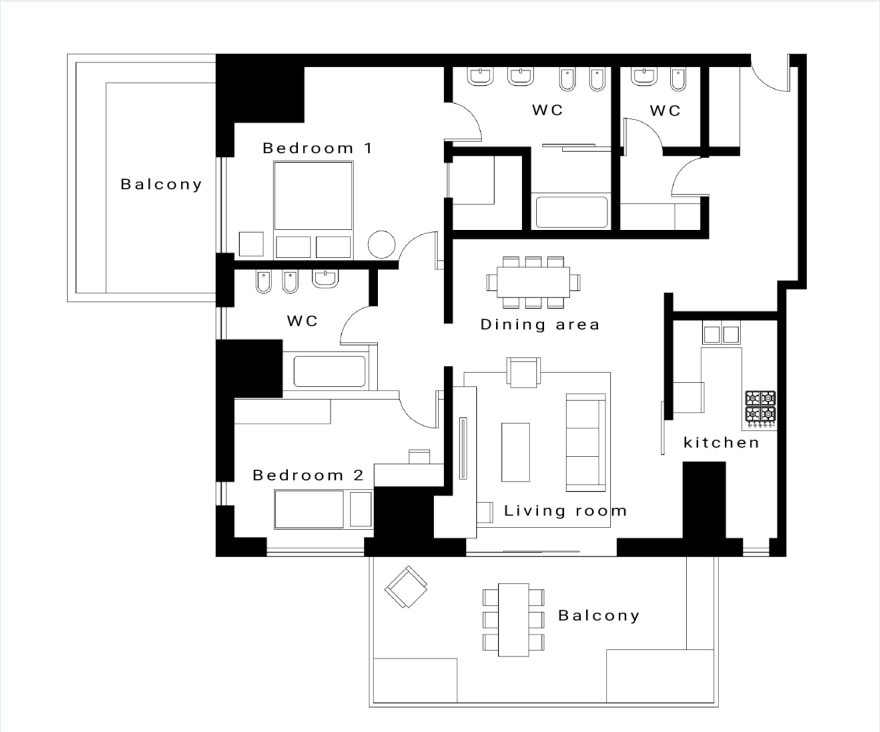
Fig 16,17 & 18. Balconies of Bosco Verticale

95. Monteith, J. & Unsworth, M., 1990. Principles of Environmental Physics. New York: Edward Arnold. Mousaad, A. et al., 2013. Wind loading on trees integrated with a building envelope. Wind and Structures, Vol. 17, pp. 69-85.
96. Giacomello, E., 2015. A New Urban Forest Rises in Milan. CTBUH Journal Issue I, pp. 11-18. Giacomello, E. & Valagussa, M., 2015. Vertical Greenery: Evaluating the High Rise Vegetation of the Bosco Verticale, Milan, Chicago: Council on Tall Buildings and Urban Habitat

• Interior

There isn't enough information available about the interior of Bosco Verticale as the focus has always been on the exterior and its features. We will study the interior by taking apart one of the plans, and discussing it in detail with images found.

Fig 19. Floor plan of Bosco Verticale



The main living area of this apartment is divided in three sections, a living area, a relaxation area that consists of a panoramic view and a dining area that has access to two terraces.

Fig 21 & 22. Images of the interior of a 3 bedroom apartment

The apartment consists of three bedrooms including a master suite with a walk in wardrobe and an ensuite bathroom. The other two rooms seem to have enough space for a wardrobe area.

Fig 23. Image of master bedroom in an apartment in Bosco Verticale

This case study will be referred to in chapter 5 as an example of typical apartments in the 21st century.

03. THE ROLE OF ARCHITECTURE IN THE PREVENTION OF DISEASE

The Covid-19 crisis has caused major disruption in our cities and physical environment. It has cut us off from our former daily patterns. The settings we are familiar with are now either inaccessible, temporarily adapted to new forms or digitalised. This inconsistency in engagement with our surroundings and other people can cause us to feel disoriented and confined in our homes. The need to find alternatives to our conventional sources of relieving stress and connecting with others grows day by day, giving us the opportunity to reimagine the spaces we live in.[97] Architecture plays an important role in determining the health and well being of the dwellers. In this chapter, we will shed light on the role built environment and human behaviour plays in the spread of diseases to better understand how in future that can be controlled or lessened with technologies and design strategies. This will be followed by a discussion on the design strategies that need to be put into application more efficiently.

3.1. HOW DISEASES SPREAD

Despite being tiny enough to be invisible to the human eye, the pathogens have had a significant impact on how and where we live, our daily habits as well as having a great impact on economies and cultures. Diseases have changed the structure of communities and the number of people inhabiting those communities.

Environmental quality has a direct impact on health and behavior that influences the impacts of spread of disease and health has an indirect effect. These impacts can happen at any scale from large to small, from the individual to a whole society from the design of our crockery we eat to the design of cities.

To be able to make impactful changes in the design of our cities, homes or even daily use objects, we must first understand how pathogens spread and what is required to curb this contamination. This includes environmental factors that propagate pathogens as well as personal hygiene habits.

3.1.1 Influence of built environment in spread of diseases

The environment contributes a great factor in the disease dynamics and determining the health of an individual and the prevention and confinement of chronic and infectious diseases. This section highlights the risk factors that can increase the likelihood of epidemics and disease outbreak along with their intensity in future.

a. Disease transmission from animals to humans

The transfer of viruses, bacteria, parasites and germs from animals to humans is known as zoonosis. It is a byproduct of urbanization

97. Kostina et al, 2021

and changes in land use. Developing countries have been most affected by zoonosis as urban expansion drives deforestation practices to log and mine activities that result in building roads and bridges.[98] Increases in population means shortage of resources. This has fueled the farming and breeding of local species that are being sold in the markets as food. All of this combined has increased the risk of transmission of disease from animals to humans.

Urbanization has resulted in the increase of awakening the dormant viruses in the wildlife which are then being spread from animals to humans.

The most recent example of that is Covid-19 which scientists believed to have originated from bats. The virus was then passed into another host that was being sold as a food. The virus then rapidly spread onto people who ate that food and unknowingly infected millions of people.[99] In developing countries of the world, the increasing interaction between wildlife and humans have accelerated the risk of spillover diseases. As the developing world becomes urbanized, the interactions are more likely to accelerate.

b. Growth of cities

By an estimation of the UN, by 2050 nearly 68% of the world population will live in urban areas. To put things in better perspective, in 30 years, 300 cities will equal the size of New York city today. This rapid increase will put a heavy strain on even the well-built, modern cities in the world. In developing countries the real challenge will be to provide basic services such as adequate housing and access to clean water.[100]

Today, one in eight people - a billion people live in slum conditions without access to basic services such as sanitation and clean water. By 2050, the number will double to more than 2 billion people. If anything we have learnt from history, slums are the breeding grounds for diseases. In Triumph of the city, Edward Glaeser writes "Urban governments in developing countries must do what the cities of the West did in the nineteenth and early twentieth centuries: provide clean water while safely removing human waste."[101]

Cities bring people together in small confined spaces, such as sharing houses, schools, working, using the transportation system to get around etc. These interactions make residents more vulnerable to spread of diseases and pandemics.

Michele Acuto, director of Connected Cities Lab, believes that city managers need to think about how basic services are provided. For Acuto and other urban planners, the digital tools provide a platform to shift basic services that assemble people into public spaces onto digital devices. [102]Tools like this can keep people connected. As Ian Klaus writes that 'Digital Infrastructure might be the sanitation of our time'.[103]

98. T. V. Padma, "Deforestation and Disease: How Natural Habitat Destruction Can Fuel Zoonotic Diseases,"
99. Gabriel Leung, "The Urgent Questions Scientists Are Asking About Coronavirus," New York Times, February 10, 2020,
100. United Nations Department of Economic and Social Affairs.
101. 86 United Nations Habitat, Slum Almanac 2015/2016 (Nairobi: United Nations, 2015)
102. Michele Acuto, "Will COVID-19 Make Us Think of Cities Differently?," New Cities, March 20,
103. Ian Klaus, "Pandemics Are Also an Urban Planning Problem," Bloomberg CityLab,

c. Globalization.

The world is interconnected now more than ever before. The expansion of the global market has allowed people and commerce to move freely around the world. It has also liberalized the economic activities such as exchange of goods and funds. Products nowadays are built in stages, parts made in one location, assembled in another etc. If anything the current virus has exposed, it is the interdependence of the world's economy and its vulnerability to supply shock. [104]

Air travel can take a local outbreak from one corner of the world to the other unknowingly. With increase in population, there will be increase in air travel leading to risk of spread of disease beyond national borders.[105]

d. Zoning

Zoning is a method of dividing land based on its industrial and residential uses to promote a pattern of orderly development.[106] Zoning has become an integral part of city planning as its impacts are widespread.

Scientists and urban planners have argued the pro-growth zoning policies have promoted the spread of disease in the developing countries. Everything is interconnected, a growth in population in informal settlements leads to more land (deforestation) which gives rise to obtaining more resources to meet the needs of people. These developments result in human and wildlife interaction which leads to easy spread of diseases.[107]

Scientists and Urban Planners are calling for the reversal of these pro-growth zoning policies and to have a buffer between human and wildlife settlements.

3.1.2. Influence of direct and indirect contact in spread of diseases

Previously, we have seen the impact the built environment has had on the spread of disease. This topic explores how human behaviour can influence the spread of disease as well as other factors that amplify its transmission. Diseases can spread from person to person by having direct or indirect contact. By examining the causes of disease transmission , we can propose better alternatives from an architectural perspective.

a. Direct Contact

Direct contact is one of the leading reasons of transmission of disease and a lot of it is related with human behaviour over the course of years such as hand shakes, hugging etc.[108]

• Person to Person contact

Transmission occurs when disease-causing organisms pass from the infected to the healthy person through physical contact such as blood or body fluid etcs. Examples of direct contact can be listed as touching, hand shakes,

104. Henry Farrell and Abraham Newman, "Will the Coronavirus End Globalization as We Know It?," Foreign Affairs,
105. 2036 Forecast Reveals Air Passengers Will Nearly Double to 7.8 Billion," International Air Transport Association
106. Dannenberg, Frumkin, and Jackson, Making Healthy Places, 20.
107. James M. Hassell et al., "Urbanization and Disease Emergence: Dynamics at the Wildlife–Livestock–Human Interface," Trends in Ecology & Evolution 32, no. 1 (2017): 55–67
108. "Disease Transmission: Direct Contact Vs. Indirect Contact". 2021.

kissing, sexual contact or contact with oral secretions.[109]

• Droplet Spread

Droplet spread is a result of spray of aerosols which are produced due to sneezing, coughing and talking. It can be classified as direct because it is sprayed directly before falling to the ground.[110] This transmission requires close proximity.

b. Indirect Contact

Indirect contact is mainly referred to transmission of disease that includes the transfer of infectious agent from reservoir to the host through air, water, inanimate objects etc.[111]

• Airborne Transmission

Indoor spaces such as homes, offices, school hospitals etc are filled with harmful pollutants. Infectious microorganisms have the ability to travel long distances and remain suspended in the air for a longer period of time.[112] It is very easy for viruses to be transmitted in crowded spaces that are inadequately ventilated. [113]

• Waterborne Transmission

Waterborne transmission can easily infect a great percentage of the population in less time. Large amounts of infectious agents can be released in aquatic environments through the waste of infected people into unprotected waterways.[114]

• Contaminated objects

Microorganisms can live on to a surface for a short time, and if a person touches the object such as door knobs etc, soon after coming into contact with an infected person, the person might be exposed to infection. Transmission can occur when you touch your mouth, hands or eyes before washing them.[115]

3.2. ARCHITECTURAL FEATURES AND STRATEGIES THAT AID IN CREATING RESILIENT ENVIRONMENTS

The design of our built environment can have crucial impacts on our well being, especially given that we spend about 90% of our time in buildings, of which 70% is spent in our homes. A recent WHO report that discusses the correlation between housing and health verifies that improved housing can have a positive effect on the quality of life and prevent disease. Furthermore, with the demographic and climate change globally, housing has become even more crucial to maintain good health.[116]

A better understanding of the impact that architecture can have in creating resilient

109. “Disease Transmission: Direct Contact Vs. Indirect Contact”. 2021.
110. “Disease Transmission: Direct Contact Vs. Indirect Contact”. 2021.
111. “Disease Transmission: Direct Contact Vs. Indirect Contact”. 2021.
112. Guiseppina LR, Marta F, Simonetta DL, Marcello, L, Michelo M. Viral Infections acquired Indoors through Airborne, Droplet or Contact Transmission
113. Lateef F. Hospital Design for Infection Control. J Emerg ,Trauma Shock.
114. Christine LM. Waterborne Transmission of Infectious Agent. In: Crawford R, Garland J, Lipson D, Mills A, Stetzenbach L, editors. Manual of Environmental Microbology 3rd edition. Washington: ASM Press;
115. “Disease Transmission: Direct Contact Vs. Indirect Contact”. 2021.
116. Baker, Nick., Steemers, Koen. Healthy Homes: Designing with Light and Air for Sustainability and Wellbeing. United Kingdom: RIBA Publishing, 2019.

environments can help us come up with more informed solutions during such a crisis. This section explores architectural design strategies that can help improve the health and well being of people and also possibly diminish the spread of illnesses in the future.

3.2.1. Design to promote social encounters

Humans tend to find joy when they experience positive unexpected encounters. The city is a ground for such opportunities and stimulation which has now been greatly reduced. Living in a monotonous routine without much to look forward to can affect our well being and enthusiasm to carry out our day to day activities.

While it may be impossible to exactly recreate the experiences we can have outdoors, we can still introduce elements in our domestic environments that can create more pleasant spaces for us.

It is essential to have 'public spaces' not only in the urban environment but also in our domestic and work spaces. This demands that houses should have sufficient spaces for social interaction and group activities. There should also be areas dedicated for activities such as practicing personal hobbies, learning new skills or any other leisure activities that bring about contentment and an opportunity for interaction between members of the household.[117]

3.2.2. Design to bring nature indoors

Nature has shown to have a positive correlation with several benefits to our mental and physical states. Especially during this time of crisis, when we have limited access to the outdoors, nature can be taken as an ideal restorative method.[118]

Bringing in natural features such as plants and natural light can create the sensation of outdoor spaces which can have an effect of visual tranquility. Many studies have shown that the presence of greenery in spaces we inhabit can help relieve stress and reduce mental fatigue. Even in our workspaces, the exposure to natural elements and plants have shown to increase concentration and productivity.[119] This is particularly necessary now that working from home has become a common practice.

Biophilia is defined as the inherent tendency that humans have to pursue connections with nature and various forms of life, and an affinity for the senses' perception of nature through sound and sight.[120]

To successfully apply biophilic design, it is important to identify the essential conditions necessary for the realisation of such an environment. These conditions can be used as a basic set of guidelines. The main aim should be to have consistent engagement with nature, that can help improve people's health, fitness and well being. Naturally, this should result in fewer illness symptoms, improved health,

117. Kostina Elizabeth, Palti Itai, Aishwarya Narayana, Maighdlyn Hadley, Grace Marie Roebuck, Urszula Kuczma "Cities In The Pandemic: What They Contribute And What We Miss | The Centre For Conscious Design". 2021. The Centre For Conscious Design
118. Kostina Elizabeth, Palti Itai, Aishwarya Narayana, Maighdlyn Hadley, Grace Marie Roebuck, Urszula Kuczma "Cities In The Pandemic: What They Contribute And What We Miss | The Centre For Conscious Design". 2021. The Centre For Conscious Design.
119. "5 Health Benefits Of Plants And Green Spaces In Your Home - Thinkhealth". 2020.
120. "Biophilia Hypothesis | Description, Nature, & Human Behavior". 2021. Encyclopedia Britannica

enhanced concentration, less anxiety and an overall satisfaction and comfort.

The space designed should enable an emotional connection and also promote positive interactions between the occupants and nature. In the long run, biophilic design should sustain the effectiveness and resilience of natural systems, therefore supporting sustainable natural communities that are ecologically robust.

According to Elizabeth Calabrese and Stephen Kellert, biophilic design can be categorised into three major applications : Direct experience of nature, indirect experience of nature and experience of space and place.

The direct experience of nature involves having real contact with features such as natural light, air, plants, water and landscapes in the built environment. When instead of actual nature, a representation of it, or a transformation from its original form is used, then we create an indirect experience of nature. This involves use of pictures, artwork and natural materials such as wood and woolen fabrics.

The last method of application, the experience of space and place, refers to spatial characteristics of natural settings. These include organised complexity, anticipation of the unexpected, sense of security, wayfinding and transitional spaces among others.[121]

Designers have been increasingly incorporating nature to architectural works, bringing a shift from a concrete world to a greener one. Ryue Nishizawa, a japanese architect and one of the founders of the Pritzker prize winning firm SANAA, designed a four story home in the city center of Tokyo, that is unlike other typical residences. It is in the form of horizontal slabs with glass facades giving it a great amount of natural light as well as a lightweight, wall-less appearance. There are gardens on each of the floors, creating a screen of greenery in front of the glass facades. Every room has a garden of its own where the occupants can relax and enjoy a natural environment right in the middle of an urban center.[122]

Fig 24. Images of Garden and house by Ryue Nzishaw

121. Kellert Stephen and Elizabeth Calabrese, “The practice of biophilic design”. 2015
122. Frearson, Amy. 2013. “Garden And House By Ryue Nishizawa”. Dezeen.

3.2.3. Design to enhance natural ventilation

Microbial particles that cause diseases can stay up in the air and be transmitted to other people through the air. Since viruses and bacteria are microscopic in size, they can easily spread, especially in crowded and inadequately ventilated environments.[123]

The aim of ventilation is to remove excessive heat, humidity and contaminants from spaces and replace it with clean air that can meet the health and comfort requirements of the occupants. The ventilation rate, airflow pattern and flow direction are key elements of designing for proper ventilation. These features should ensure that the exchange of air is done properly where clean outdoor air is introduced into a building and contaminated air is removed, all in a timely manner.[124]

According to the US Center for Disease Control and Prevention, improvement in building ventilation is one of the approaches necessary to reduce exposure to the virus that causes COVID-19. The microorganisms spread more easily indoors than outdoors due to the high concentration of the virus in an enclosed space. Ventilation mitigation strategies such as airflow direction can help in reducing the concentration of the virus particles, therefore making it less likely to be inhaled or to accumulate on surfaces.

Efficient ventilation which delivers clean air and eliminates contaminants can be achieved using various methods.

The simplest and most cost effective way would be to regularly open doors and windows, however certain weather or safety conditions may not always allow this. Ventilation systems, exhaust systems in kitchens and restrooms should be inspected regularly to ensure they operate properly. While these ventilation interventions cannot eliminate the risk of infection entirely, they can reduce the risk of exposure to the virus and therefore reduce the spread of disease.[125]

3.2.4. Design to enhance natural light

For more than a century now, it has been known that direct sunlight kills germs in buildings. This strategy was even applied in hospitals and tuberculosis sanatoria. The findings in a report by Dr. Hobday, propound that sunlight could help prevent the spread of communicable diseases in buildings. While solar radiation can act as a germicide for harmful microorganisms, research indicates that exposure to sunlight also helps synchronise the body's biological functioning, therefore, improving the immunity and resistance to pathogens of occupants.[126]

One of the most influential discoveries in photobiology was made in 1877 by British scientists Downes and Blunt, where they demonstrated how sunlight plays a role in killing and inhibiting the survival and development of bacteria that were then newly discovered. They placed bacteria under different conditions,

123. Emmanuel, Udomiaye, Eze Desy Osondu, and Kalu Cheche Kalu. 2020. "Architectural Design Strategies For Infection Prevention And Control (IPC) In Health-Care Facilities: Towards Curbing The Spread Of Covid-19". Journal Of Environmental Health Science And Engineering
124. Qian, Hua, and Xiaohong Zheng. 2018. "Ventilation Control For Airborne Transmission Of Human Exhaled Bio-Aerosols In Buildings". Journal Of Thoracic Disease
125. "Community, Work, And School". 2020. Centers For Disease Control And Prevention.
126. Hobday, R.A., and S.J. Dancer "Roles Of Sunlight And Natural Ventilation For Controlling Infection: Historical And Current Perspectives". Journal Of Hospital Infection 2013,

respectively in direct sunlight, indirect sunlight and darkness, and were able to observe that the bacteria in darkness could thrive, while those exposed to direct ultraviolet light were impeded in growth.[127]

In 1890, a study carried out by Koch showed that exposure to direct sunlight through glass was also lethal for bacteria, depending on the thickness of the layer of bacteria exposed. He also reported that ordinary diffuse daylight from windows in houses could also kill bacteria in five to seven days.[128]

During the 1920s when solar radiation was popular, manufacturers produced glass that allowed transmission of a greater amount of UV radiation than that of ordinary glass. The World Health Organization also refers to sunlight under the guide for infection prevention in hospitals. Furthermore, under the guidelines for health housing, it is stated that natural lighting should be provided for toilets, ideally using special higher UV transmitting glass.[129]

Exposure to sunlight inside buildings can discourage the survival and proliferation of harmful microorganisms. Most of the studies linking sunlight and health have been carried out in the pre-antibiotic era, but with the current pandemic it may be an opportunity to look into the potential benefits of these strategies and apply them more effectively in the design of buildings.

3.2.5. Design with adaptive finishing materials and construction methods

Following the coronavirus outbreak, recent studies have shown the virus behaves differently and is able to survive for varying time periods depending on the material surfaces it comes in contact with. A study carried out by Doremalen et al shows that coronavirus is able to survive up to 3 days on plastic and steel, while on spongy fabrics like cotton, leather and cardboard it is less stable and survives less than 24 hours and the same strain survives only 4 hours on copper surfaces. Since material plays a role in the survival of microorganisms, material selection and surface treatment must be carefully considered.

Based on this study the use of copper-infused or plated materials on surfaces such as staircase handrails and bed rails can be useful in reducing the spread of the virus.[130] Infact, in recent years, researchers have promoted the use of copper to curb the spread of diseases such as SARS and MERS. Antimicrobial coatings are increasingly being used on surfaces such as doorknobs, countertops and walls to inhibit the growth and spread of viruses. The industry has also evolved accordingly, producing alternatives such as paint and primer coatings that have added microbe-killing agents or coatings that contain organosilanes which form a highly abrasive surface for microorganisms effectively ripping them apart.[131]

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127. Volf, C., 2013. Light, Architecture and Health – a Method. PhD thesis - Aarhus School of Architecture. Aarhus.
128. Hobday, R., n.d. “The influence of sunlight and ventilation on indoor health : Infection control for the post-antibiotic era.”
129. Hobday, R.A., and S.J. Dancer “Roles Of Sunlight And Natural Ventilation For Controlling Infection: Historical And Current Perspectives”. Journal Of Hospital Infection 2013,
130. Emmanuel, Udomiaye, Eze Desy Osondu, and Kalu Cheche Kalu. 2020. “Architectural Design Strategies For Infection Prevention And Control (IPC) In Health-Care Facilities: Towards Curbing The Spread Of Covid-19”. Journal Of Environmental Health Science And Engineering
131. Brownell, Blaine. 2020. “Materials And Coatings That Reduce Surface Transmission Of Bacteria And Viruses”. Architect.

An important aspect to consider when designing is to facilitate any cleaning processes. Designers should avoid areas that are difficult to reach or tight corners. High touch surfaces and working surfaces should not have overly complicated designs and be kept flat and smooth making them easier to clean. Use of non porous surfaces such as steel, quartz or corian are recommended as they do not allow moisture, food particles and microbial spores to accumulate and are easier to sanitize.[132]

Other strategies include automation of entrance doors where there is high traffic and use of motion sensors for sinks to eliminate possibilities of transmission.[133]

3.2.6. Design for flexibility

With the onset of the coronavirus pandemic, our homes, offices and schools may need to be reconfigured, repurposed or even completely reimagined. In the article "Why we'll need more flexible buildings in the post covid era" by John Dale, he puts forward the concept of open building which creates permanent settings that can allow continuous and incremental change when needed. This would make it possible for buildings to have long term use and adaptability.[134]

It is important to note that not all the design features discussed previously can be effective in all situations. For example the strategic placement of doors and windows to enhance airflow cannot guarantee proper ventilation because they cannot be kept open during unfavorable climate. Therefore a flexible design should be capable of responding to new challenges and appraising preventive strategies.[135]

While homes will continue to function as places of refuge, there is also a need for them to evolve into more versatile environments. Interior layouts should be able to shift, expand or retract according to the needs of the occupants. To achieve 'open building' and successfully create structures that are more adaptable and versatile, a number of things should be carefully considered. Firstly, the systems in a building should be separated into different levels of control such that each can be altered independently without affecting the others. The structural systems that give a shape to the overall building should have the potential to be reconfigured.

Buildings should allow autonomous control and decision making so that change is inexpensive to carry out. For example, walls that might need to be changed or removed should be non structural and should not hold any shared services or plumbing should be done in a way that it can be changeable without disturbing the surrounding dwellings. To be able to achieve such flexibility, it is important to carry out a capacity study for a range of uses and anticipate the adaptive reuse of a space.[136]

132. Spolidoro, Bea "Healthy Buildings: How Architecture" 2020Spolidoro, Bea. 2020. "Healthy Buildings: How Architecture Can Defend Us From COVID-19". Work Design Magazine.
133. Emmanuel, Udomiaye, Eze Desy Osondu, and Kalu Cheche Kalu. 2020. "Architectural Design Strategies For Infection Prevention And Control (IPC) In Health-Care Facilities: Towards Curbing The Spread Of Covid-19". Journal Of Environmental Health Science And Engineering
134. Dale, John "Why We'll Need More Flexible Buildings In The Post-Covid Era" 2020
135. Emmanuel, Udomiaye, Eze Desy Osondu, and Kalu Cheche Kalu. 2020. "Architectural Design Strategies For Infection Prevention And Control (IPC) In Health-Care Facilities: Towards Curbing The Spread Of Covid-19". Journal Of Environmental Health Science And Engineering
136. Dale, John "Why We'll Need More Flexible Buildings In The Post-Covid Era" 2020

3.2.7. Design for aesthetics

Humans are strongly visually oriented, and receive about 87% of sensory information through the colours in their environment. Psychologists have proven that colours play an important role in impacting the emotions, moods and well-being of people.

Since modern society spends a major part of their life indoors, it is important that this space has a positive impact on them. The interior has to be functional as well as aesthetic, and colors are a powerful tool in interior design. They can be utilised to create various illusions which can make a room appear larger or more vibrant.

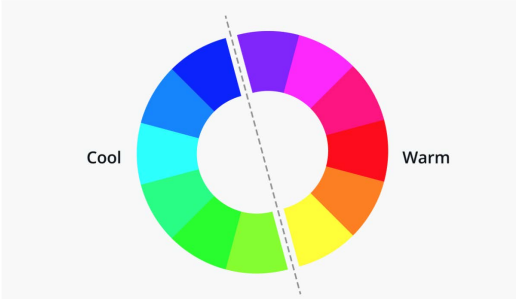
The choice of colours in a residential space can be done based on various factors. The purpose of the space and what time it is mostly in use can be a deciding. The climate and orientation of rooms can also be a factor to consider, such that in cool climate, warm colors and patterns would be used and vice versa.[137]

Colours have an effect on our mood, temperature, blood pressure, our metabolism as well as the way we perceive certain sizes and shapes.

Colours are categorised in warm and cool to better understand the role they play in interior as well as on the occupants. [138]

Cool Colours :- (Blue, Violets and green) are considered to be cool colors because they absorb light rather than reflecting it. As a result the room feels cooler and makes the room look bigger. Cool colours are best suited for bedrooms and rooms that intend to be calm.[139]

Warm Colors :- (Red, Yellow and Oranges) are under the category of warm colors. Warm colours are brighter compared to Cool colours and work best in rooms that have less light. They are considered to be much more inviting[140]



a. Color Theory Terminology

Hue:- A hue can be described as a pure color without the addition of black and white. It can also be described as colors that are formed when mixing pure colors. Example a color can be described as having a yellow hue or an orange-red hue. [141]

Tints:- Adding white to a base hue, can lighten the color. This helps lessen the color's intensity and balances the vivid combinations.

Shade:- Adding black to the base hue, can darken the color creating a deeper and richer color. Shades have the tendency to be overpowering and dramatic.

Tone:- A color tone can be modified by addition of black, whites and grays. Tints are subtle versions of the pure colours. Tones can help

137. Ćurčić, Aleksandra & Kekovic, Aleksandar & Ranđelović, Dušan & Momcilovic-Petronijevic, Ana. (2019). Effects of color in interior design. Zbornik radova Građevinskog fakulteta.
138. "12 Color Meanings — And Where To Use Them In Your House". 2015. House Beautiful.
139. "Color Theory Basics For Your Home". 2021.
140. "12 Color Meanings — And Where To Use Them In Your House". 2015. House Beautiful.
141. "Color Theory Basics For Your Home". 2021.

reveal the complexities that are not evident in the base color. Lighter tones can make rooms look larger while darker tones help make a room feel cozier.

Saturation/chroma:- It refers to the intensity of a color and its appearance under different lighting. It corresponds to the purity of the colour

Value:- Value is referred to the brightness of a color, may that be light or dark. It corresponds to the reflectance of the colour and the value of the color is dependent on how close it is to white.

Grayscale:- A grayscale refers to neutral colors starting from white on end of the spectrum to gradually increasing in value towards the end of the spectrum with black. [142]

b. Colors Influence on moods.

Red :- Red is considered to be a stimulating color and works best in offices or rooms where a lot of mental activity is going. It is quite an attention grabbing color. Red color promotes courage as well as fearlessness. The downside of red is that it can evoke feelings of rage in some people.

Blue:- Deep Blue encourages efficiency while light blues gives a sense of peace. Overall, Blue has a calming and restful affect on a person. It helps lower blood pressure and helps in sleeping if used in bedrooms. On the contrary it can also evoke feelings of sadness.

Violet :- Violet can be linked to richness and royalty. If used in paler tones it can be relaxing. This color works best in the bathroom and bedroom.

Orange :- Orange is considered to be a cheerful and active color. It is suggested to be used in gathering places as color stimulates feelings of socialising. The vibrant hues of this color can help reduce self consciousness and allows one to be more confident.

Yellow:- Yellow is a happy color, like sunlight it brightens the rooms where it is used. It helps increase focus as well as puts one in a creative mood.

Green:- It is the primary color of nature which refers to growth and fresh starts. Green helps ease anxieties and stress. [143]

142. “12 Color Meanings — And Where To Use Them In Your House”. 2015. House Beautiful.
143. “Color Theory Basics For Your Home”. 2021

3.2.8. Design for smart living

Until recently, home automation was an unfamiliar idea to most people as the devices were costly and considered to be a luxury. However, as they now become more accessible, more people are upgrading their homes. There are many benefits achieved from such digital technologies. Systems such as automated lighting using motion sensors and automated door lock systems which can be controlled remotely from an app can be installed to ensure home security.

By remotely switching off systems and appliances when they are not use, users can increase the energy savings in your home, furthermore systems triggered by motion sensors are also energy efficient as they would switch off automatically when there is no user. The comfort of the home becomes easily adaptable with intelligent lighting, sound and temperature to create a comfortable indoor environment according to the needs of the occupants. Since almost anything can be controlled remotely, these technologies allow people to manage their homes better and give them peace of mind as they can ensure the safety of their homes even when away.[144]

Across the last five years, smart home technology has advanced in its application in buildings to respond to the consumer demand. With the onset of the COVID 19 pandemic, our perception of the home has changed, as a result, highlighting the importance of automation in our homes more than ever.[145]

The increase in demand for automated devices has propagated the market into mainstream, where a large range of middle and basic entry level home automation gadgets are now available.[146] The reason why COVID 19 has been a catalyst in the growth of this market is because it has created new applications and use cases of these technologies.[147]

The new habits formed such as social distancing, remote working and minimal contact can all be facilitated with digital technology.

3.2.9. Design to promote sanitation

The design of the places we live in should facilitate cleanliness and encourage the users to practice sanitary habits. The traditional Japanese entryway in houses, known as 'Genkan' is an example of a feature that promotes good hygiene practices. Genkan are located right in front of the door on a recessed level of about

144. "What Are The Benefits Of Home Automation?". 2021. Safewise.
145. "Smart Home And Automation Trends Are On The Rise". 2020. Wray Ward.
146. "Covid-19 To Have Positive Impact On The Home Automation Market | Iot Now News & Reports". 2021. Iot Now News - How To Run An Iot Enabled Business.
147. Umair, M.; Cheema, M.A.; Cheema, O.; Li, H.; Lu, H. Impact of COVID-19 on IoT Adoption in Healthcare, Smart Homes, Smart Buildings, Smart Cities, Transportation and Industrial IoT. Sensors 2021, 21, 3838.

5-10 centimetres. The main function of this space is for the removal of shoes at the entrance before going into the main part of the house. This ensures that dirt tracked from outside is not carried into the house. They even place storage in this area for shoes and coats.[148]

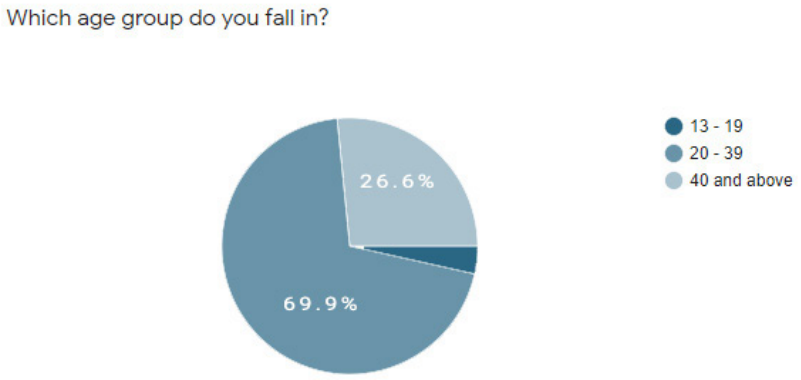
Powder rooms that were introduced in the 20th century, are a feature that should be retained. They are generally located at the entrance of the house and can function as sanitation stations when entering the house.

148. Chavez, Amy. "Rules of the 'genkan': First, wear shoes". Retrieved 1 August 2014.

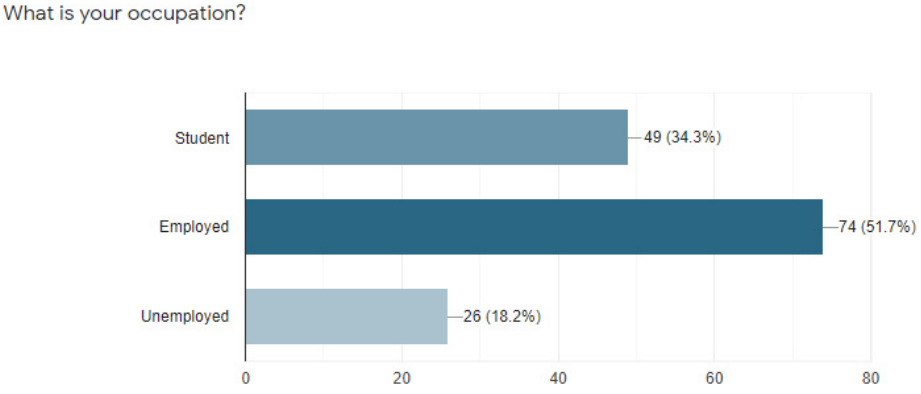
04. ANALYSIS OF THE SURVEY

We carried out a survey with participants from various places across the globe to help us better understand how people with different personalities, professions and locations dealt with the pandemic crisis and what they expect the new normal to be. The survey took place during June 2021 for a period of one week.

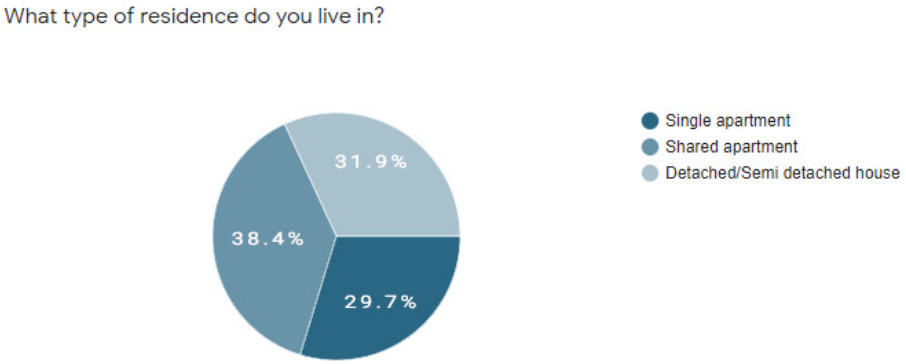
Out of 142 responses received, the majority of the participants were in the age bracket of 20-39 (70%) while the rest were in the age bracket of 40 and above (27%) and 13-19 (3%) respectively. The responses we received were from Asia (22), Africa(60), Europe (50) and America (10) giving us the opportunity to compare and analyse the similarities and differences of their experiences.



We also asked the participants to indicate their occupations as it was quite important to understand how their daily routine was affected and how they adapted to being confined in their homes. Students comprised 38% of the respondents, while employed and unemployed made 52% and 18% respectively.

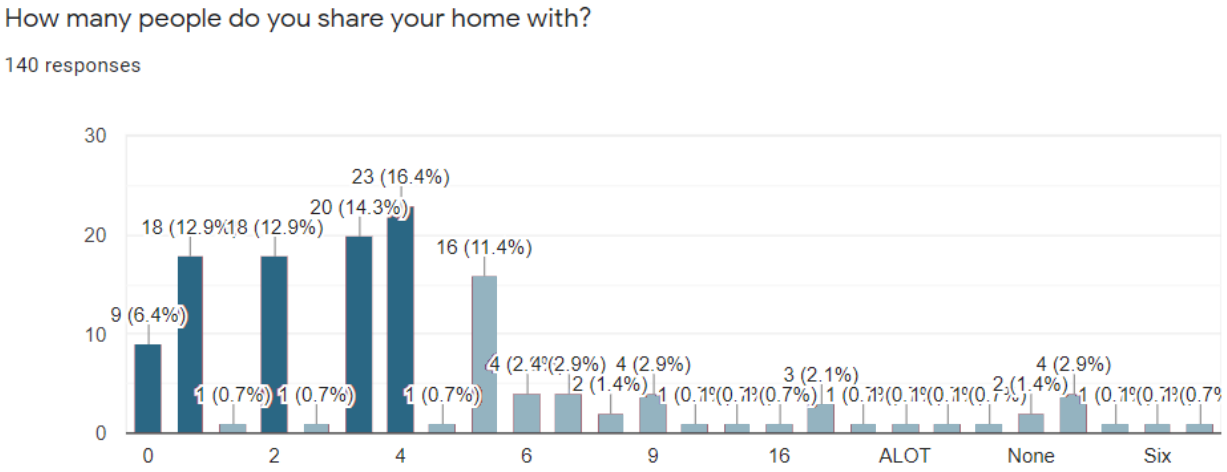


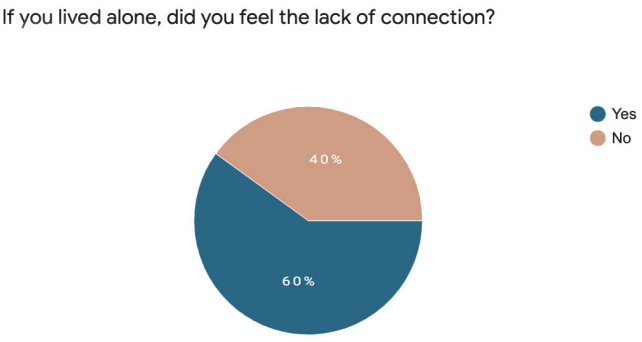
The typology of a residential house determines the ease of access to outdoor spaces, the degree of privacy as well as social connection within a space. These factors hold a great significance on the experience of an individual during a lockdown and may have an impact on mental and physical health. Based on our survey, most participants lived in shared apartments (38%) with house members of 0-6 people.



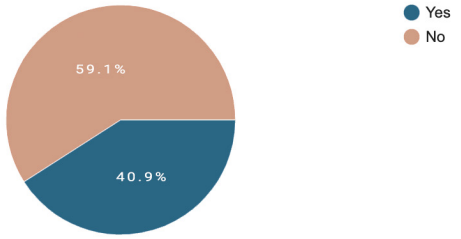
61% of the participants felt the lack of connection during the pandemic while 40% felt the lack of privacy. The lack of connection is clearly felt by the majority of lonely people during the lockdown, while the majority of people in shared housing do not show problems of denied privacy, therefore the role of building a small temporary community emerges. The lockdown period and confinement in homes has shown to have an effect on the mental and physical health of people.

In addition to previous question, it was asked how many people the partcipants shared their residence with. The most chosen answer ranged from 0 - 4. Mostly people shared their homes with their spouses and kids (family) but a few shared their homes with others such as students.

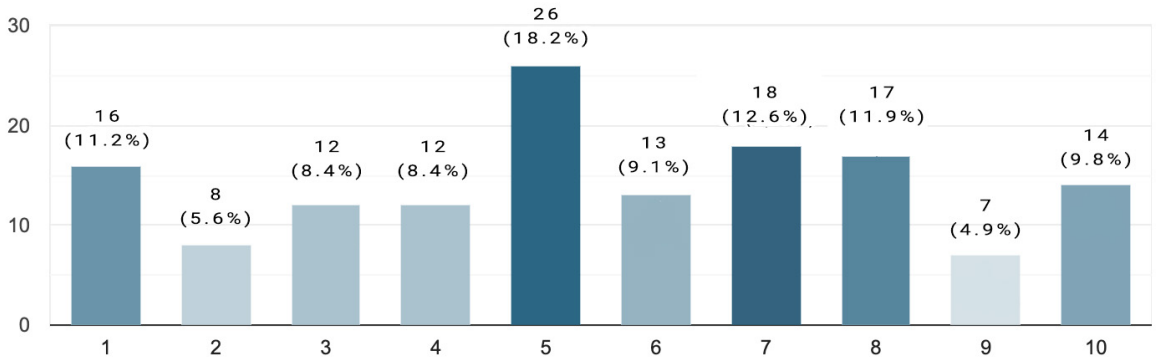




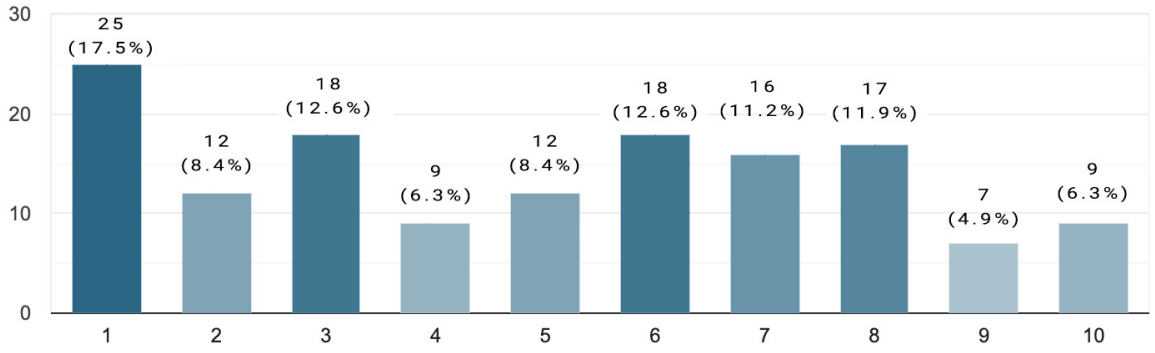
If you lived in a shared apartment/house, did you feel the lack of privacy?



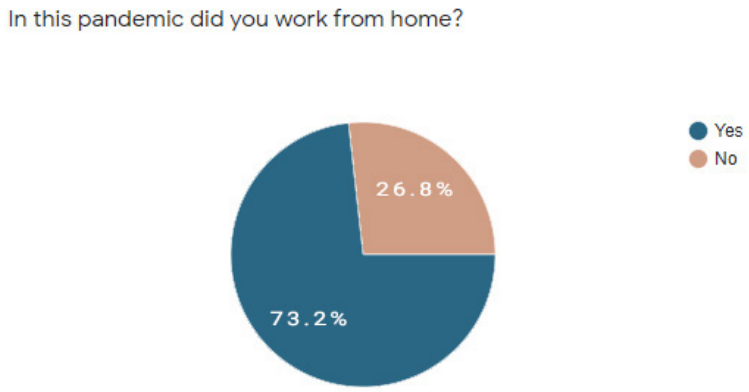
How much did the lockdown affect your mental health?

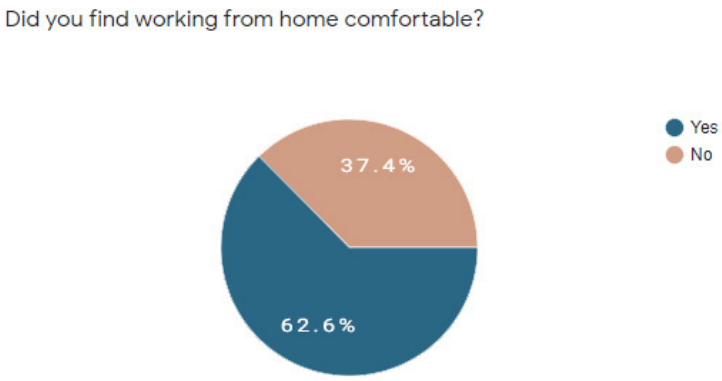


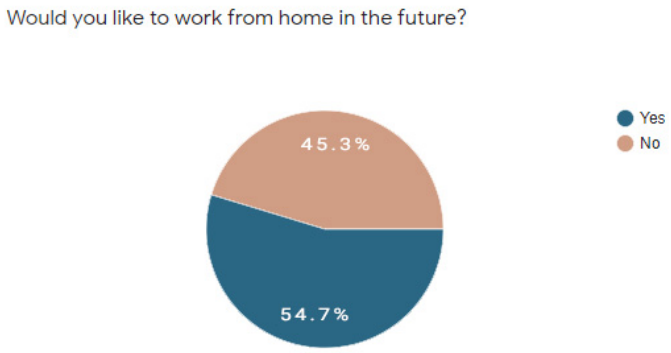
How much did the lockdown affect your physical health?



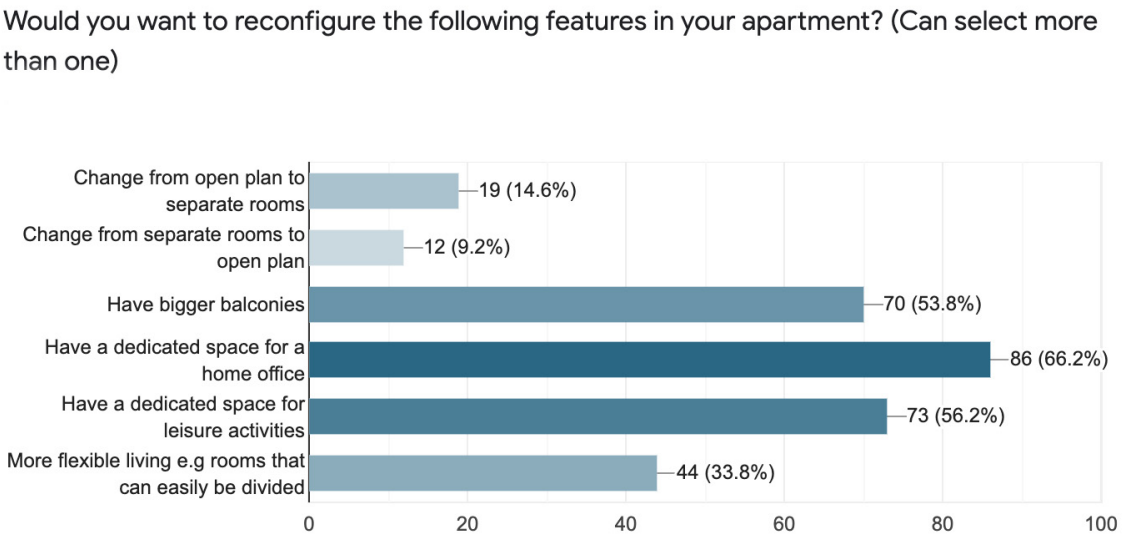
73% of the respondents had experienced working from home, and 63% found working from home comfortable, 55% would like to work from home in the future. The results show a strong possibility that working from home full time could become a norm in the future, therefore the presence of comfortable working spaces in homes should be considered as an essential feature when designing.



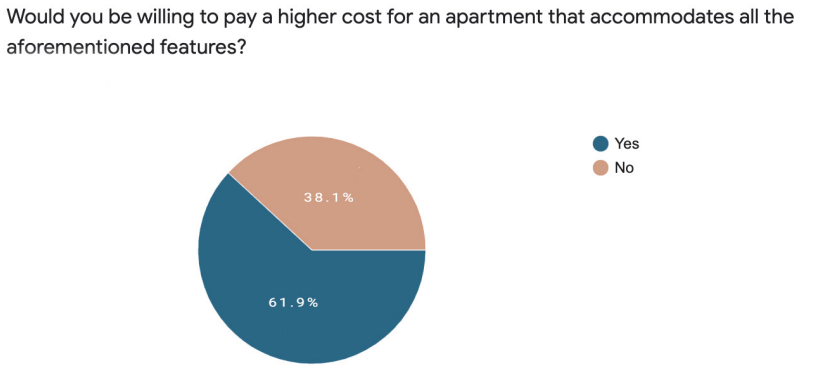


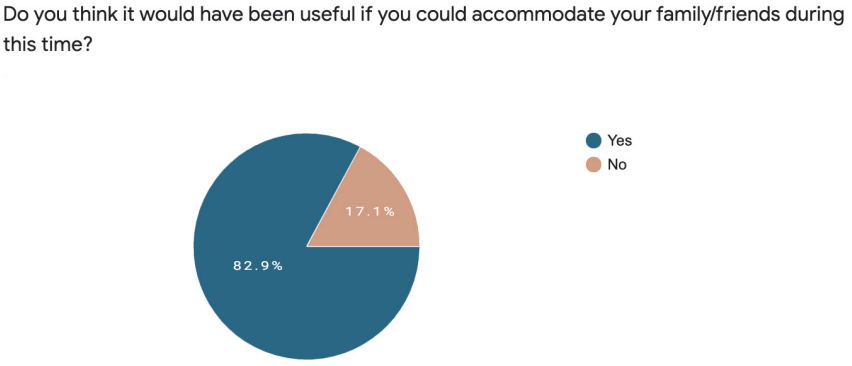


Based on our research in chapter 2.2, 'The impact of architecture features in creating resilient environments', we picked common architectural features that have been applied to residential spaces in the modern era, following pandemics such as tuberculosis. In the survey, the participants were required to indicate their preferences for a post pandemic residential apartment. The most selected features were bigger balconies (55%), dedicated space for home office (67%) and dedicated space for leisure activities (56%).



What emerges is not so much a demand for open or closed space, but for greater multifunctional equipment and an effective internal-external relationship.
Furthermore, 63% of the people said they would be willing to pay a higher cost for a house that provided the features mentioned above and 73% preferred having all ensuite bedrooms which is however, a difficult demand to meet due to economical constraints.



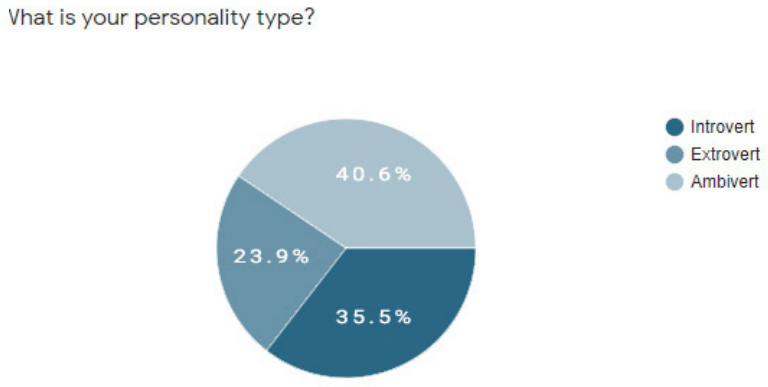


4.1 THE RELATION BETWEEN DIFFERENT PERSONALITY TYPES AND THEIR PREFERENCES ON WORKING FROM HOME AND SOCIALISING

Personality type	Comfortable home office	Work from home in the future	Lack of privacy	Lack of connection
Introvert (49)				
yes	27	25	24	24
no	22	19	25	25
Extrovert (34)				
yes	20	14	9	17
no	14	17	25	17
Ambivert (55)				
yes	37	30	26	35
no	18	22	29	20

According to our analysis, 49 people out of 143 were in the category of introverts. Approximately 55% of them found working from home comfortable and would like to continue working remotely in the future while the rest did not find it comfortable. There was a close tie on whether they felt a lack of privacy or not in their homes with 24 answering yes and 25 answering no. Similarly, the results for lack of connection were about the same.

34 people identified as extroverts of which a larger percentage of 58% found working from home comfortable and would like to continue working from home. 9 of the 34 participants felt a lack of privacy in their homes while the remaining 25 did not. The answers for lack of connection were again a tie with 50% saying they did feel a lack of connection.



Finally, the remaining 60 participants were ambiverts of which about 70% of them found working from home comfortable. However only 56% would like to continue remote working in the future. While there was a close tie on whether they felt a lack of privacy in their homes or not, a majority of them answered that they felt a lack of connection. As seen from the above analysis, most of the answers lie on the average line of 50% which leads us to the understanding that it is crucial to provide for needs on both ends of each category. Working from home may be a necessity in some situations and should be designed to be more comfortable, however it is also important to provide safe co working places or study rooms for those who would prefer to have a change of environment. Similarly, homes should have spaces that encourage socialisation and increased connection between the residents but also allow them their privacy and personal space.

4.2 THE RELATION BETWEEN DIFFERENT AGE GROUPS AND THEIR PREFERENCES ON WORKING FROM HOME AND SOCIALISING

Age	Comfortable home/ study office?	Work from home in the future	Mental health (Average)	Physical health (Average)	Lack of privacy	Lack of connection
13-19 (5)						
yes	3	3	7	8	0	0
no	2	2	-	-	5	5
20-39 (99						
yes	65	51	7	5	56	70
no	20	23	-	-	41	37
40 and above (39)						
yes	22	25	4	4	12	18
no	17	14	-	-	28	21

For the age group, we divided the participants in three categories, 13-19 (3%), 20-39 (70%) and 40 and above (27%). We have broken down the survey into 5 main questions that can help us understand the needs of users in each age group and how through design we can cater to their needs. People who fall in the age group of 13-19 who constitute almost 5 in total from the survey of 143, between that about 3 found studying from home comfortable and would like to do so in the future, and the remaining answered no. The lack of privacy and connection were a unanimous no. The average of mental and physical health was 7 and 5 respectively.

The age group of 20-39 was composed of 99 participants, in which 65 found working from home comfortable and 51 would like to work from home in the future. The lack of connection seemed to be an issue in this age group as the total number amounted to 70 for people who felt it. The lack of privacy didn't appear to be a problem as 56 participants in this age group answered no. The mental and physical health made an average of 7 and 5, sequentially, similar to the age group of 13-19.

The remaining 39 participants made up the age group of 40 and above. From 39 participants, 20 found working from home comfortable and 24 answered yes for working from home in the future. In this age group both the lack of privacy and lack of connection didn't seem to be a great concern as a large part of the participants chose to answer no. As compared to other age groups, the mental health was far less, making it an average of 4, whereas the average for physical health was same throughout the age groups i.e. 5.

From the above analysis, it can be concluded that most participants in the age group of 20-39 and 40 and above would like to work from home in the future which means a design strategy that provides them an indoor, secluded working space. The results for the effect pandemic had on people's mental health was higher in the age group of 13-19 and 20-39, which is quite concerning. For this, we need to propose flexible spaces that can cater to their needs such as having a separate space for hobbies, taking into account privacy and connection, better light, ventilation as well as having more greens inside. For physical health, we can propose bigger balconies which can be utilised as open spaces for exercising.

4.3 THE RELATION BETWEEN DIFFERENT OCCUPATIONS AND THEIR PREFERENCES ON WORKING FROM HOME AND SOCIALISING

	Comfortable home office?	Work from home in the future	Mental health	Physical health	Lack of privacy	Lack of connection	ensuite
Student (49)							
yes	28	**18**	**18**	**21**	**18**	**32**	**26**
no	19	**29**	**31**	**28**	**26**	**9**	**13**
Employed (68)							
yes	40	**45**	**39**	**42**	**27**	**31**	**43**
no	20	**23**	**29**	**26**	**41**	**37**	**25**
Unemployed (24)							
yes	13	**11**	**8**	**12**	**10**	**12**	**20**
no	10	**12**	**16**	**12**	**14**	**7**	**4**

The main occupation categories in our survey are students, employed and unemployed people. In this sub chapter we have analysed the link between different occupation types and their preferences and experiences in the covid situation. 68 out of 143 respondents were employed people, followed by 49 students and finally 24 unemployed.

More than 50% of the employed people indicated that they found working from home comfortable and would like to continue this in the future. In regards to mental and physical health, 57% and 62% of the participants respectively, answered that they were affected in the range of 0-5 on a scale of 1-10. Most of the participants (41) in this category did not feel the lack of privacy while about half of them felt the lack of connection. On the question of whether the participants would like to have all bedrooms to be en-suite, 43 of them in the category of employed answered yes, and the design strategies they mostly selected were bigger balconies, dedicated space for a home office and for leisure activities. Among the students (49), 60% of them said they were comfortable working from home, however 62% said they would not like to continue working remotely in the future. I

n this category, more than 50% of the students said that their mental and physical health was affected above average in the range of 6-10. More than half of the participants (29) did not feel the lack of privacy in their homes however a big number of them (32) felt a lack of connection. Similar to the previous category, most of the students (26) were in support of having all ensuite bedrooms and also mainly opted for the same design strategies which were bigger balconies and dedicated spaces for a home office and for leisure activities.

Lastly, In the group of unemployed people (24), the responses on whether they found working from home comfortable were 50-50 as well as on whether they would like to continue working remotely in the future. Also in the question of mental and physical health, half of them indicated a number in the range below 5 while the other half above 5. There also wasn't much of a difference in the responses regarding the feeling of lack of privacy and connection in their homes. Majority of them (20) indicated that they would prefer to have all bedrooms ensuite and once again their preferences in the design strategies were similar to the previous categories.

4.4 THE RELATION BETWEEN DIFFERENT LOCATIONS AND THEIR PREFERENCES ON WORKING FROM HOME AND SOCIALISING

Continents	Comfortable home office?	Work from home in the future	Mental health (Average)	Physical health (Average)	Lack of privacy	Lack of connection	ensuite
Africa (60)							
yes	36	34	5	3	24	25	46
no	24	26	-	-	36	25	14
America (9)							
yes	1	1	6	6	0	7	6
no	8	8	-	-	9	2	3
Asia (25)							
yes	17	13	7	6	13	15	18
no	8	12	-	-	12	10	9
Europe (49)							
yes	33	22	6	5	20	35	29
no	16	24	-	-	29	14	20

In the survey, we asked the participants to mention their continent for us to better understand how much the answers and preferences vary. The results were surprising to say the least. Starting from Europe, the survey had 49 participants out of 143, from which the majority (33) found it comfortable to work from home during the pandemic and would like to continue working from home in the future. More than half participants from Europe didn't feel the lack of privacy (29) in their homes but numbers were huge when it came to lack of connection as almost 35 people out of 49 felt it. The mental and physical connection was an average of 6 and 5. In addition we asked if participants would like to have an ensuite room and what parts of their homes would they like to be configured. 29 participants answered yes for having ensuite rooms in the future. For reconfiguration the most selected answers were having bigger balconies, having dedicated space for home office and leisure activities.

The survey consisted of 60 participants from Africa. Starting from the question of finding it comfortable working from home, we had 36 surveyors answering yes and 34 who'd like to work from home in the future. Most participants didn't feel the lack of privacy in their homes (36) but felt the lack of connection (25). The demand for ensuite rooms was quite high (46). The mental and physical health during pandemic averaged to 5 and 3. On average what most people wanted reconfigured in their homes was a dedicated space for home office and leisure.

About 25 people from Asia partook in the survey from which 17 people found working from home comfortable and 13 would like to continue working from home in the future. In comparison to Europe and Africa, participants from Asia did feel the lack of privacy (15) as well as the lack of connection (13). The mental and physical health averaged to quite high making it 7 and 6 respectively. Majority of participants preferred to have ensuite rooms in the future. The parts they would like to reconfigure were similar to that to Europeans i.e. having bigger balconies, having a dedicated space for home office and hobbies.

Lastly, we have America as a continent from which he had least participants from (9) but compared to all other mentioned continents, the answers were quite opposite as 8 people answered no for working from home comfortably as well as working from home in the future. The lack of privacy was a unanimous no but majority felt the lack of connection (7). The mental and physical health averaged to 6 and 6. 6 surveyors answered yes to having ensuite rooms. The parts of their house that they wanted configured were bigger balconies and dedicated space for home office.

Our comparison of location has shown us the disparities between the answers. As Europeans, African and Americans didn't feel the lack of privacy, Asians majorly felt that as the cause of concern. Similarly, participants in all three continents (Asia, Africa, Europe) found working from home comfortable and would like to work from home in future but the participants from America neither found working from home comfortably nor would like to work from home in future. Mental and physical health was a cause of concern throughout the continents as the mental health was above average in all cases.

Analysing the results, it can be concluded that dedicated space for home office and leisure activities is one thing that has been constant and for that we can suggest movable walls that can form spaces as required. Bigger balconies for people who don't have access to gardens as it can also be used for physical health purposes. The movable walls can then also be moved as per requirement of privacy and connection.

4.5 CONCLUSION OF THE ANALYSIS

The analysis of the survey highlights preferences of the main classification that are personalities, age, location and occupation. It helped us identify the major obstacles people faced in pandemic and drive the main design strategies for our conceptual units. The conclusion we derived from the survey are as follow

1. Many people found working from home comfortable and preferred having a dedicated space for home office.

2. Our analysis highlighted some shocking numbers in the mental and physical health category, particularly in the age group of young adults, for which we can have dedicated space for leisure and sports activities.

3. People with apartments preferred having bigger balconies. The balconies can be utilised for gym activities, urban gardens and a sitting space that can be incorporated with the living.

4. As discussed in the previous chapter, nature plays an important role in improving quality of health (mental and physical). Nature can be incorporated via urban gardens as one option. Good ventilation, clean air and natural light plays a significant role for better indoor quality living.

5. Another important thing we noticed were the habits people had picked during the pandemic such as washing and sanitizing their hands before entering their house. For that purpose, a toilet/sink or sanitizing station in the entrance can be introduced.

6. In our survey, based on the main categories, several people faced a problem of having a lack of connection while others felt the lack of privacy. For that purpose a midway solution can be provided for both by having movable walls and equipments and flexible spaces that can change due to one's preference.

05.1 SINGLE UNIT TYPOLOGIES

INTRODUCTION

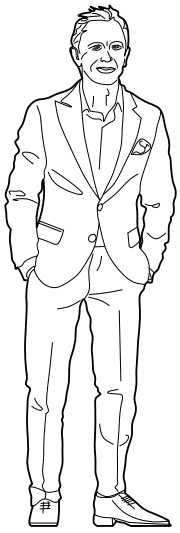
The survey we carried out highlighted different types of housing units and how many people shared their residence with which helped us form personas. Based on the survey as well as the previous studies we carried out in chapters we have identified a series of generalizable types of unit typologies on which we will carry out post-pandemic changes in accordance to the needs of the personas. Each housing unit refers to the case studies of typologies that are typical to the certain historic period (19th, 20th and 21st) based on the different occupants.

SUMMARY

For single unit typologies we will review the case studies we have studied in the previous chapters and try to reconfigure them according to the needs of the mentioned persona that we have taken from the survey data. A couple who are both working professionals. The case studies are apartments from each century, which will now be modified to needs of the said persona.

Persona 1:- Pam
Personality Type:- Introvert
Occupation:- Employed
Age:- 20-39 years
Location:- Europe
Hobbies:- Painting and Sports.

Pam is an art teacher by profession, she needs a table for attending meetings and classes. She likes to paint or do yoga in her free time. She is married to Jim.



Persona 2:- Jim
Personality Type:- Extrovert
Occupation:- Employed
Age:- 40 and above
Location:- Europe
Hobbies:- Jogging and reading book.

Jim works for a firm, he needs a table where he can attend meetings and work. Jim likes to have people over on the weekends. He likes to read books in his free time.

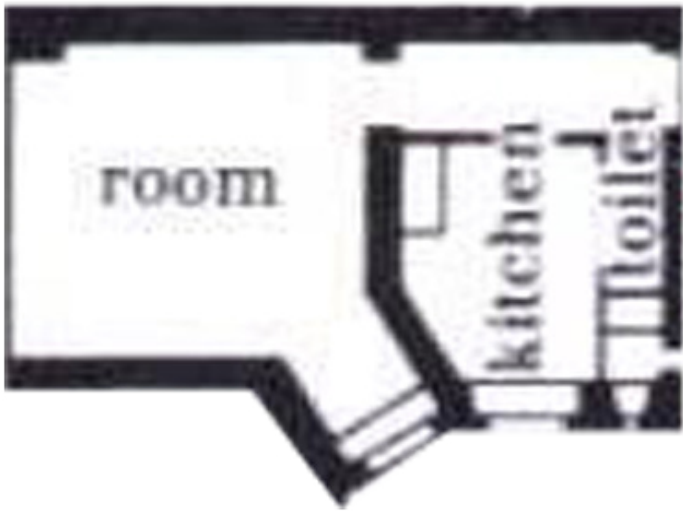
Typology 1:- Studio Unit (19th Century)

Case Study Information

Project Name :- Berlin Tenements

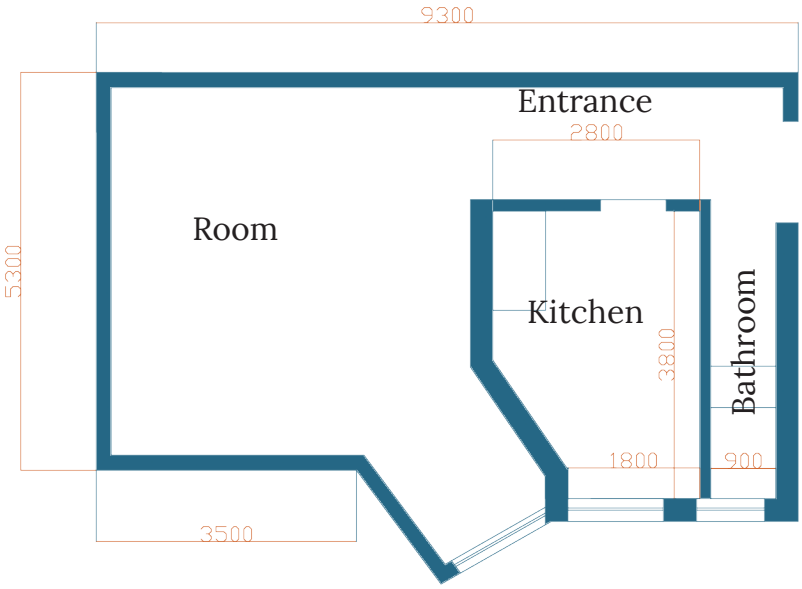
Year Built :- 1880

Location, Berlin, Germany (Europe)



Original Image (Studio)

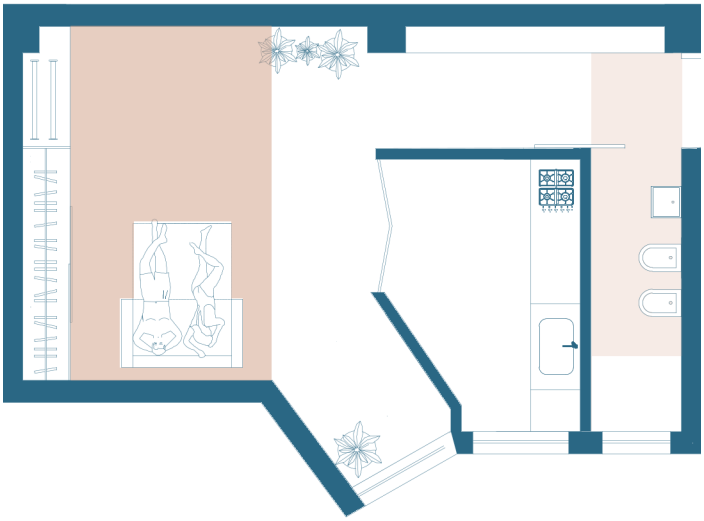
This image is taken from the plan of tenements. We have chosen a single room apartment for the couple which we will revamp according to their needs.



Original Plan redrawn (1:100)

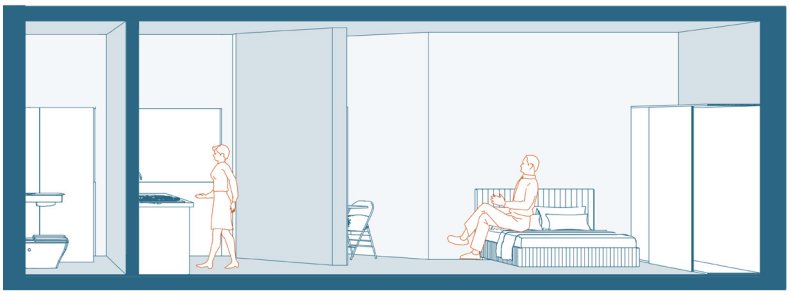
The original image has been redrawn for better clarity of the scale of the building and how it functions.

Typology 1:- Studio Unit (19th Century)



Updated Plan 1:100- Sanitizing Station and Relax Mode

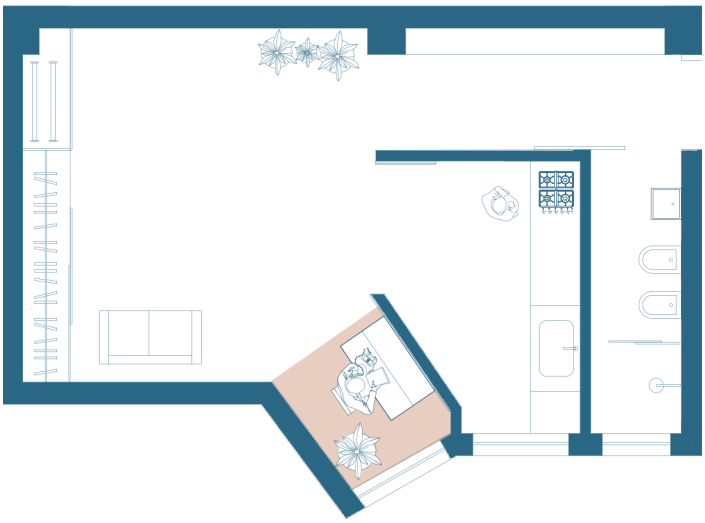
The Plan has been updated by installing a wardrobe in entrance with a bigger wash room for sanitizing. The technical spaces such as bathroom and kitchen have remained intact. A flexible unit has been installed that cater to the needs of our persona's. It includes the wardrobe and sports equipment. Tight space made it harder to provide with all amenities. The kitchen wall between the living room was demolished to create an open plan which can be closed using panels as needed. The sofa in the living room works as a fold-able sofa bed.



Section 1:100- Relax Mode

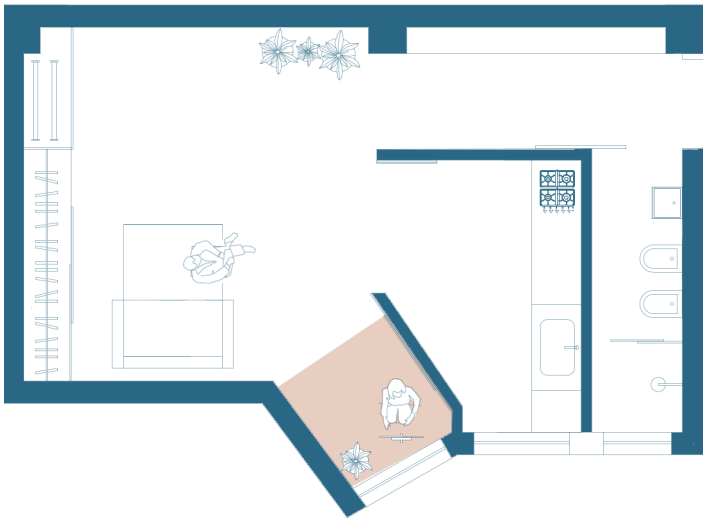
The section cuts through the wash room, kitchen and living room showing our Persona in the studio. Jim is sitting on the bed while Pam makes herself a coffee.

Typology 1:- Studio Unit (19th Century)



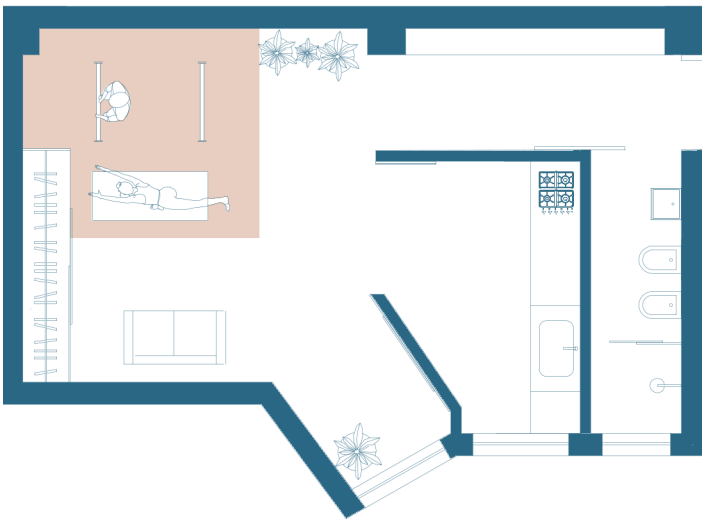
Updated Plan 1:100 - Work Mode

It's 9:00am and Jim has started working from home while Pam makes herself a coffee. The apartment is small so Jim and Pam swap between working on sofa and working on the desk.



Updated Plan 1:100 - Hobby Mode

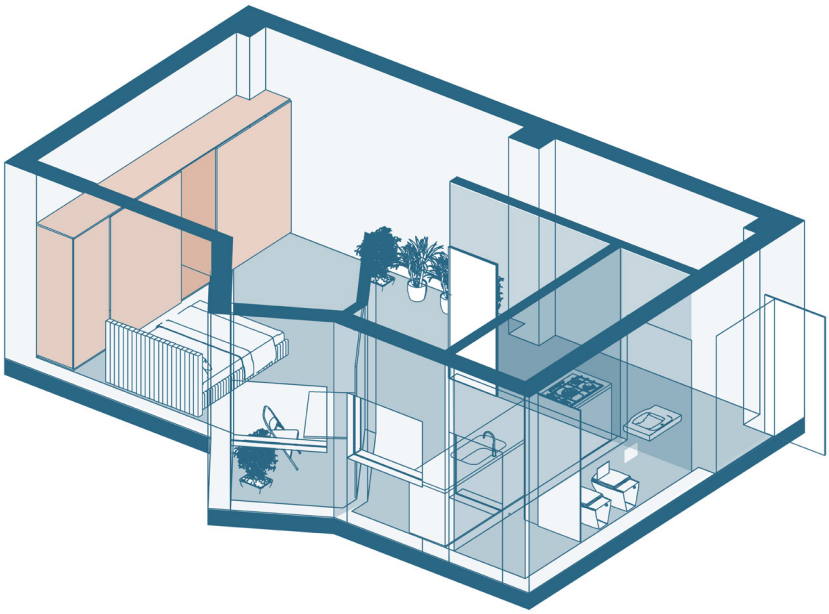
It's a Sunday morning and Pam is taking some time off and doing painting in the small private nook, while Jim reads a book in the bed



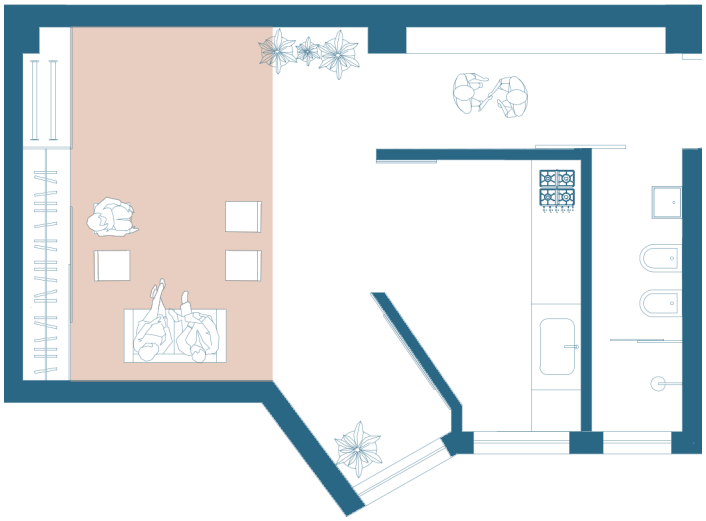
Updated Plan 1:100 - Sports Mode

It's 18:00 and Pam is doing Yoga in the open space, while Jim pulls out rods from the flexible unit for some exercising.

Typology 1:- Studio Unit (19th Century)



Isometric 1:100
The isometric shows the studio in a 3 dimensional form. The flexible unit is fixed in studio units, the height is smaller than the wall. In original plan the windows are placed in the kitchen and living room which we have kept as they are.



Updated Plan 1:100 - Party Mode

It's a Friday night and Jim has invited a few friends over. The table has been folded back and so are the panels in the kitchen to create a bigger open space.

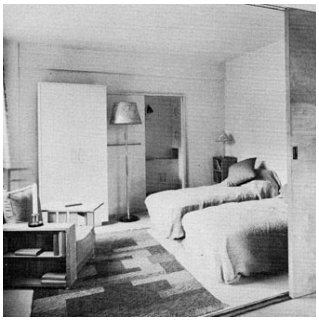
Typology 1:- Studio Unit (20th Century)

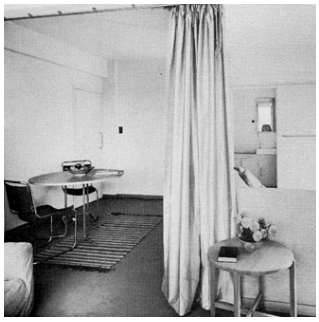
Case Study Information

Project Name :- Lawn Road Flats Hampstead

Year Built :- 1934

Location:- London, UK (Europe)

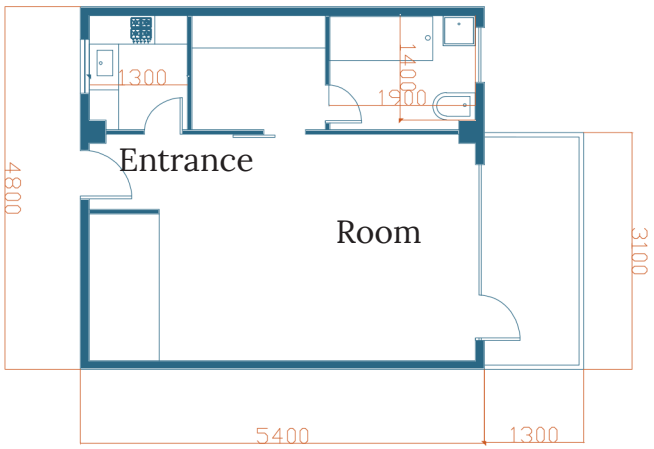




Original Image (Studio)

This image is taken from the plans of Lawn Road Flats in London. The apartments as per the architect were minimalist.

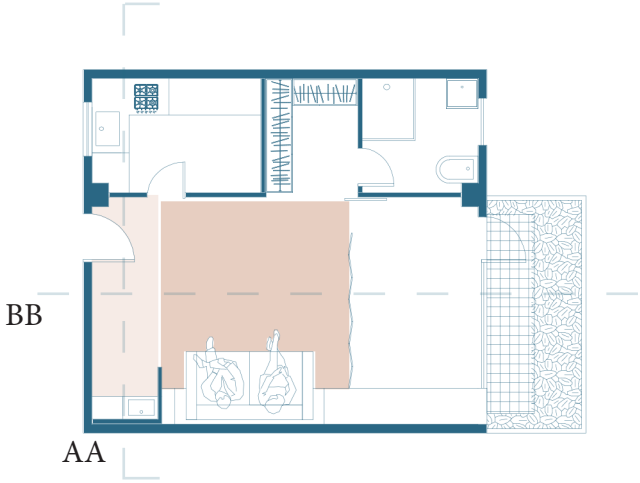
Kitchen Dressing Bathroom



Original Plan redrawn (1:100)

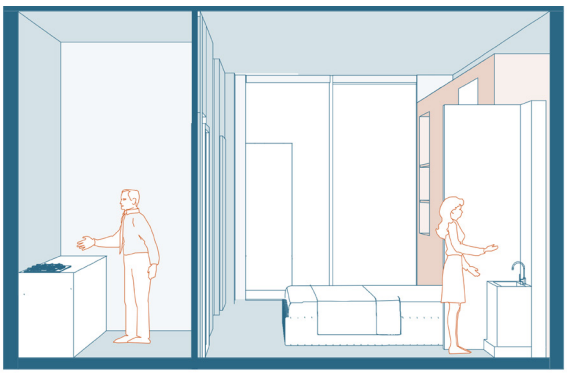
The original image has been redrawn for better clarity of the scale of the building and how it functions. The size of the studio was smaller than expected.

Typology 1:- Studio Unit (20th Century)

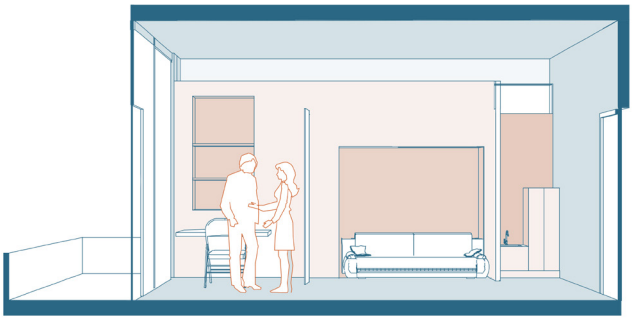


Updated Plan 1:100- Sanitizing Station and Relax Mode

The plan has been updated by keeping the technical spaces intact. In the entrance, small sink has been added in the corner with a wardrobe for sanitization. The flexible unit has been installed on the edge of the wall which remains fixed. The flexible unit consists of sofa bed, sports equipment and a table for work. The panel can be folded out from the unit to close off living from the work room. The balcony is upgraded with plants and grass, a part of it can be used for the urban gardens.



Section AA 1:100- Relax Mode

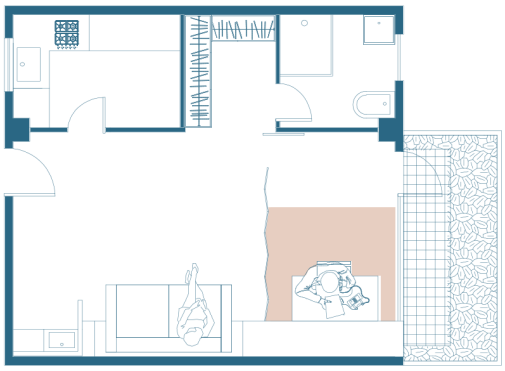


Section BB 1:100- Relax Mode

Sections 1:100-

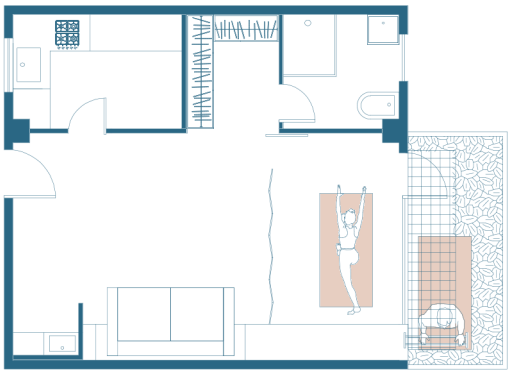
The sections show the studio unit. The AA section cuts through the kitchen and the sanitizing station. The section BB cuts through showing the flexible unit in an elevation showing how the sofa sits within it and how the table can be taken out and folded back.

Typology 1:- Studio Unit (20th Century)



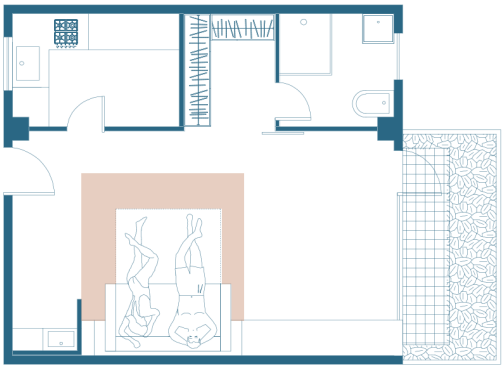
Updated Plan 1:100 - Work Mode

It's 9:00am and Jim has started working from home while Pam makes herself a coffee. The apartment is small so Jim and Pam swap between working on sofa and working on the desk.



Updated Plan 1:100 - Sports Mode

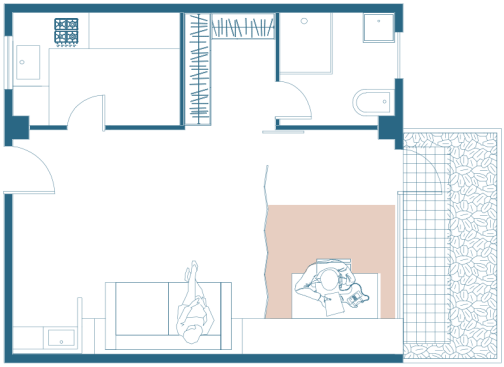
It's 18:00 and Pam is doing Yoga in the open space, while Jim pulls out rods from the flexible unit for some exercising.



Updated Plan 1:100 - Sleep Mode

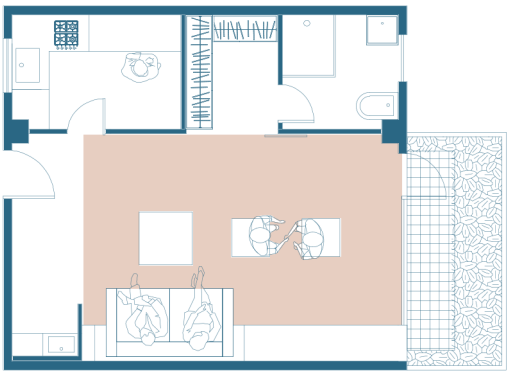
It's 22:00 and Jim and Pam are sleeping. The sofa can be extended to make a bed.

Typology 1:- Studio Unit (20th Century)



Updated Plan 1:100 - Hobby Mode

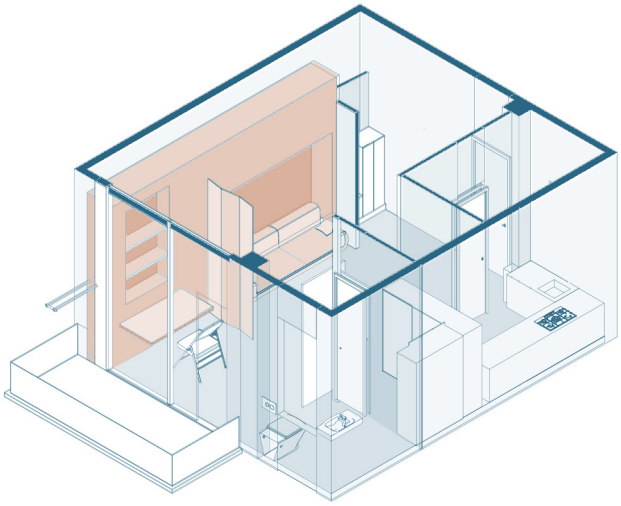
It's a Sunday and Jim is desiging something on his laptop while Pam is relaxing on the sofa.



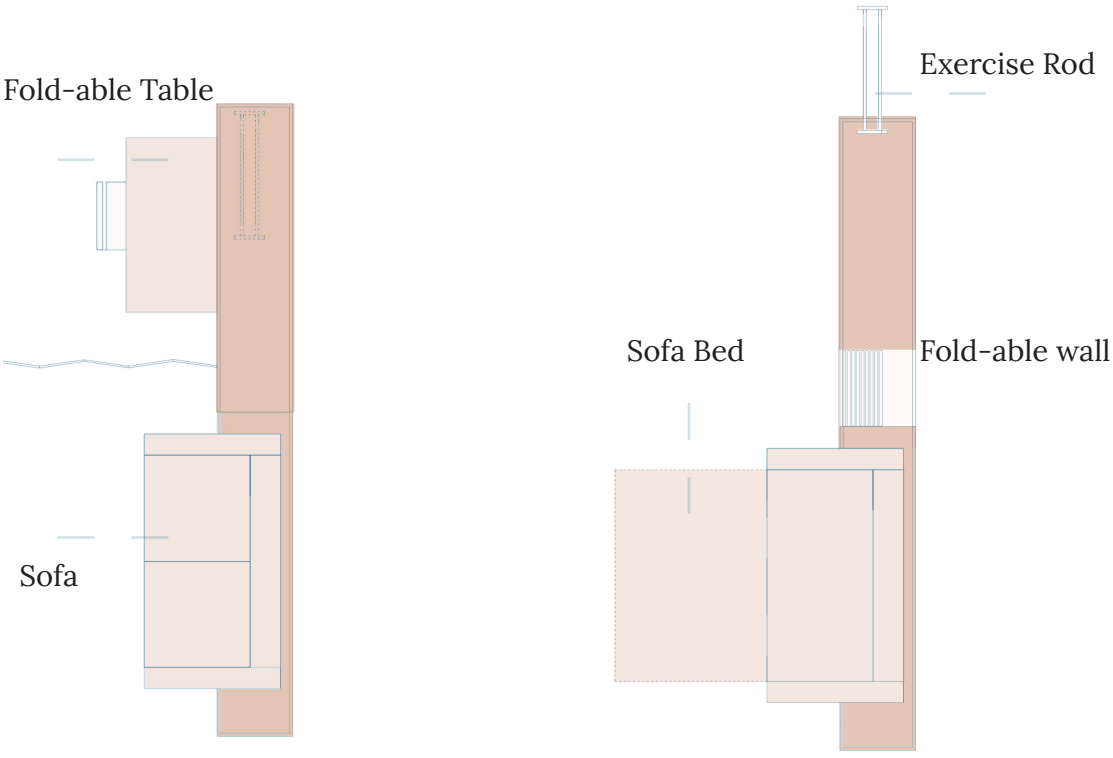
Updated Plan 1:100 - Party Mode

It's a Friday night and Jim has invited few friends over for a party.

Typology 1:- Studio Unit (20th Century)



The isometric shows the studio in a 3 dimensional form. The flexible unit is fixed in studio units, the height is smaller than the wall. In original plan the windows are placed in the kitchen and living room which we have kept as they are.



Typology 1:- Studio Unit (21st Century)

Case Study Information

Project Name :- Bosco Verticale

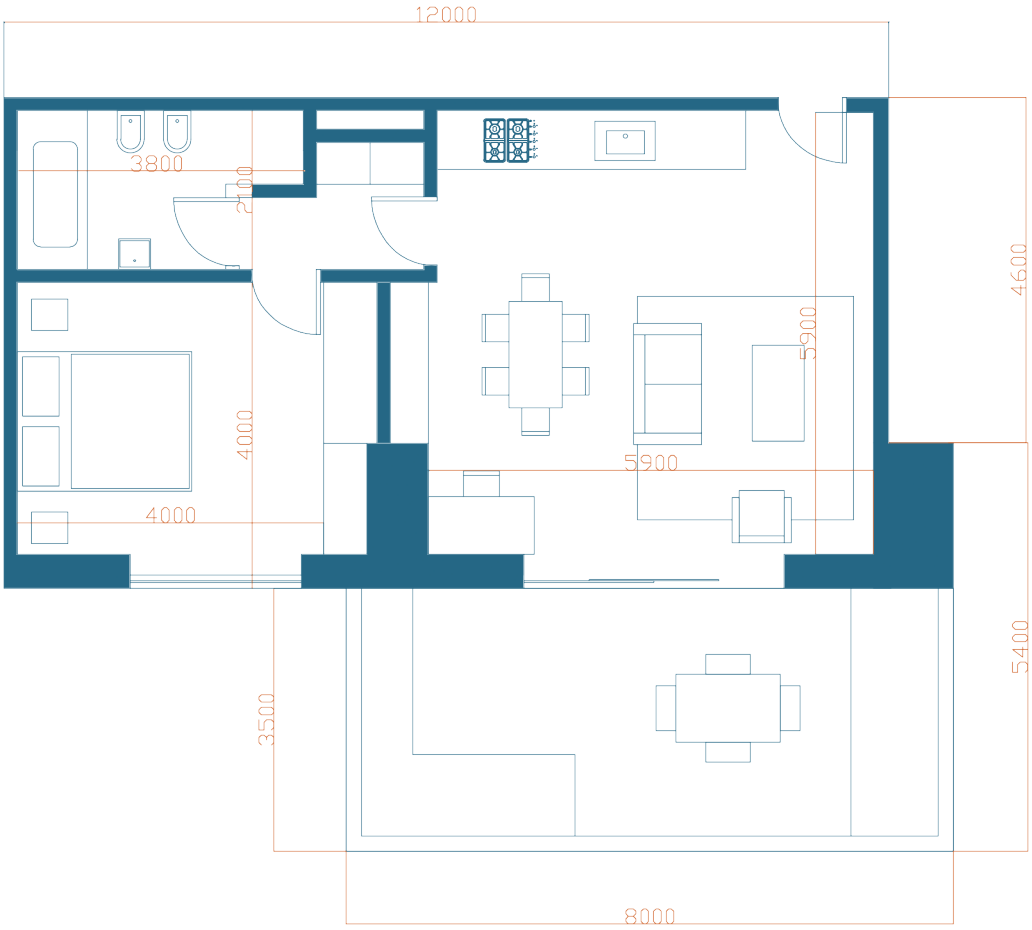
Year Built :- 2014

Location:- Milan, Italy (Europe)

Original Plan photograph

The Original Photo of Bosco Verticale shows the apartment and its functionality.

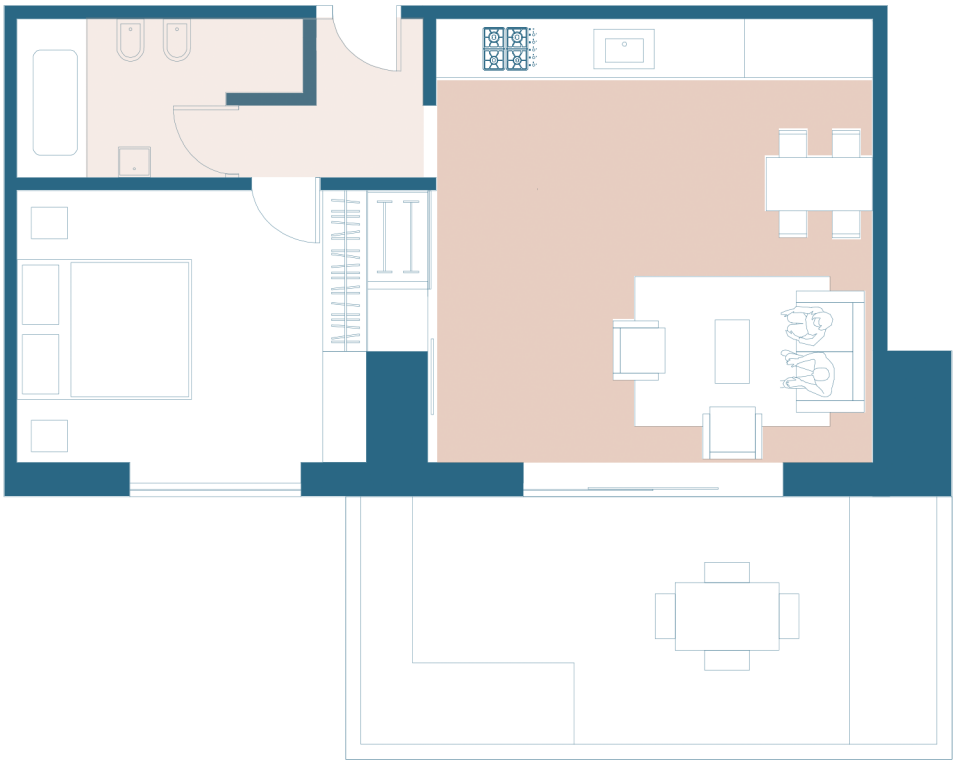
Typology 1:- Studio Unit (21st Century)



Original Plan redrawn (1:100)

The Original Plan was drawn with the help of the image of the plan. The Bosco Verticale is a luxurious residential building with spacious rooms.

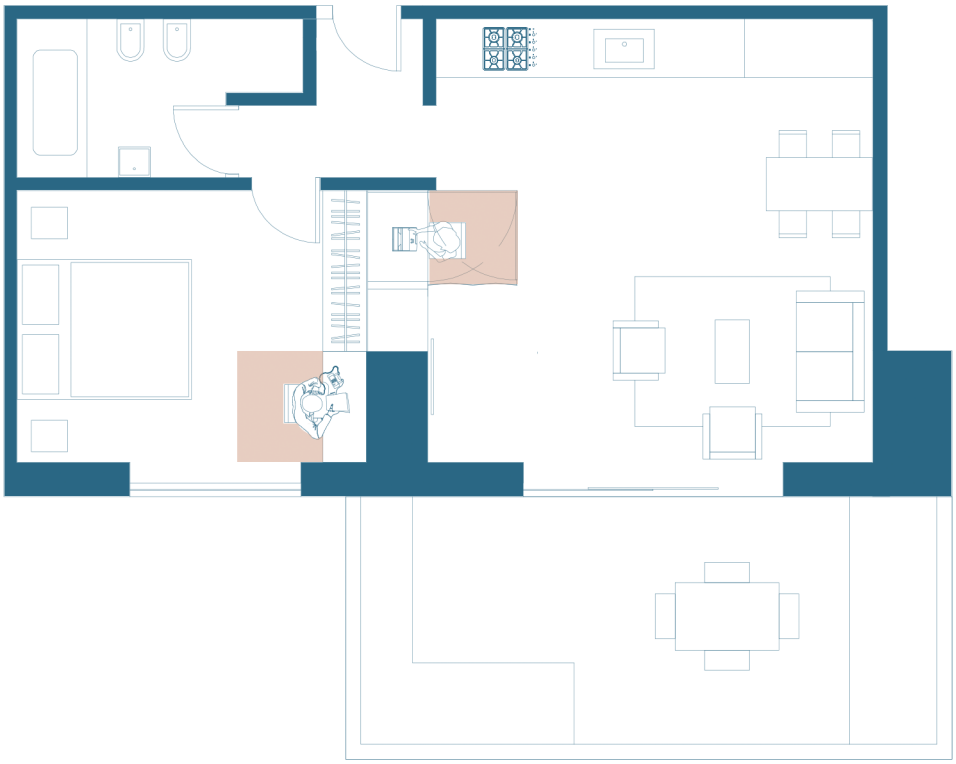
Typology 1:- Studio Unit (21st Century)



Updated Plan 1:100 :- Sanitizing Station and Relax Mode

The Plans of Bosco Verticale are spacious, and are provided with the bathroom in the entrance. There wasn't any major changes added i it except the flexible unit which helps both the personas to work efficiently. The huge columns were a bit hard to deal with.

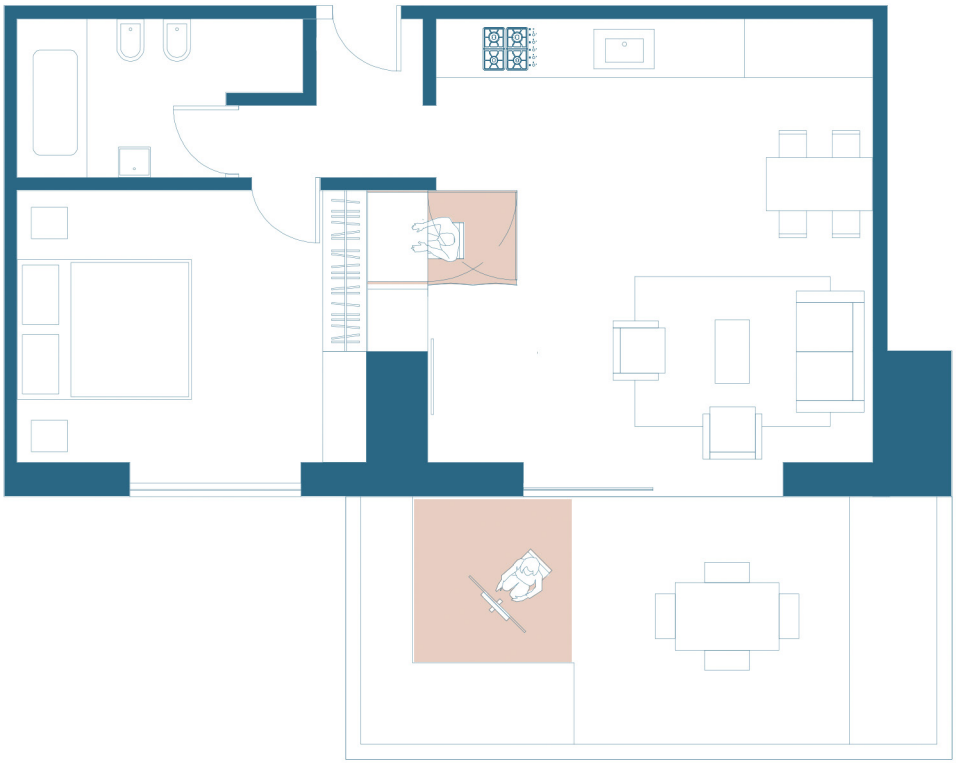
Typology 1:- Studio Unit (21st Century)



Updated Plan 1:100 :- Work Mode

Its 9:00 am and Jim and Pam have both started working on their desks. Jim is attending a zoom call on his computer in the booth while Pam goes through her lecture notes.

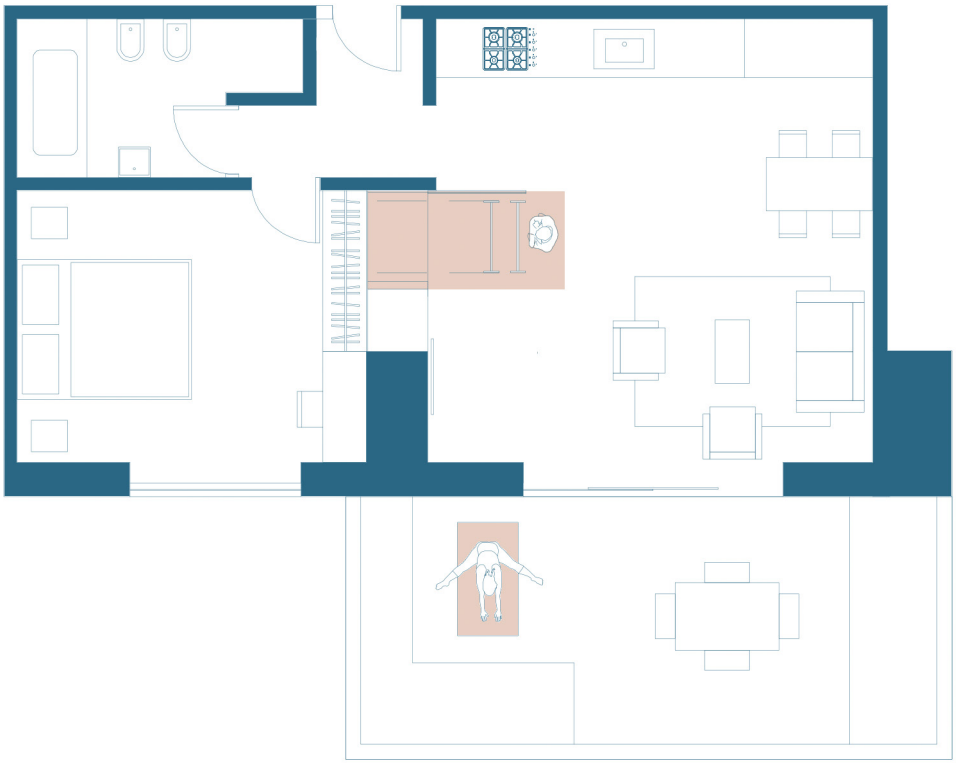
Typology 1:- Studio Unit (21st Century)



Updated Plan 1:100 :- Hobby Mode

Pam has moved her canvas to the balcony and is painting there while Jim works on his designing in the booth.

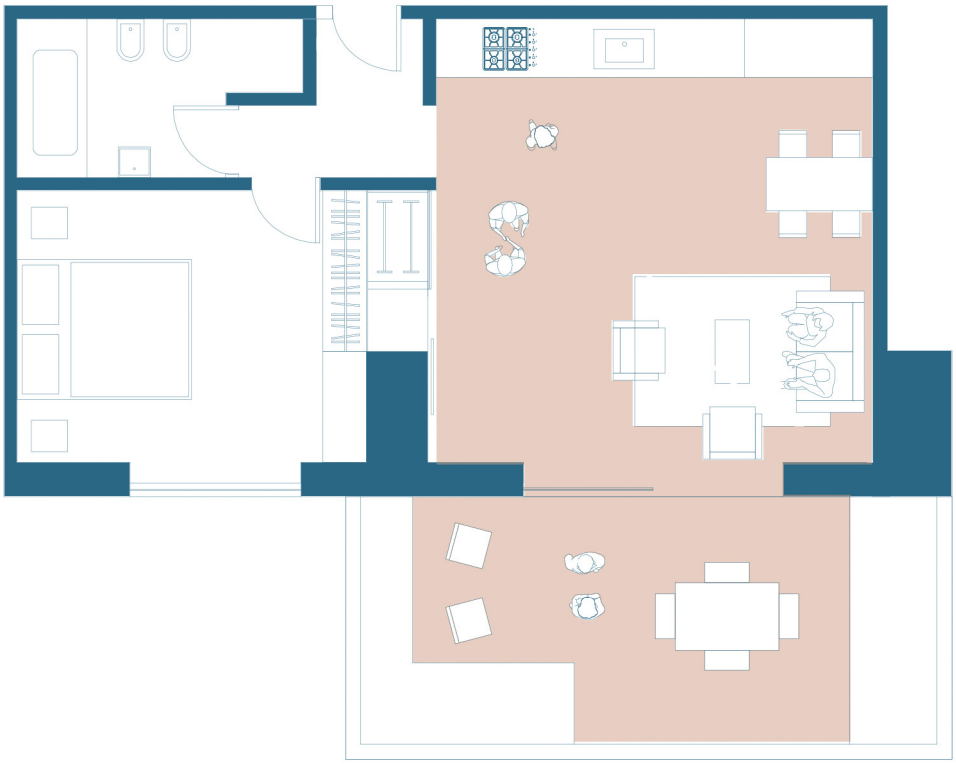
Typology 1:- Studio Unit (21st Century)



Updated Plan 1:100 :- Sports Mode

It's 18:00 and Jim and Pam are tired from sitting on the tables. Jim has turned the zoom booth into his work out area while Pam does Yoga in the balcony.

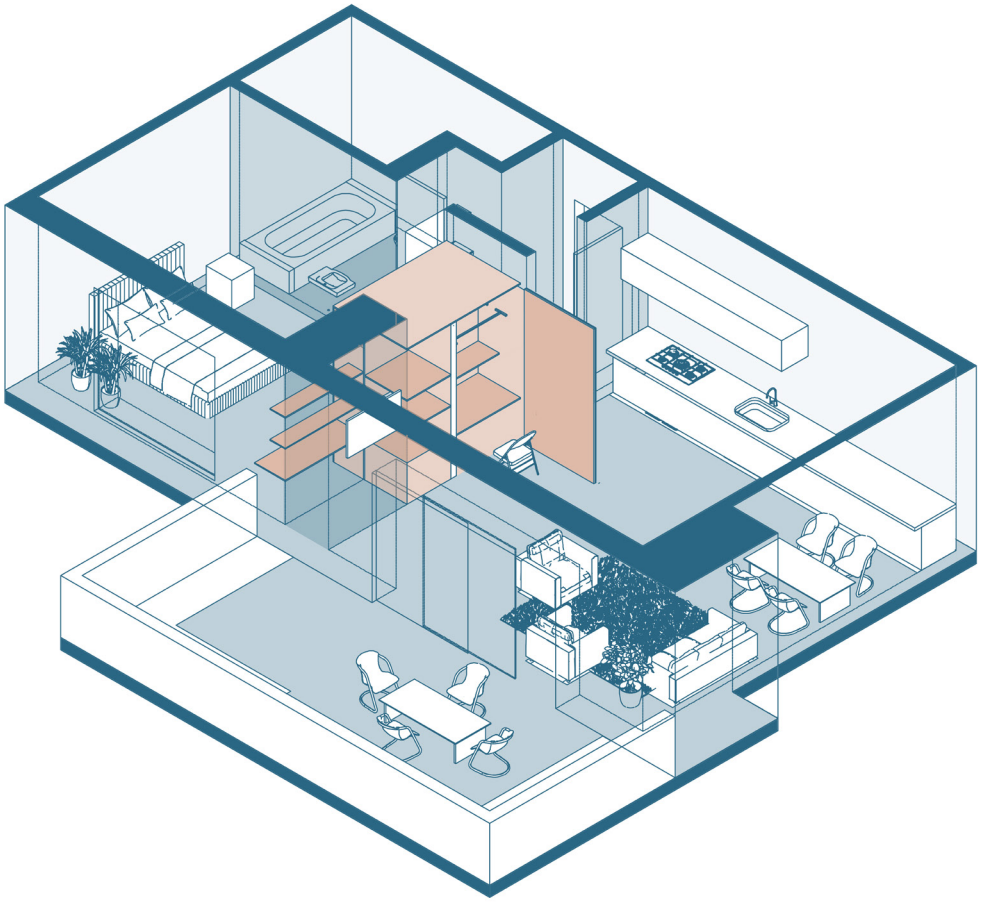
Typology 1:- Studio Unit (21st Century)



Updated Plan 1:100 :- Party Mode

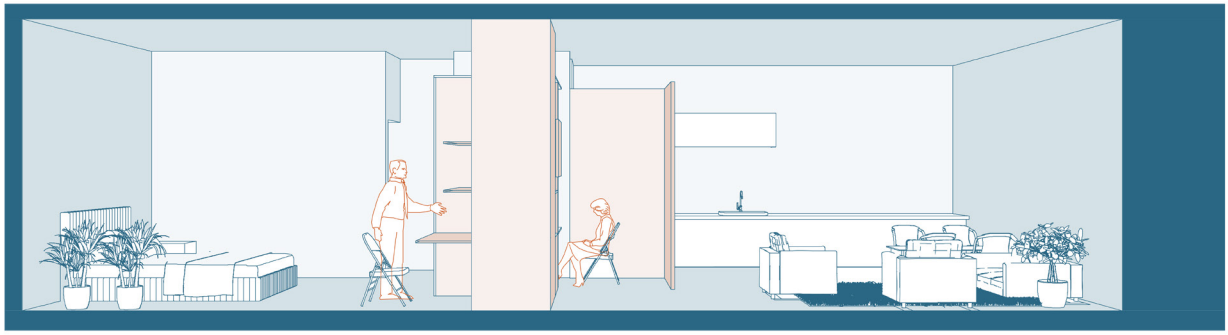
It's Friday evening and Jim has invited his friends over, the glass panel between the living and balcony has been folded back to create a a bigger space for guests to hang out.

Typology 1:- Studio Unit (21st Century)



Isometric 1:100

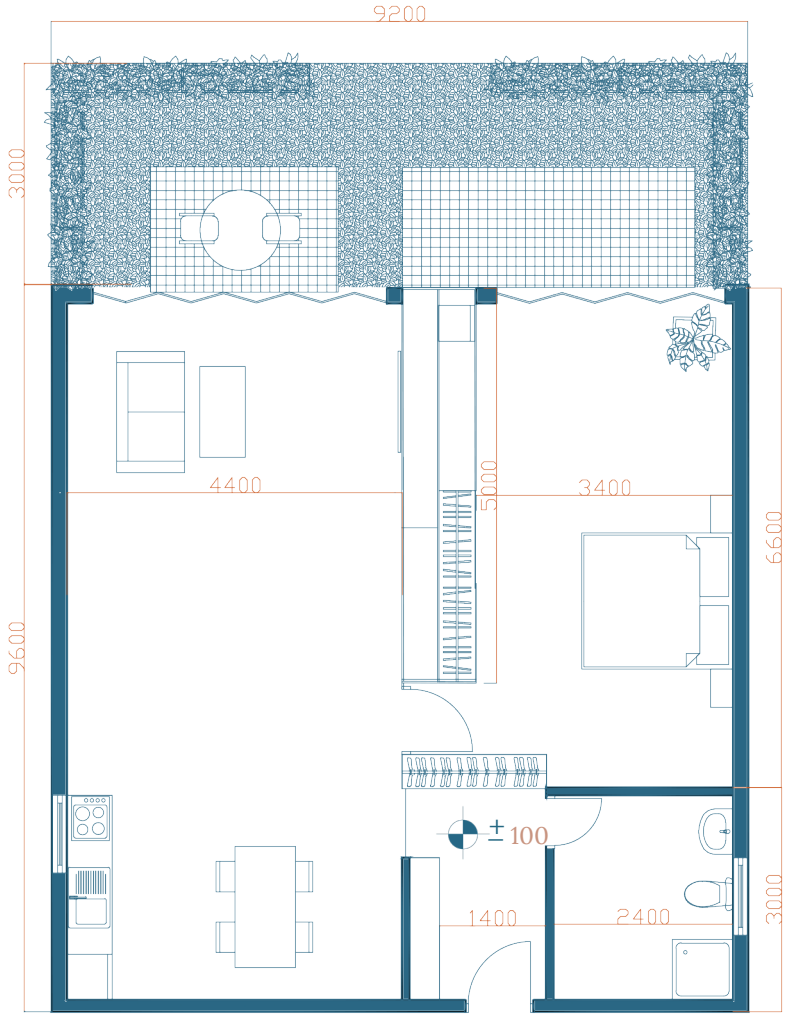
The isometric shows how the unit sits between the living and bedroom in 3 dimensional form.



Section 1:100

The Section shows both Jim and Pam working on their tables.

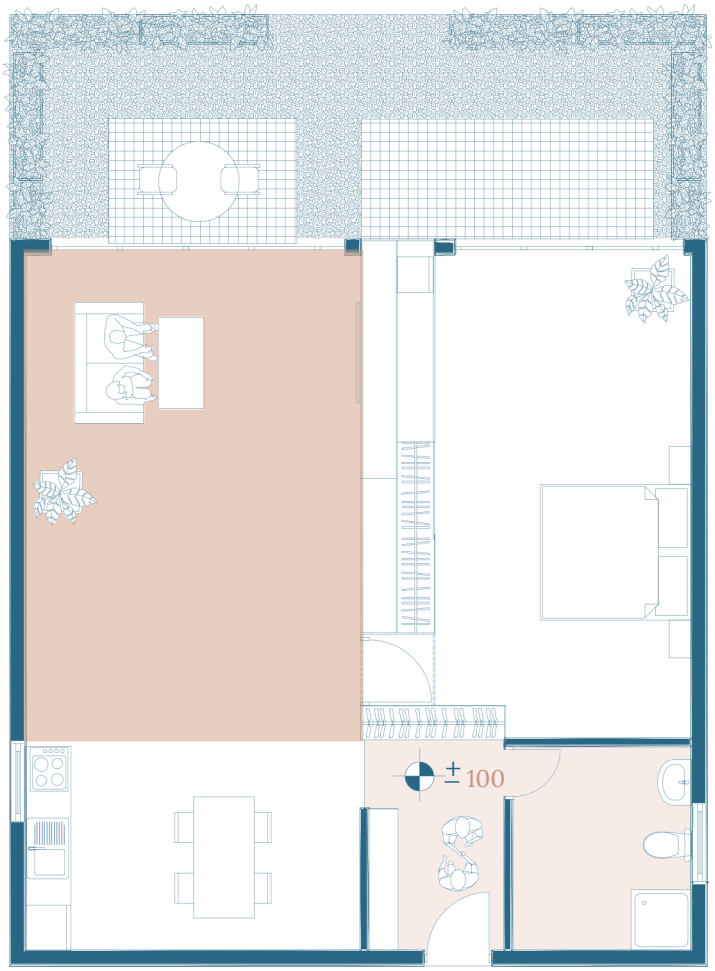
Typology 1:- Studio Unit (21st Century)



New Proposed Plan and Section 1:100 :- Dimensions

The plan shows the dimensions of the new proposed typologies.

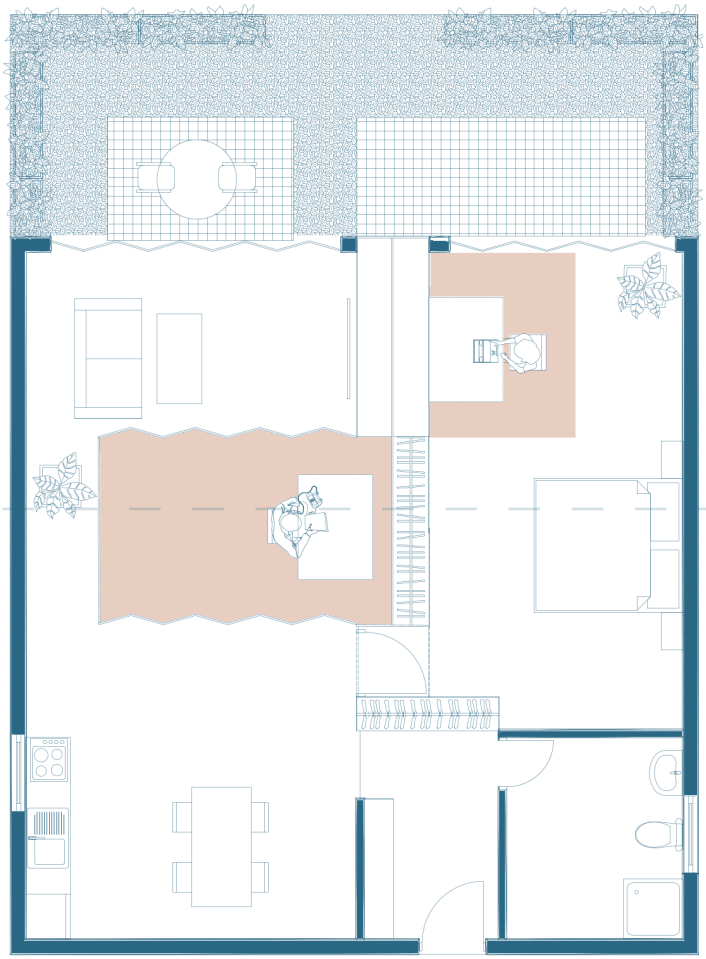
Typology 1:- Studio Unit (21st Century) Post Pandemic

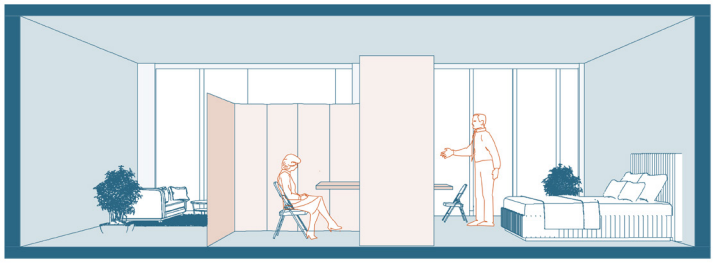


New Proposed Plan 1:100 :- Relax and Sanitization Mode

Inspired by Japanese Genkan we have provided a one foot lower sanitization station in all new proposed typologies. It has a shoe shelf to take shoes off, coat shelf that is part of the flexible unit and a toilet.

Typology 1:- Studio Unit (21st Century) Post Pandemic

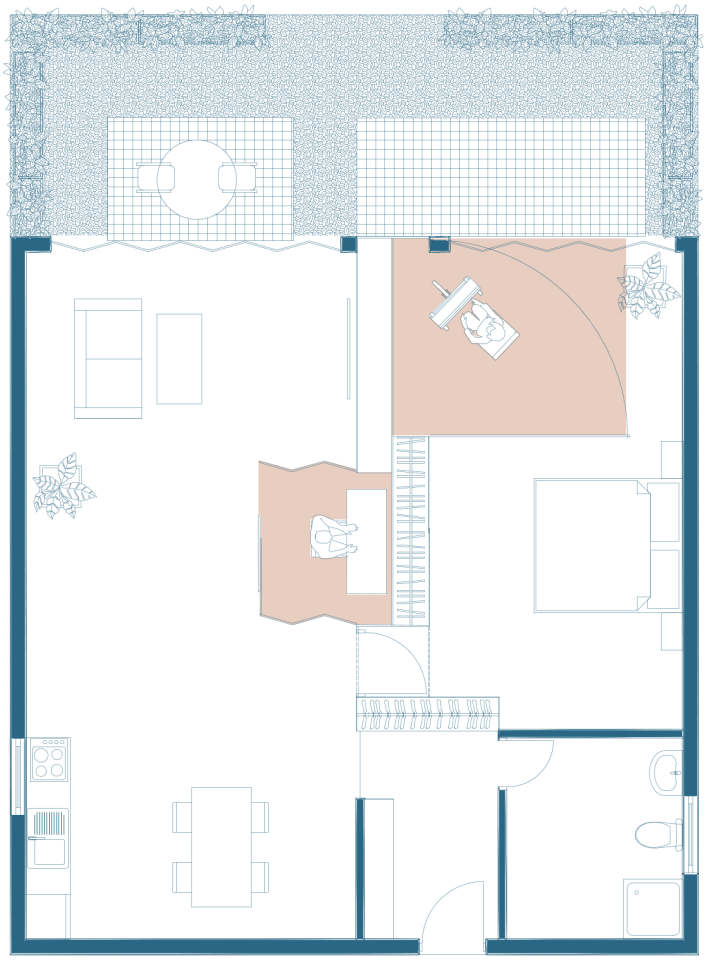




New Proposed Plan and Section 1:100 :- Work Mode

It's 9:00 am and Jim is attending the meeting inside the booth while Pam is giving lecture to her student online from her table.

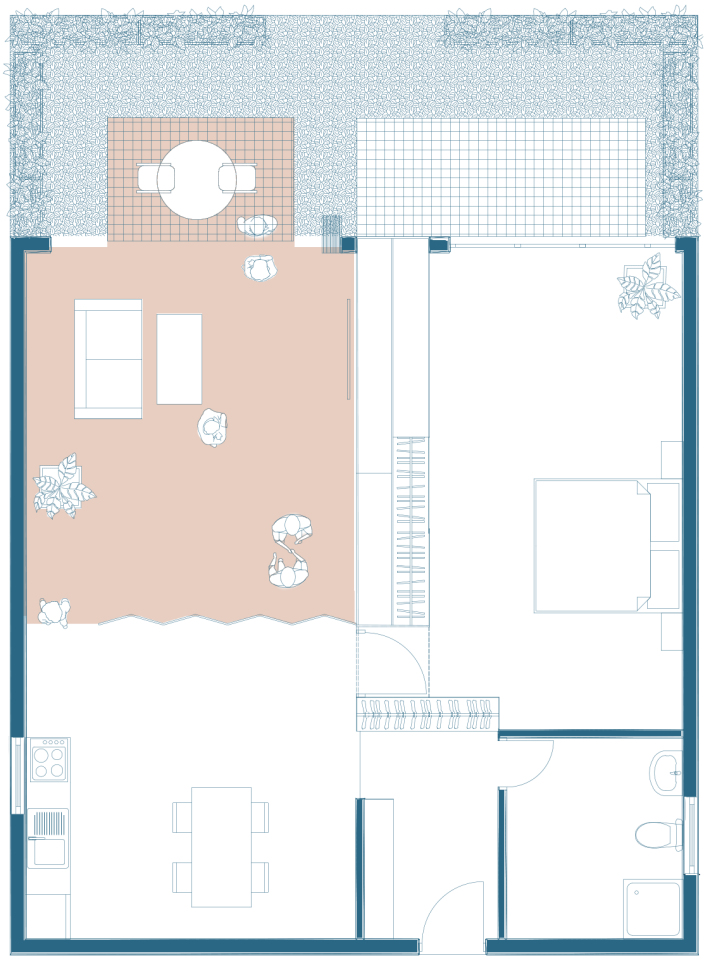
Typology 1:- Studio Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 :- Hobby Mode

It's a Sunday morning, Pam is painting in her room by folding out the door and creating a private enclosed space while Jim sits inside the booth to work on his design.

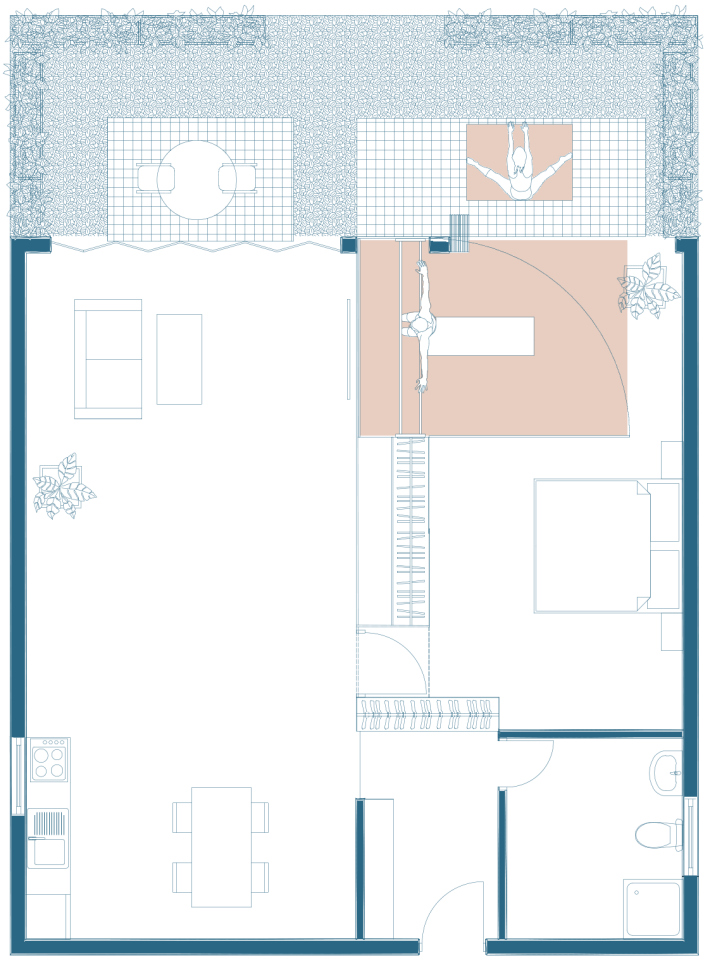
Typology 1:- Studio Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 :-Party Mode

It's a Friday Evening and Jim has invited few friends over. The panel from inside the unit has been folded out to create close the kitchen from the living room. The glass panel has been folded to create a bigger space by incorporating the balcony.

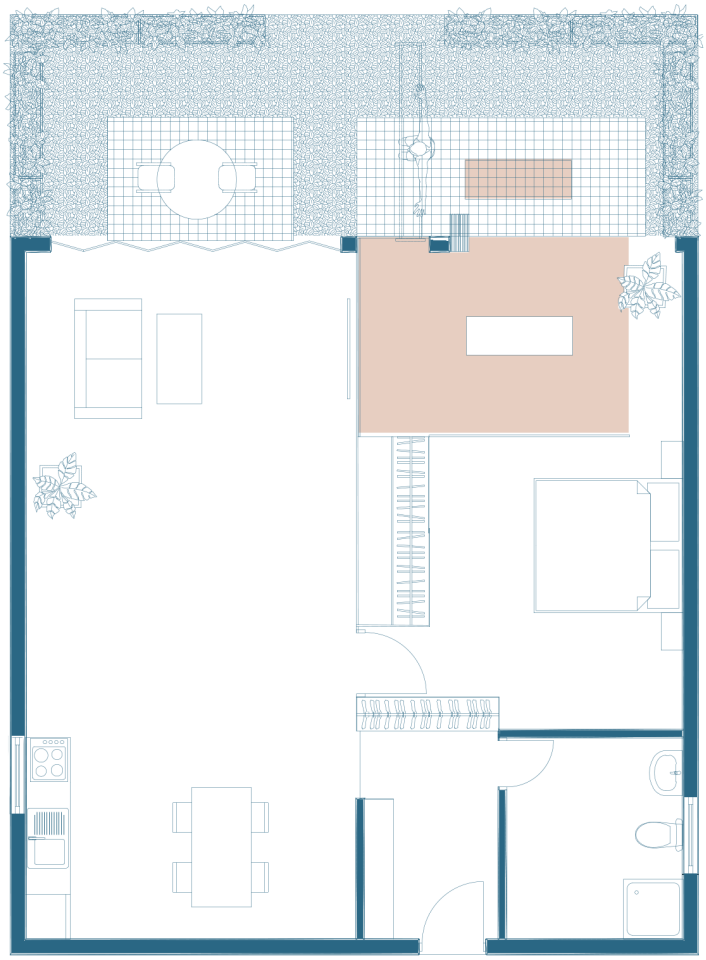
Typology 1:- Studio Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 :- Sports Mode 1

It's 18:00 and Jim and Pam are tired from working and sitting all day. Pam is doing Yoga in the balcony. Jim has opened the panel of the unit to create a booth. On the upper side, there are rods for exercising.

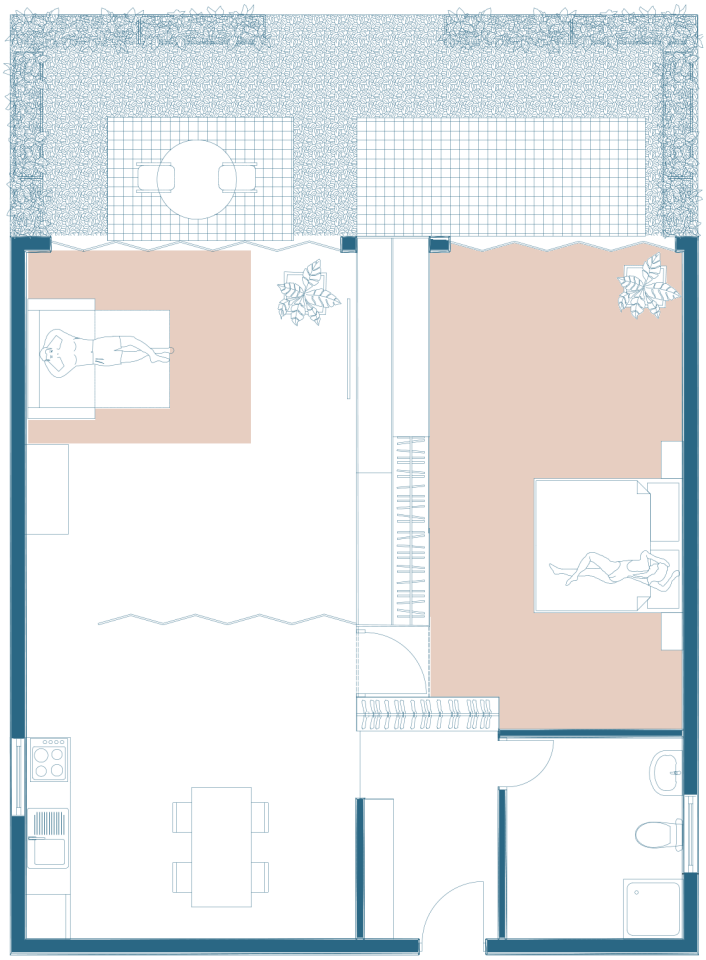
Typology 1:- Studio Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 :-Sports Mode 2

The rods can be pulled outside in the balcony too for breath of fresh air.

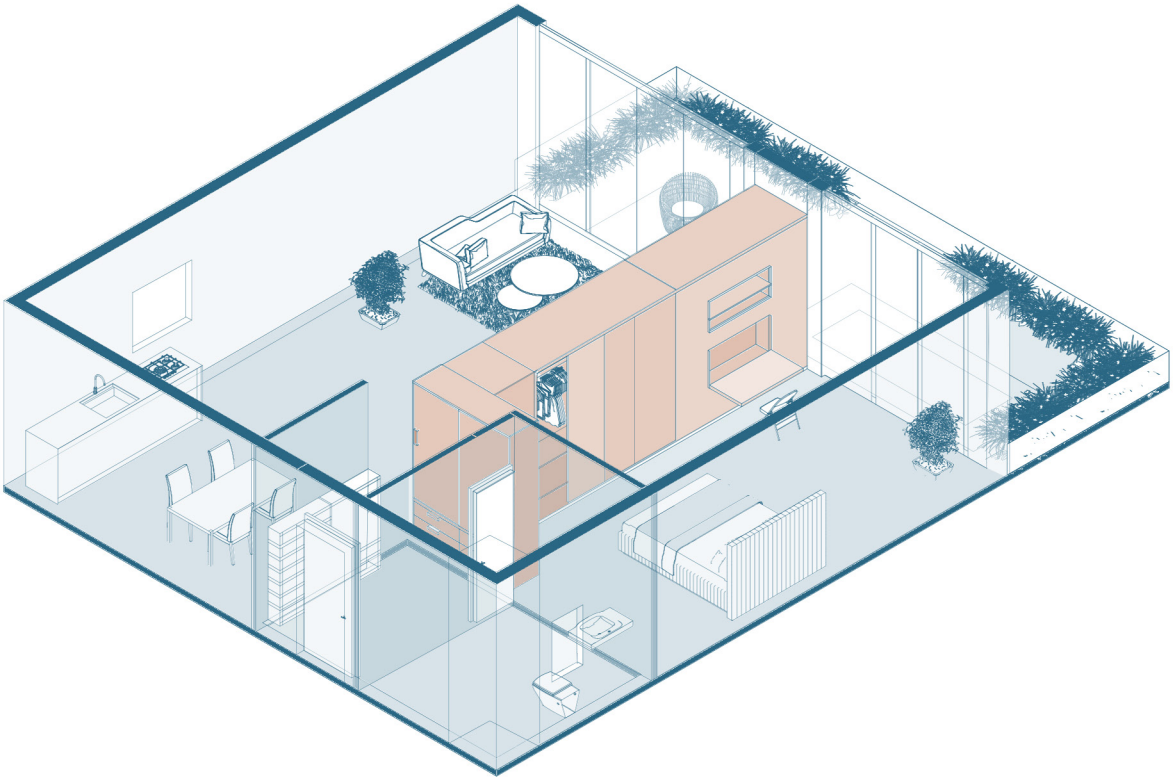
Typology 1:- Studio Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 - Isolation Mode

Pam has fallen sick so Jim has moved out of the room. He is sleeping on the sofa bed while Pam is isolated inside the room.

Typology 1:- Studio Unit (21st Century) Post Pandemic



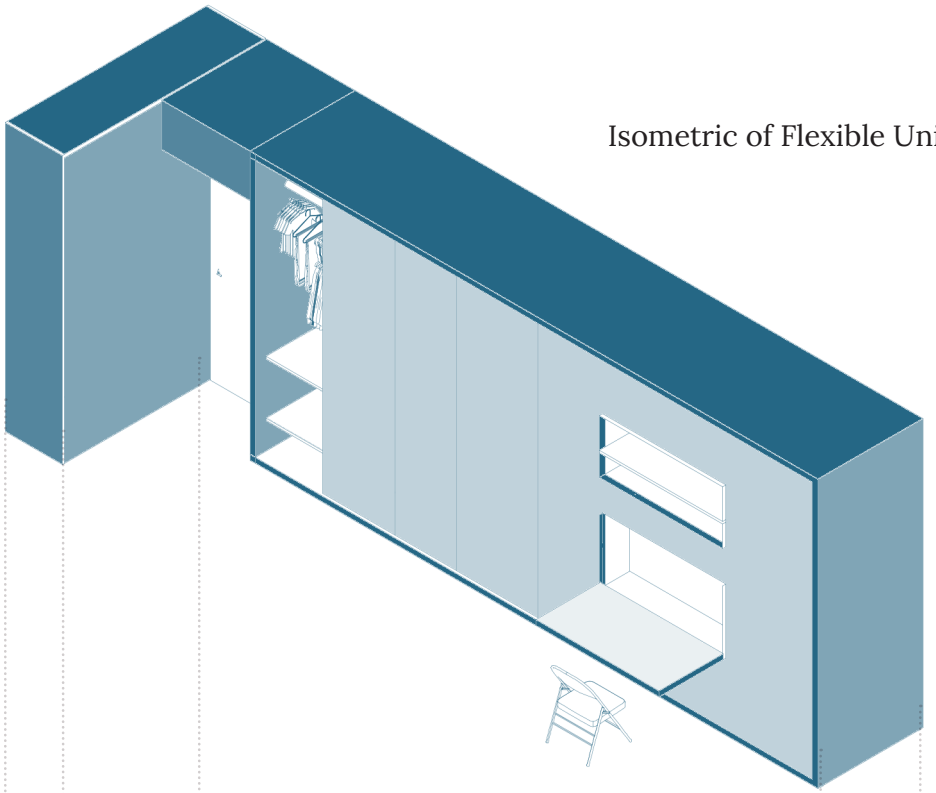
Isometric 1:100

The isometric shows how the flexible unit sits in between the living and bedroom.

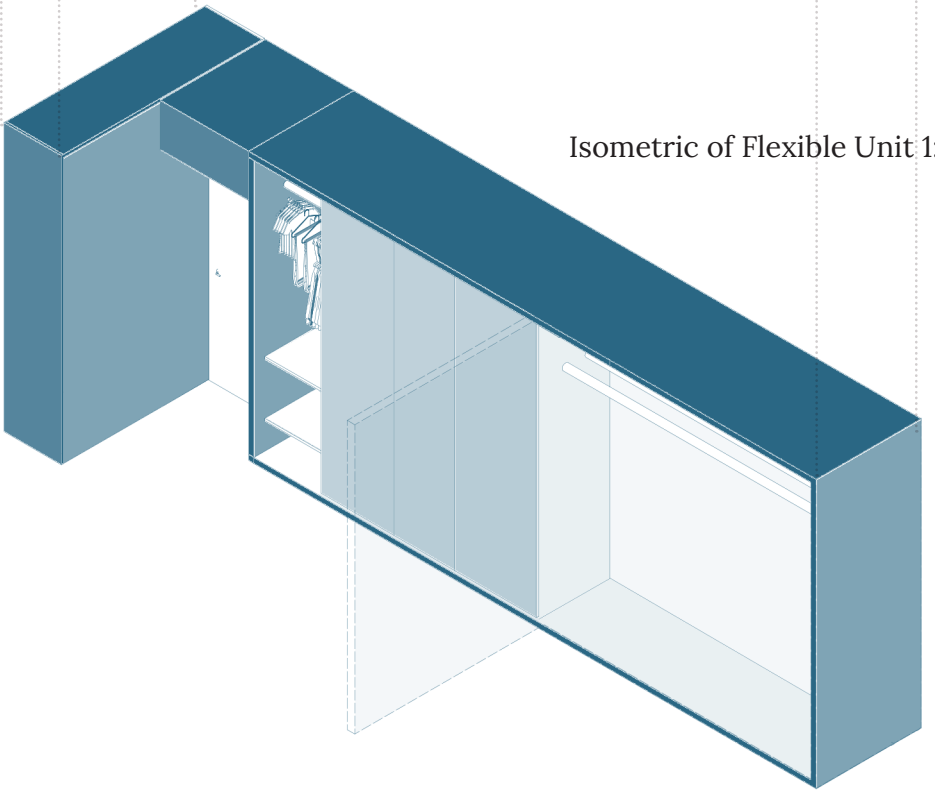
Interior Render

The walls have been kept light and the colour has been added in the flexible unit.

Typology 1:- Studio Unit (21st Century) Post Pandemic

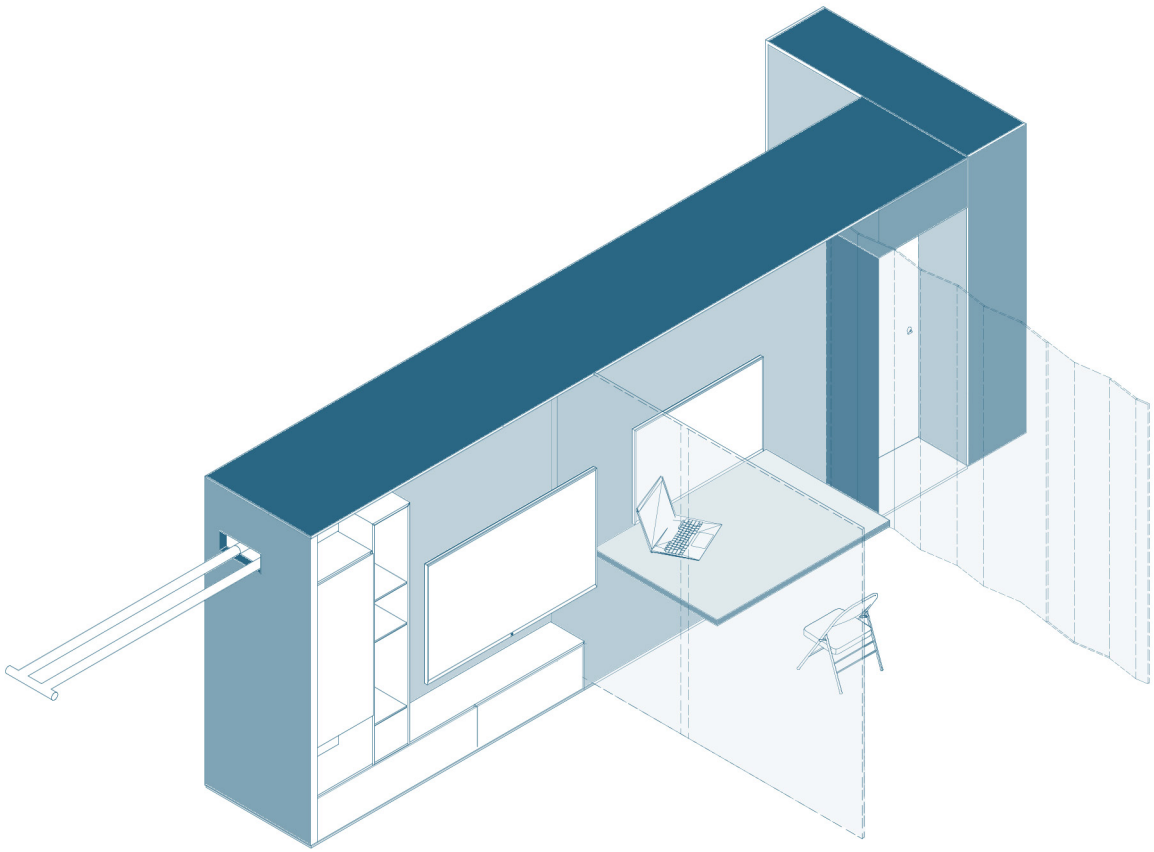


Isometric of Flexible Unit 1:50. (Work Mode)



Isometric of Flexible Unit 1:50. (Sports/Hobby Mode)

Typology 1:- Studio Unit (21st Century) Post Pandemic



Isometric of Flexible Unit 1:50. (Zoom Room)

The Isometric shows how the Zoom room works and is flexible to convert into a hobby mode as well. The rods can be pulled out for working out.

05.2 DOUBLE UNIT TYPOLOGIES

SUMMARY

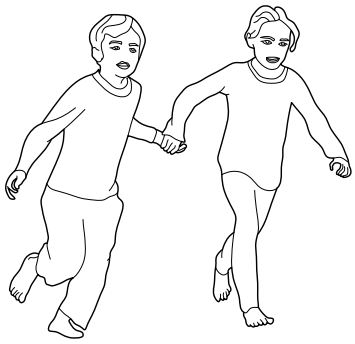
For double unit typologies we wil take the same case study as the single unit but the plans will be bigger that can accommodate a family of four. We will try to reconfigure the plans of each century according to the needs of our users and propose a new one in the very end.

Persona 1:- Rebecca
Personality Type:- Ambivert
Occupation:- Unemployed
Age:- 20-39 years
Location:- Europe
Hobbies:- Painting and Sports.

Rebecca is a stay home mom, she is unemployed. She likes to paint and do sports as a hobby. She is married to Antonio. They are parents to two boys.

Persona 2:- Antonio
Personality Type:- Introvert
Occupation:- Employed
Age:- 20-39 years
Location:- Europe
Hobbies:- Reading books

Antonio works in a firm. He likes to read books in his free time. He needs a table for his work. He is married to Rebecca and has two sons with her.



Persona 3 & 4:- Joey and Chris
Personality Type:- Introvert
Occupation:- Students
Age:- 8-10 years
Location:- Europe
Hobbies:- Sports, computer games.

Joey and Chris both go to school. Joey is in high school and Chris is in middle school. They both are attending school from home these days.

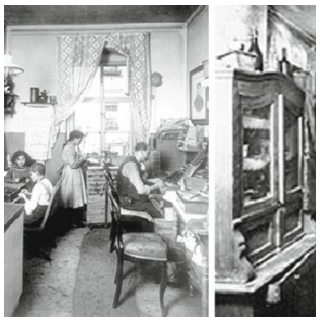
Typology 2:- 2-Bedroom Unit (19th Century)

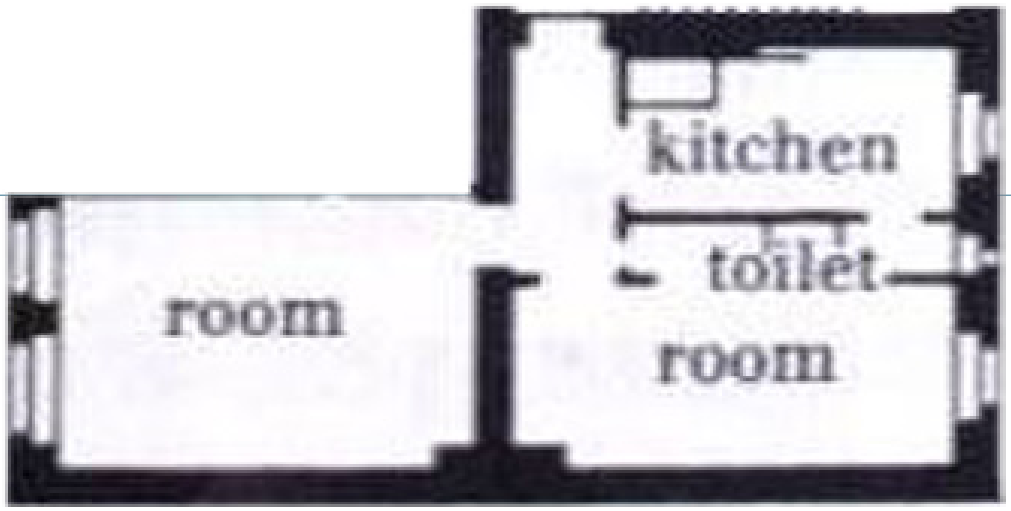
Case Study Information

Project Name :- Berlin Tenements

Year Built :- 1880

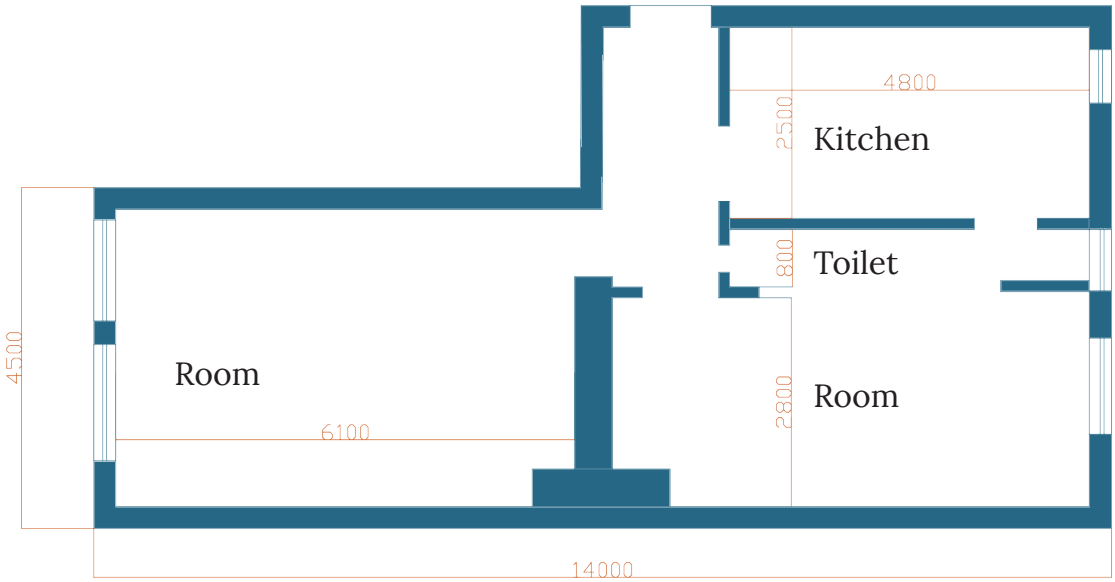
Location, Berlin, Germany (Europe)





Original Photo

The Original Photo is from the Tenements.



Original Plan Redrawn (1:100)

The Original Plan is redraw to better understand the scale of the typology and its functionality.

Typology 2:- 2-Bedroom Unit (19th Century)

Updated Plan 1:100 - Sanitization and Relax Mode

The kitchen and Toilet have been swaped. The toilet has been made bigger with an installation of a shower. The flexible unit is movable to adjust according to the mode.

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Updated Plan 1:100 - Sleep Mode

Since the space is less, the lounge is used as second room for Joey and Chris while Rebecca and Antonio sleep in the room.

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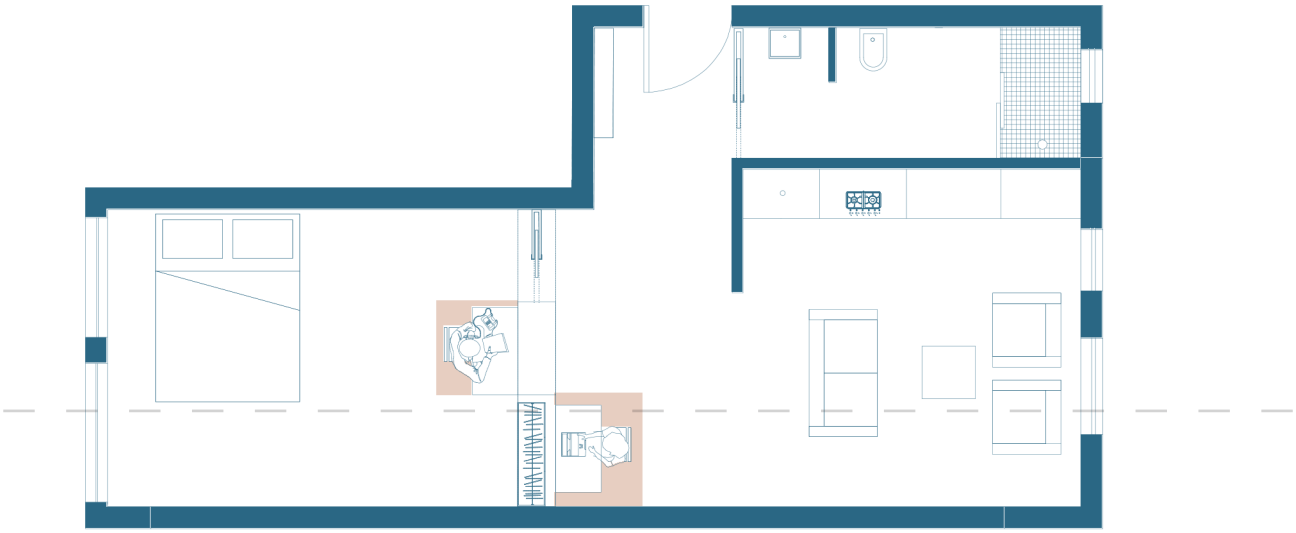
Typology 2:- 2-Bedroom Unit (19th Century)



Updated Plan 1:100 - Work Mode

It's early morning on a Monday and Antonio has started working while Joey attends the lecture in the living room. Rebecca is out with Chris for grocery shopping.

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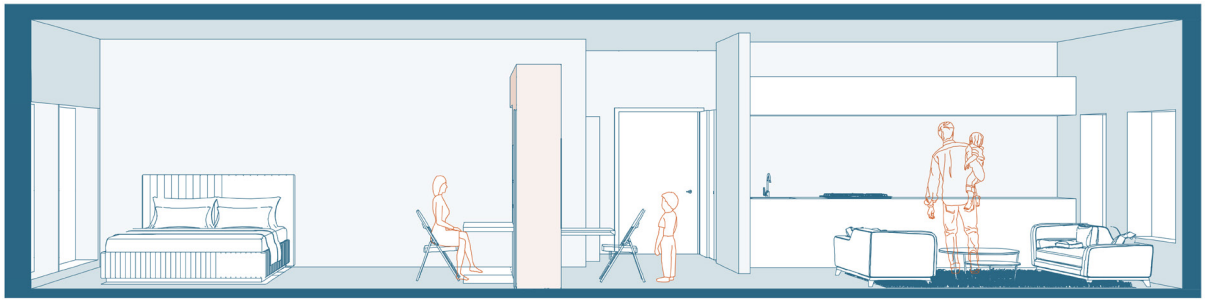
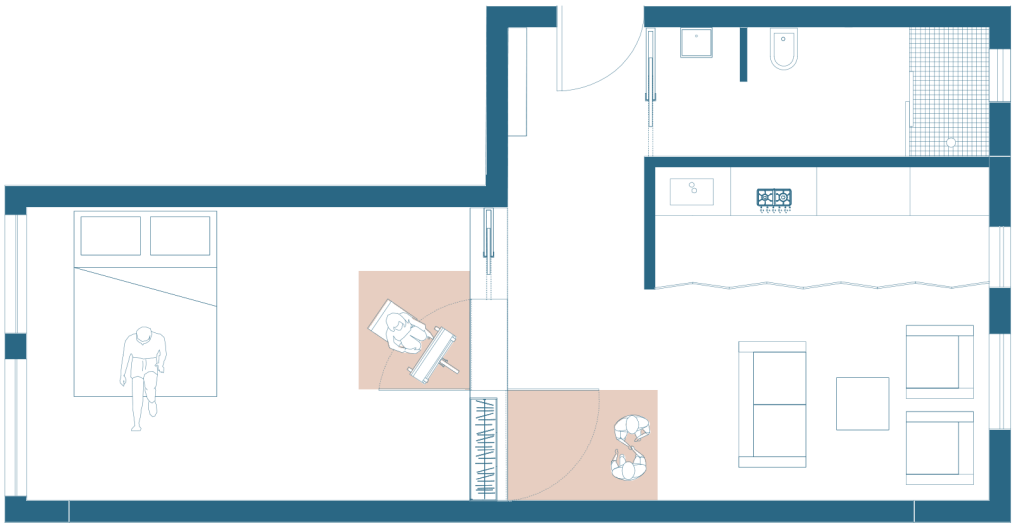


Section 1:100 - Work Mode

The section cuts through the flexible unit to show the fold-able tables and the typology in the work mode.

Typology 2:- 2-Bedroom Unit (19th Century)



Updated Plan 1:100 - Hobby Mode

It's a Sunday afternoon, Rebecca has folded out the panel to create space for her canvas to paint while Joey and Chris play in the living room and Antonio reads a book on the bed.

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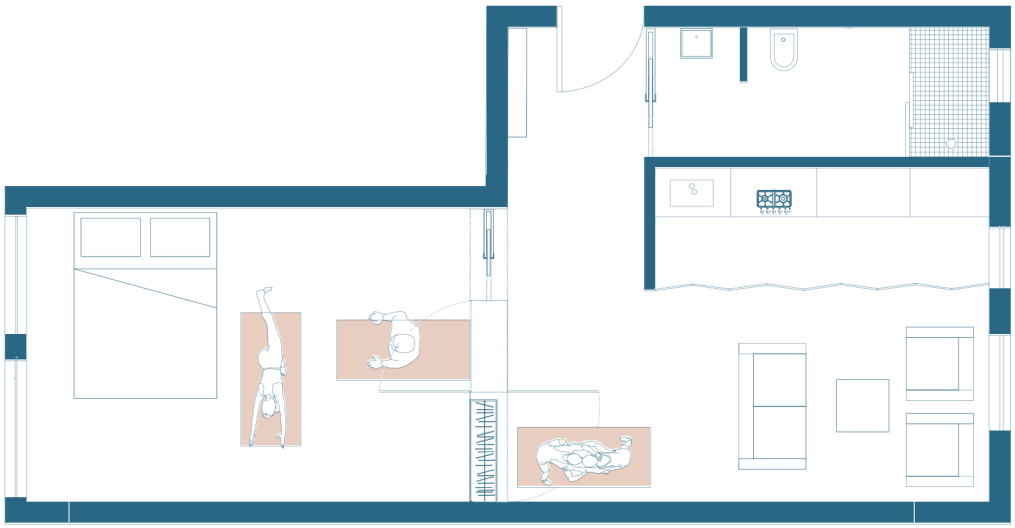

Updated Plan 1:100 - Sports Mode

It's evening on a weekday, Rebecca is doing yoga in the room while Antonio follows her. Joey and Chris try wrestling in the living room.

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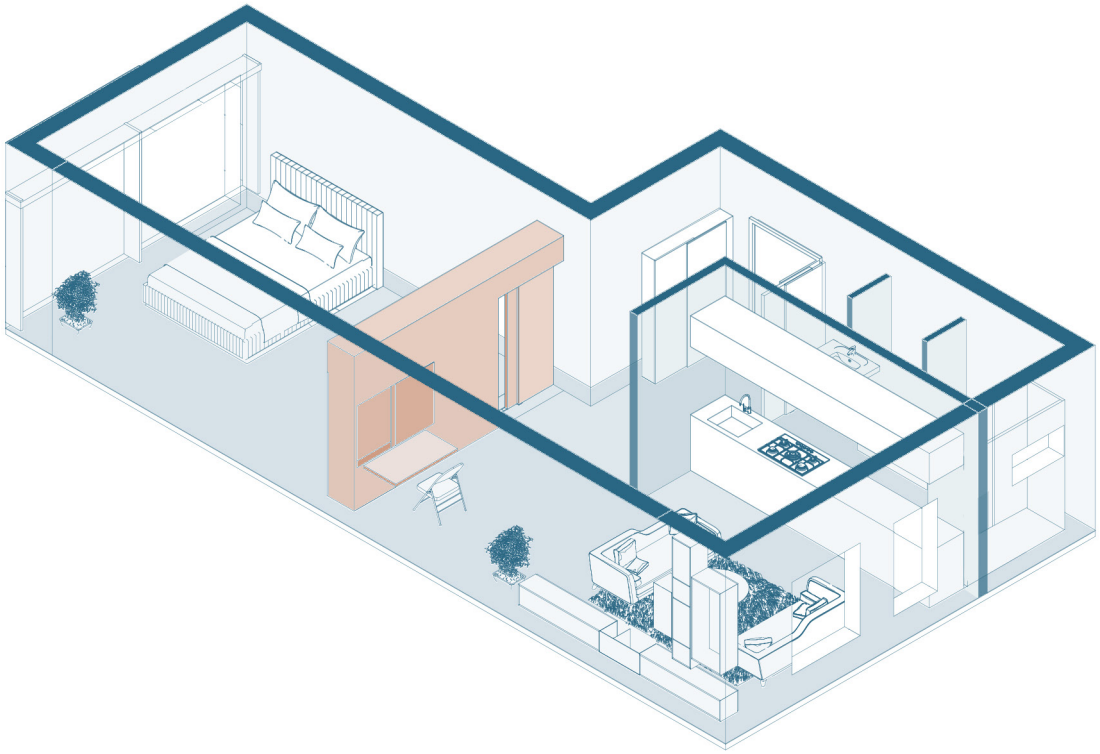
Typology 2:- 2-Bedroom Unit (19th Century)

Updated Plan 1:100 - Party Mode

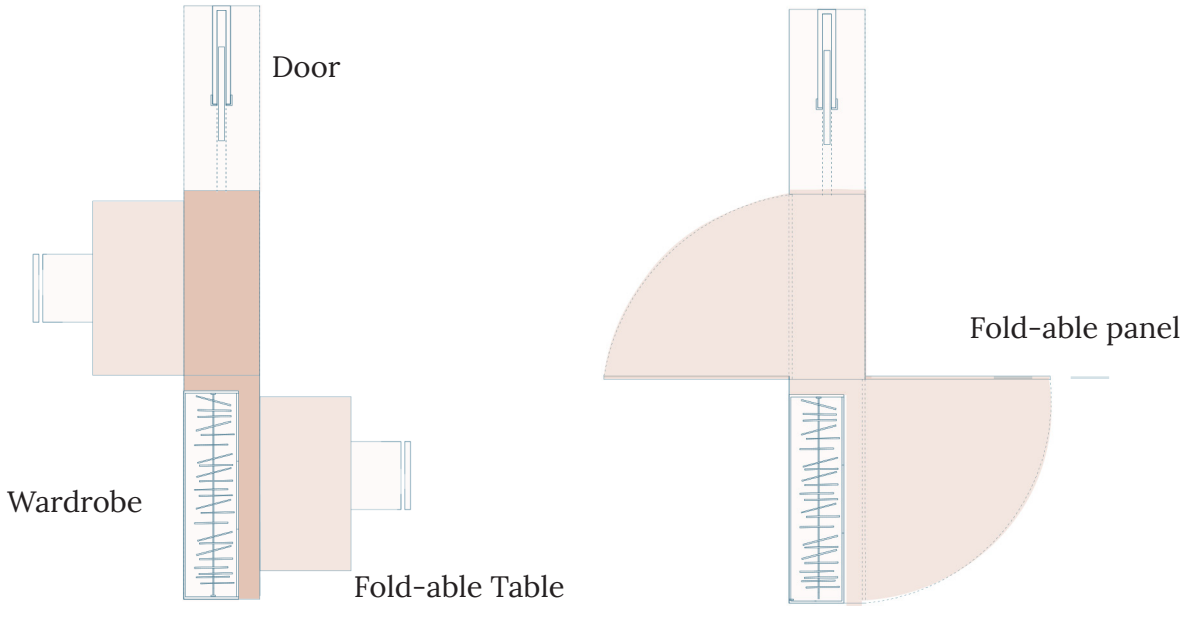
It's a Saturday night and Rebecca has invited people over. The flexible unit has been pushed away to create a bigger space. The kitchen panel has also been folded back to open it for the guests.

Typology 2:- 2-Bedroom Unit (19th Century)



Isometric 1:100.

The Isometric highlights how the flexible unit sits between the living and bedroom.



Units Diagram 1:50

The unit diagarms show how the flexible unit operates.

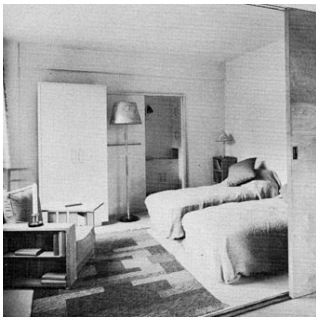
Typology 2:- 2-Bedroom Unit (20th Century)

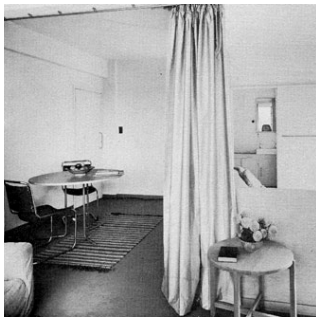
Case Study Information

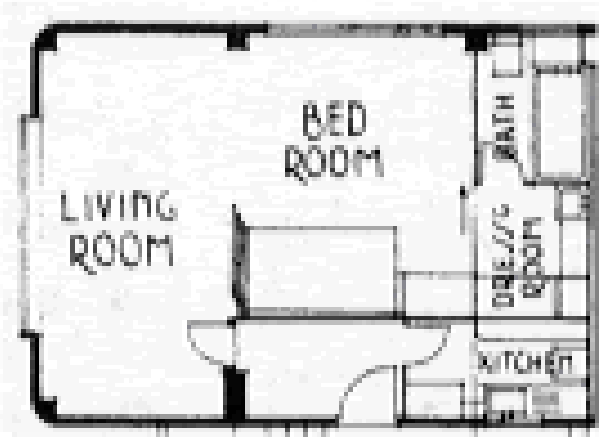
Project Name :- Lawn Road Flats Hampstead

Year Built :- 1934

Location:- London, UK (Europe)

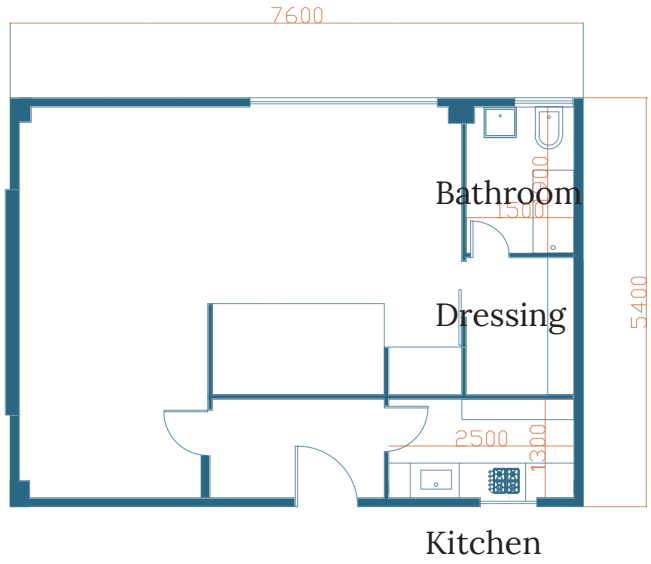






Original Image (Studio)

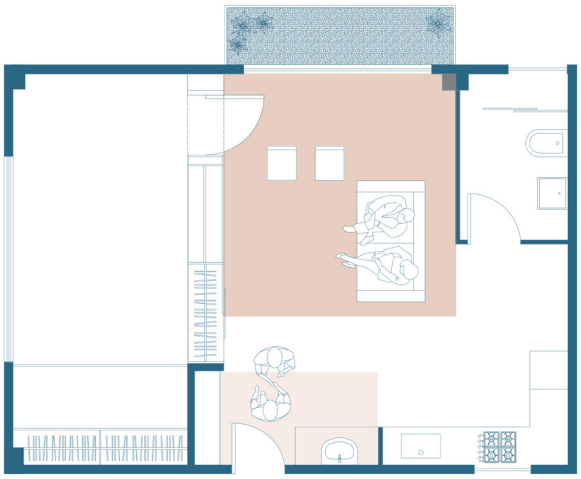
This image is taken from the plans of Lawn Roads Flats. It was a flat that consisted of two rooms.



Original Plan redrawn (1:100)

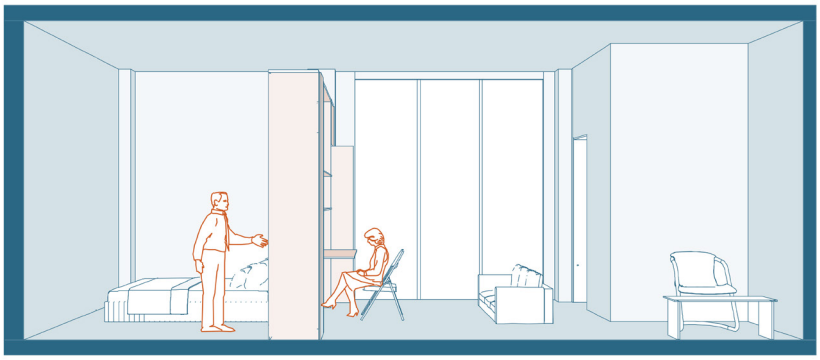
The original image has been redrawn for better clarity of the scale of the building and how it functions.

Typology 2:- 2-Bedroom Unit (20th Century)



Updated Plan:- Sanitizing station and Relax mode.

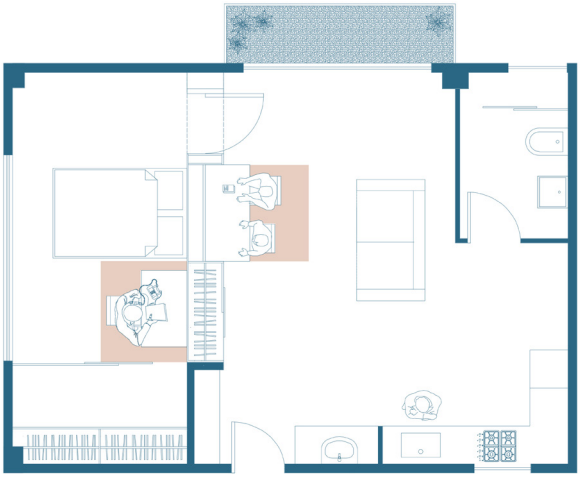
The updated plan has a sink in the entrance for sanitization purposes. The flexible unit is fixed as the apartment has windows on three sides. Kitchen has been opened to make the living bigger. The dressing has been replaced and entrance has been changed.



Section 1:100 :- Work Mode

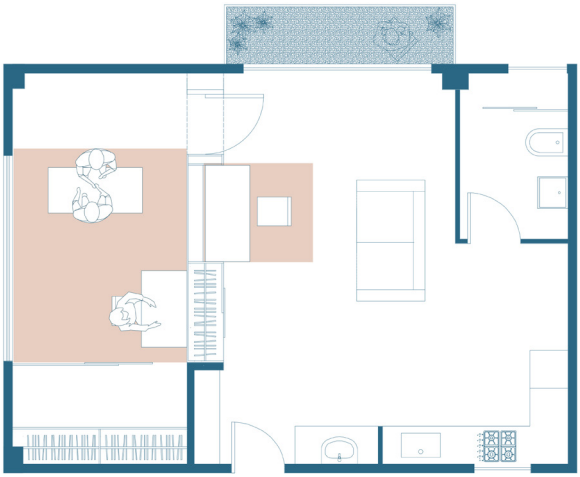
The section cuts through the flexible unit that shows the table and the bed.

Typology 2:- 2-Bedroom Unit (20th Century)



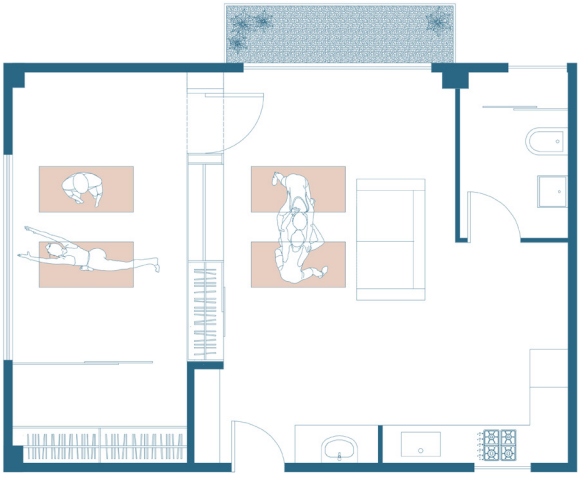
Updated Plan:-Work Mode

It's early Morning on a Monday and Antonio has started working while both kids are studying from the desk. The desks have been folded out from the unit. Rebecca makes herself in the coffee.



Updated Plan:-Hobby Mode

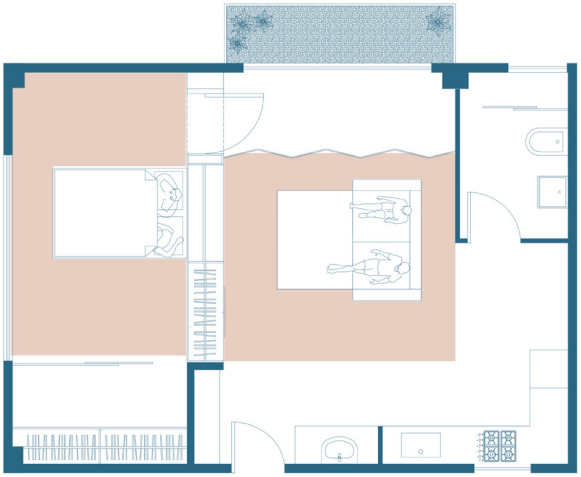
Rebecca is working on the table for her drawings, while kids play in the background.



Updated Plan:-Sports Mode

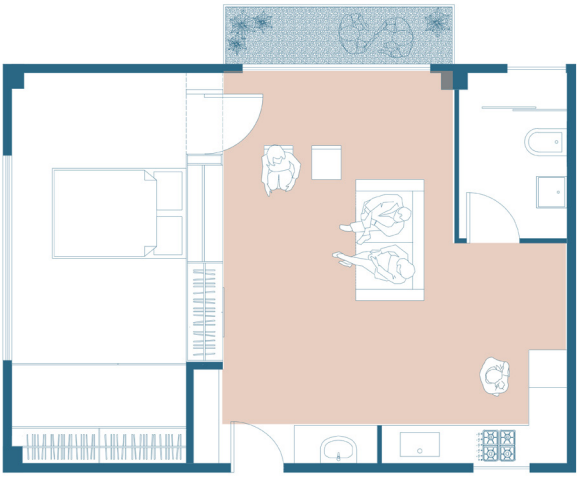
After tiring day of sitting on the chairs all day, Rebecca and Antonio are doing Yoga in the room while Joey and Chris are trying wrestling.

Typology 2:- 2-Bedroom Unit (20th Century)



Updated Plan:-Sleep Mode

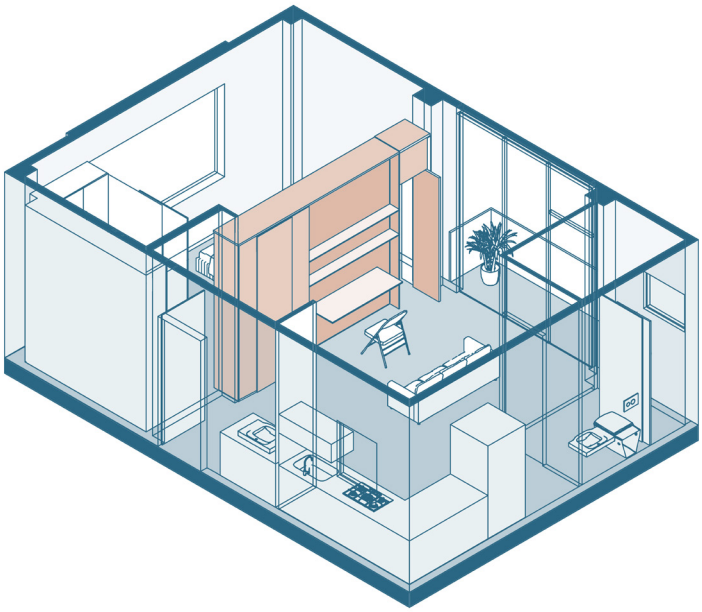
It's 22:00 and Joey and Chris have folded out the sofa bed and Rebecca and Antonio have folded out the bed from the unit.



Updated Plan:-Party Mode

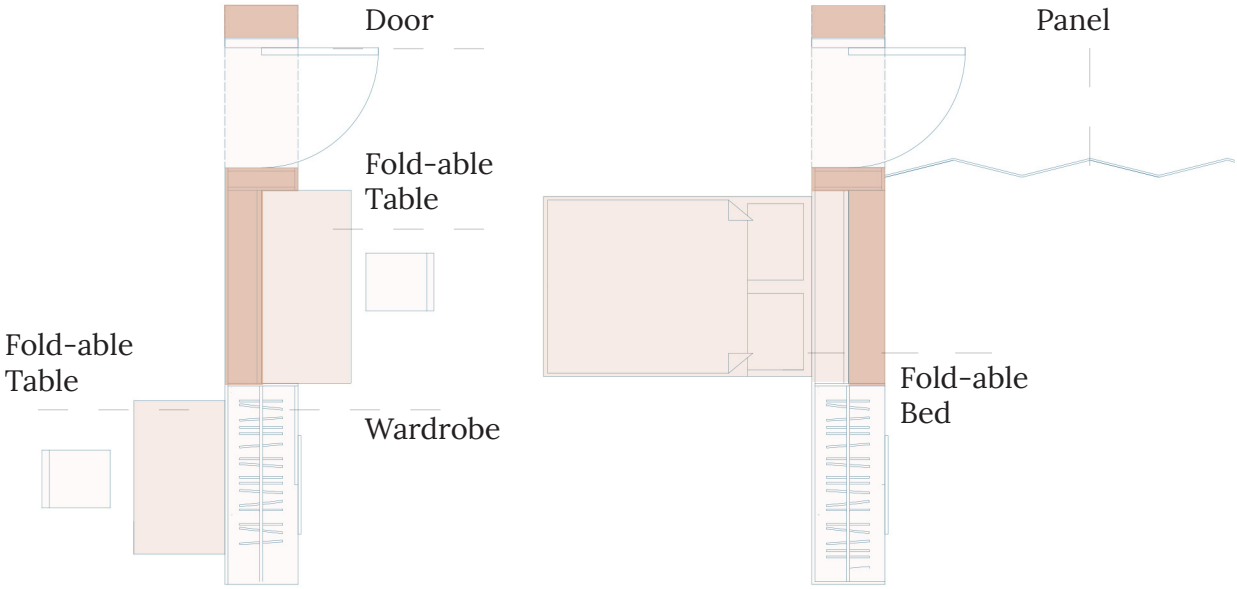
It's a weekend and Rebecca has invited people over. The balcony has been added next to the window as some of the apartments have balconies.

Typology 2:- 2-Bedroom Unit (20th Century)



Isometric 1:100

The Isometric shows the flexible unit at the very edge which can be moved according to the needs of the users.



Unit Diagrams 1:50

Typology 1:- Studio Unit (21st Century)

Case Study Information

Project Name :- Bosco Verticale

Year Built :- 2014

Location:- Milan, Italy (Europe)

Original Plan photograph

The Original Photo of Bosco Verticale shows the apartment and its functionality.

Typology 2:- 2- Bedroom Unit (21st Century)

Case Study Information

Project Name :- Bosco Verticale

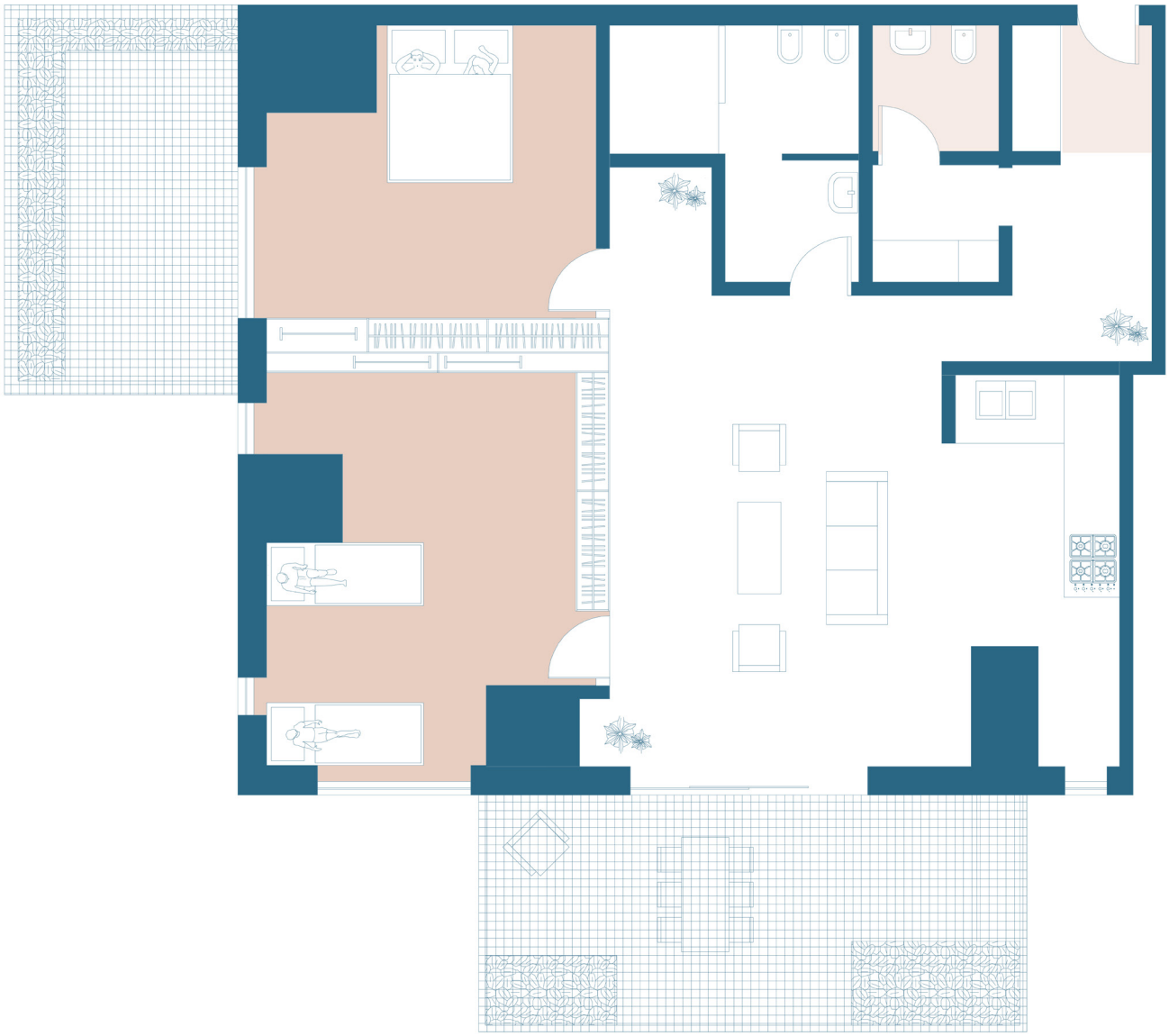
Year Built :- 2014

Location:- Milan, Italy (Europe)

Original Plan redrawn (1:100)

The Original Plan was drawn with the help of the image of the plan. The Bosco Verticale is a luxurius residential building with spacious rooms.

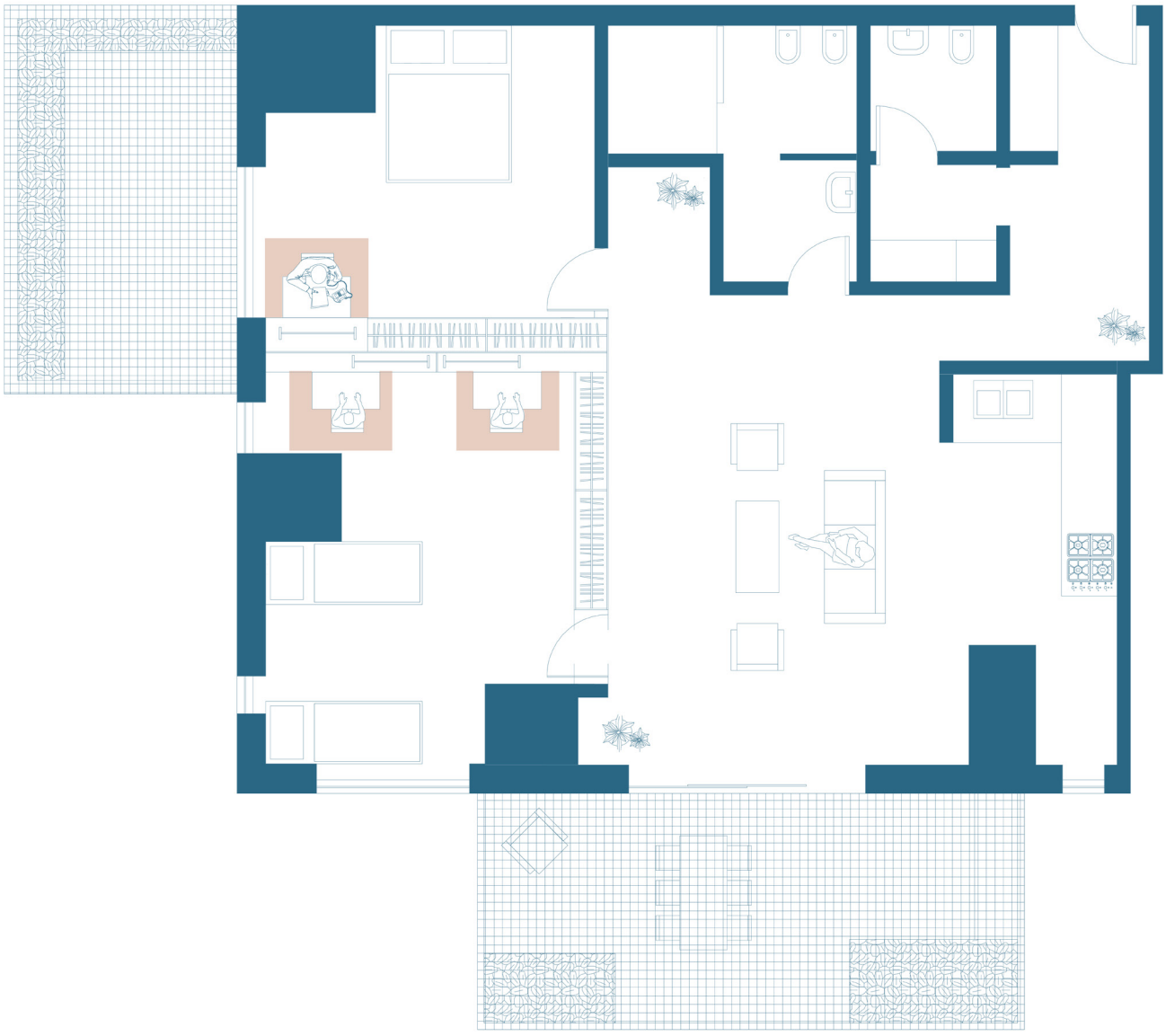
Typology 2:- 2- Bedroom Unit (21st Century)



Updated Plan 1:100 :- Sanitization and Relax Mode

In updated plan to accommodate the fourth user, we demolished the bathroom and proposed a room. The flexible unit sits between the two bedrooms. The height of the unit has been kept lower for the light and wind to pass through easily.

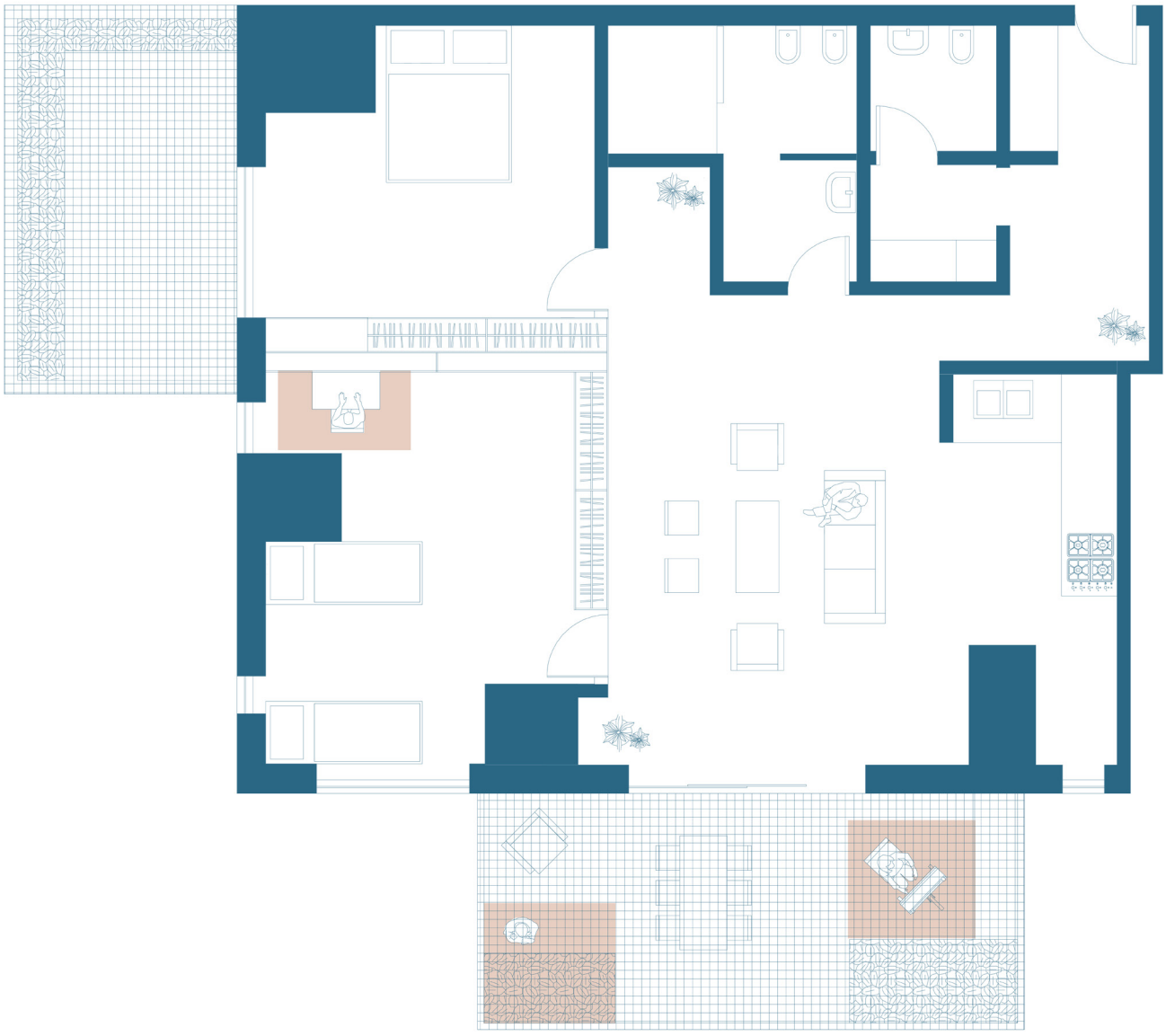
Typology 2:- 2- Bedroom Unit (21st Century)



Updated Plan 1:100 :- Work Mode

It's a Monday morning and Antonio has started working from the home office. The kids attend their lectures in their room by folding the tables out.

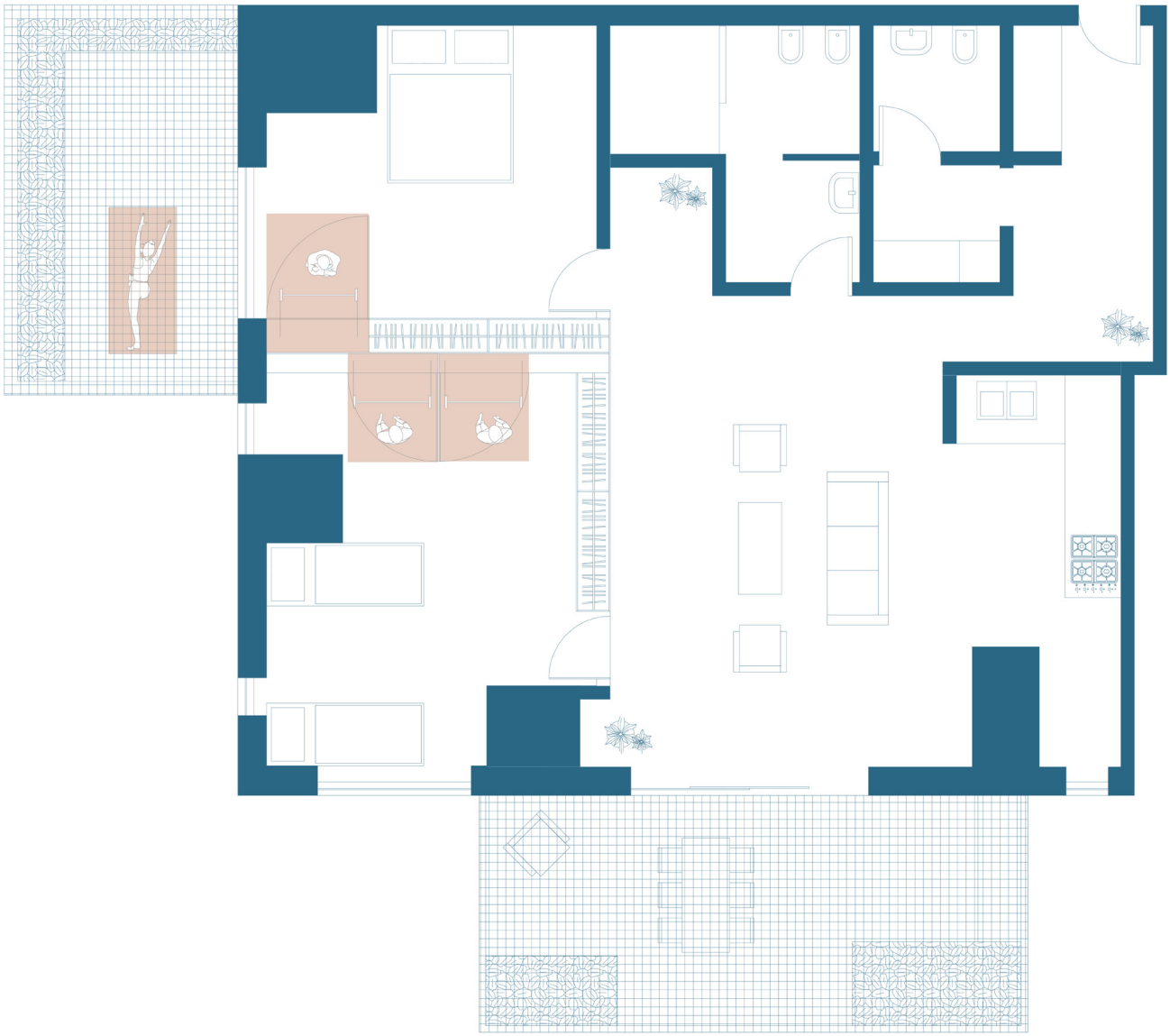
Typology 2:- 2- Bedroom Unit (21st Century)



Updated Plan 1:100 :- Hobby Mode

It's a Sunday afternoon and Rebecca has moved her canvas to the balcony while Joey plays games on his laptop, Chris is playing with plants. Antonio reads a book in the lounge.

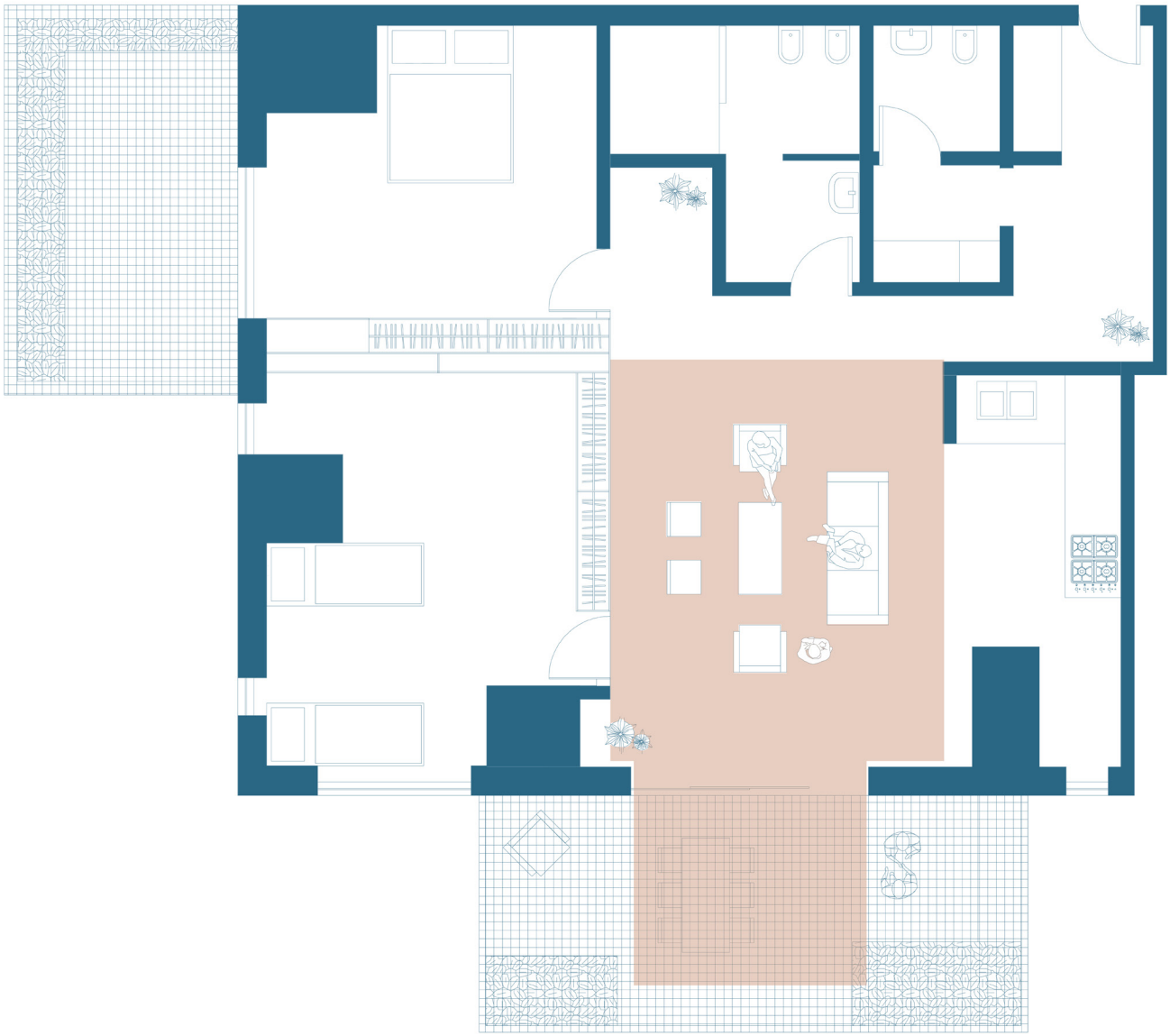
Typology 2:- 2- Bedroom Unit (21st Century)



Updated Plan 1:100 :- Sports Mode

It's 18:00 and after a tiring day of sitting on their chairs, the users are taking a break by stretching. Rebecca is doing yoga in the balcony while other pull out the rods to work out in their room.

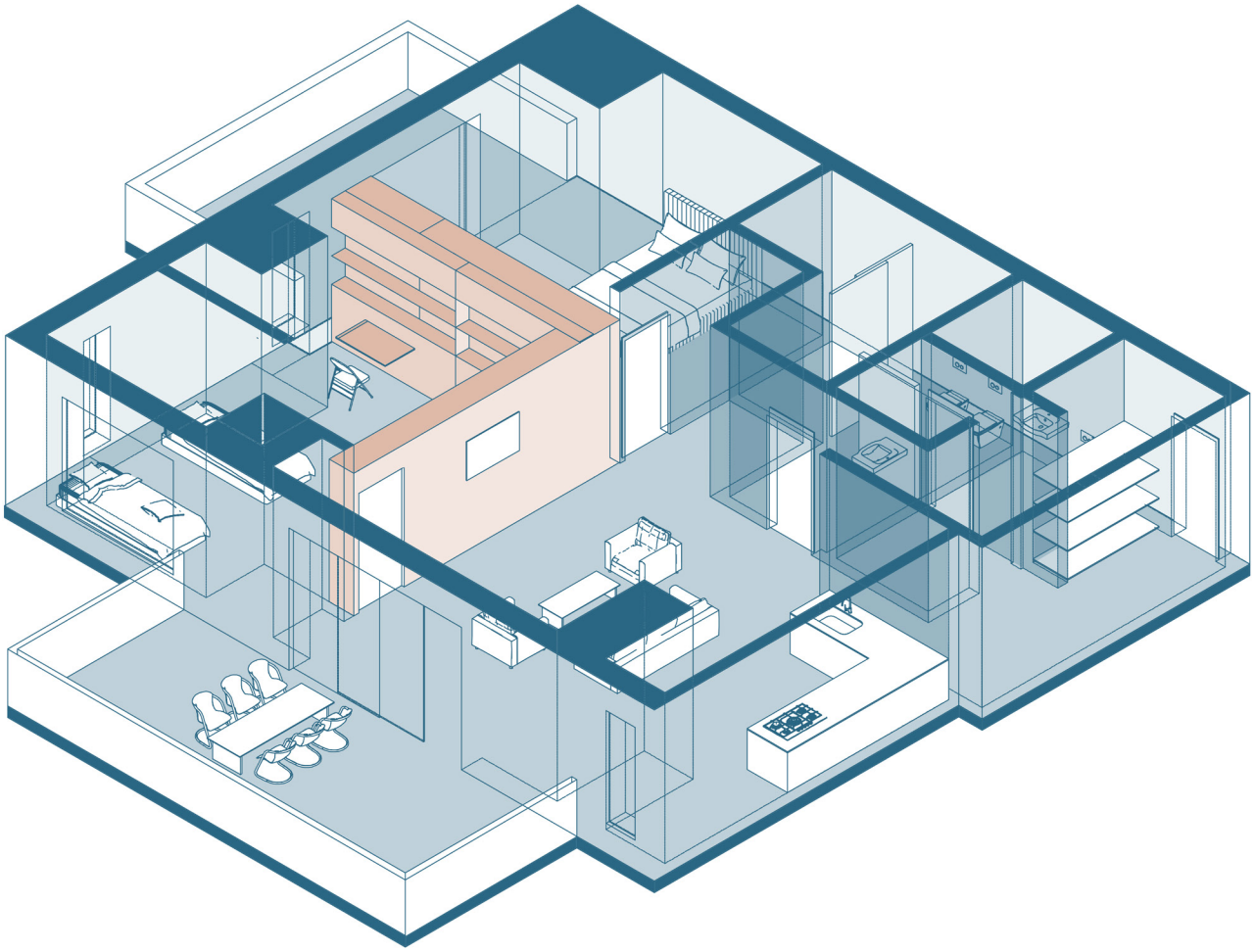
Typology 2:- 2- Bedroom Unit (21st Century)



Updated Plan 1:100 :- Party Mode

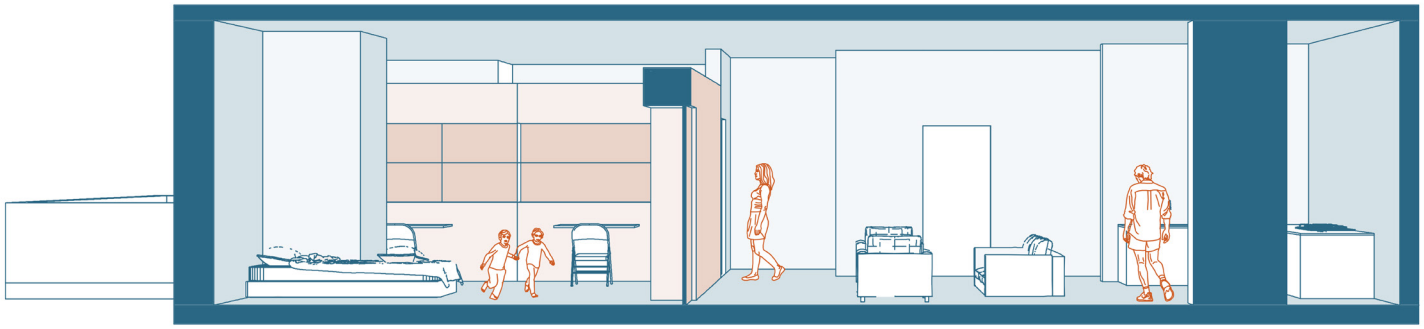
It's the weekend and Rebecca has called few of her friends over. the glass panel has been moved to incorporate the balcony with the lounge. The dinning can also be folded out as needed.

Typology 2:- 2- Bedroom Unit (21st Century)



Isometric 1:100

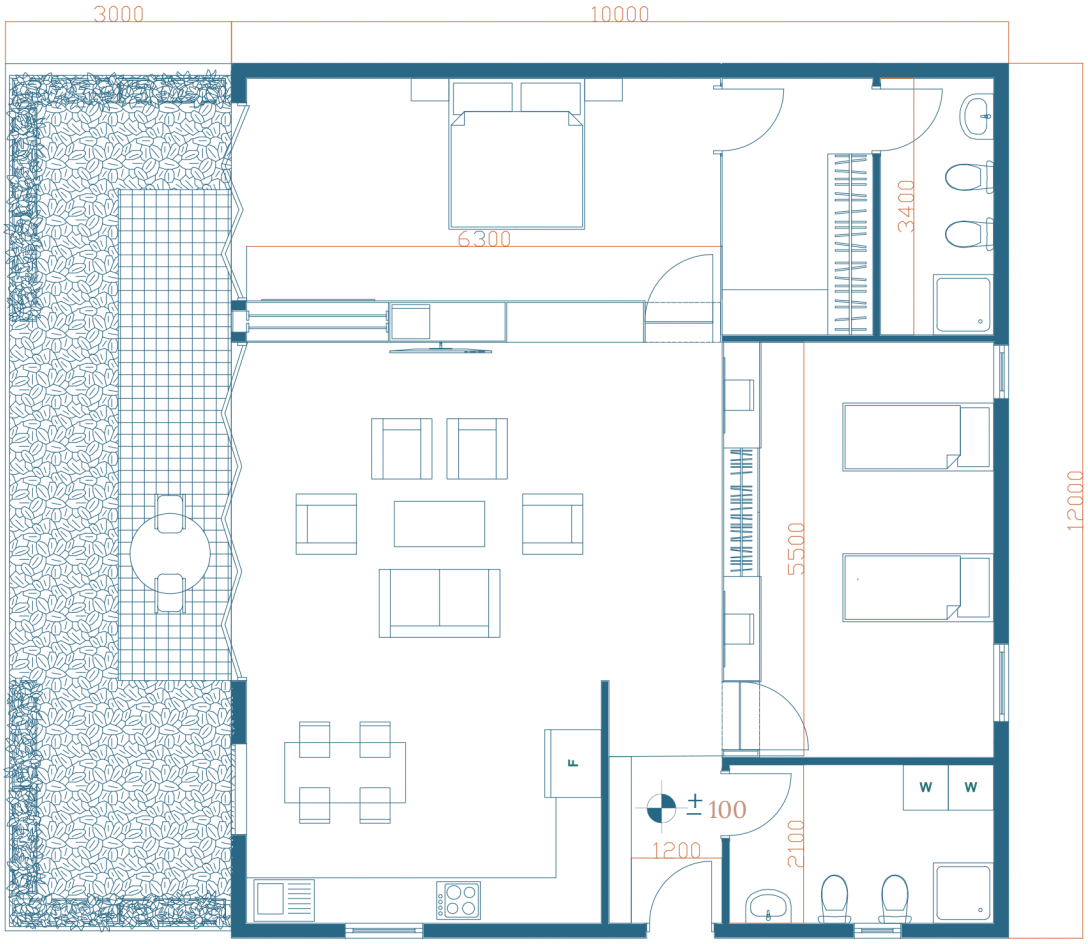
The isometric shows how the unit sits between the living and bedrooms.



Section 1:100

The section cuts through the flexible unit.

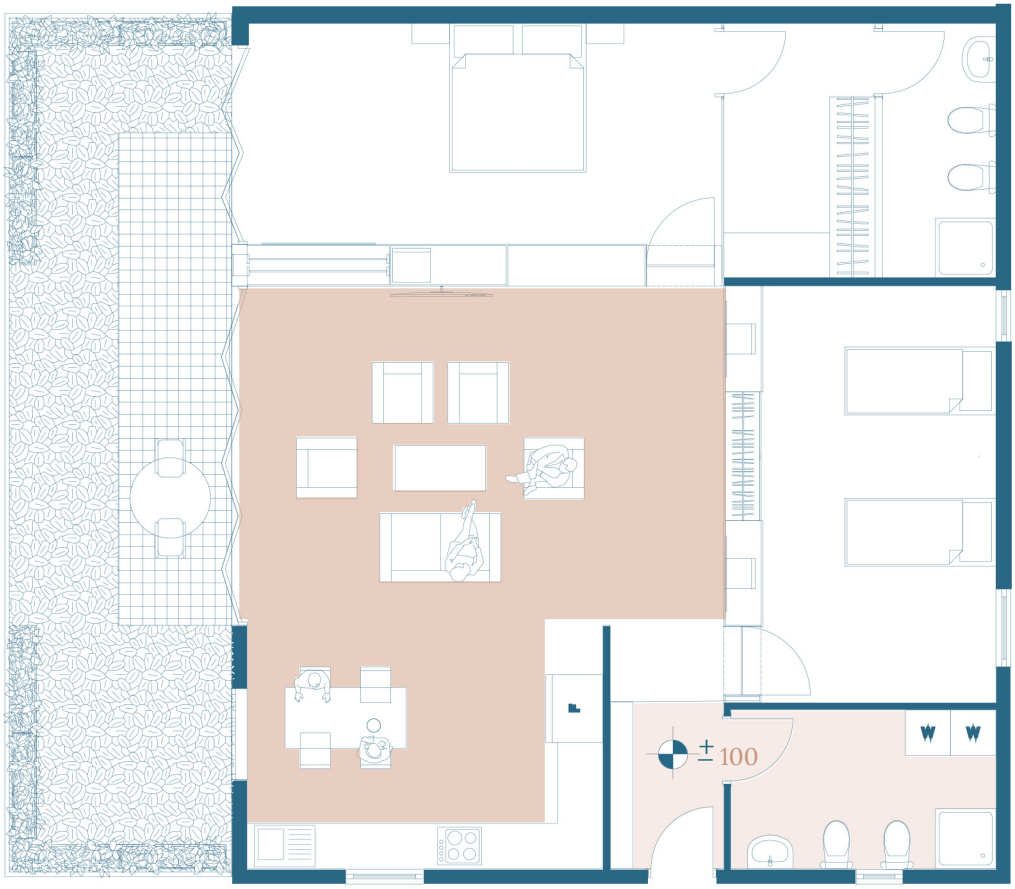
Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic



New Proposed Plan 1:100- Dimensions

The plan shows the dimensions of the proposed building.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic



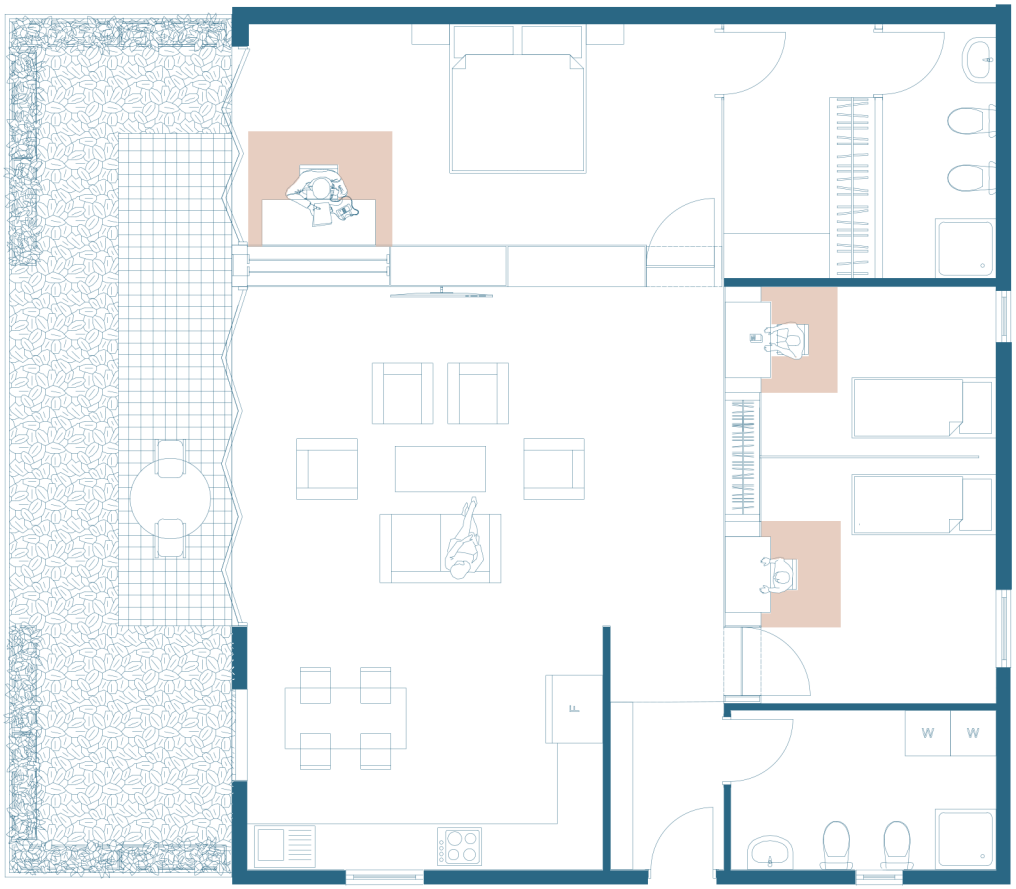
New Proposed Plan 1:100- Sanitization and Relax Mode

Inspired by Genkan we have added a lower step for sanitization station, to take shoes off and wash hands. The typology has two flexible units from which one is fixed and one is movable.

Section 1:100

The section cuts through the the flexible unit while the second one sits in the elevation.

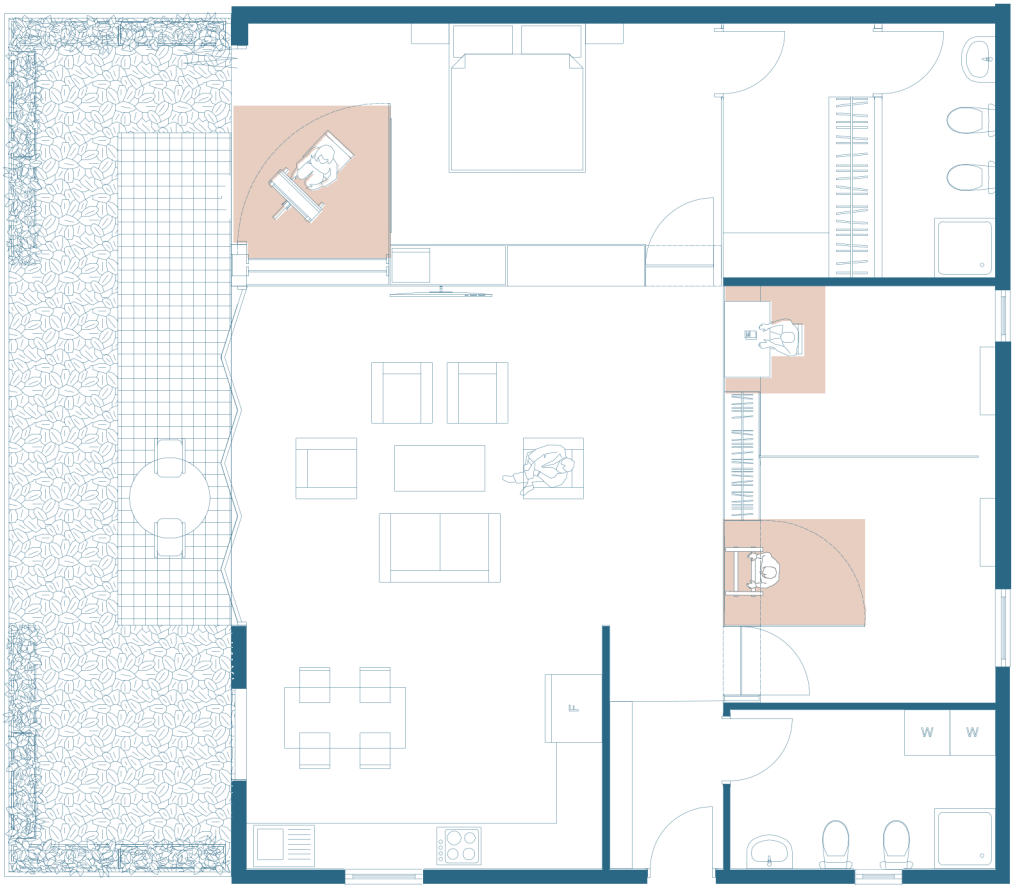
Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic



New Proposed Plan 1:100- Work Mode

It's early morning on a Monday and Antonio has started working in his home office. Joey and Chris are attending classes in their rooms. They have dragged the panel out for privacy and acoustics.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic



New Proposed Plan 1:100- Hobby Mode

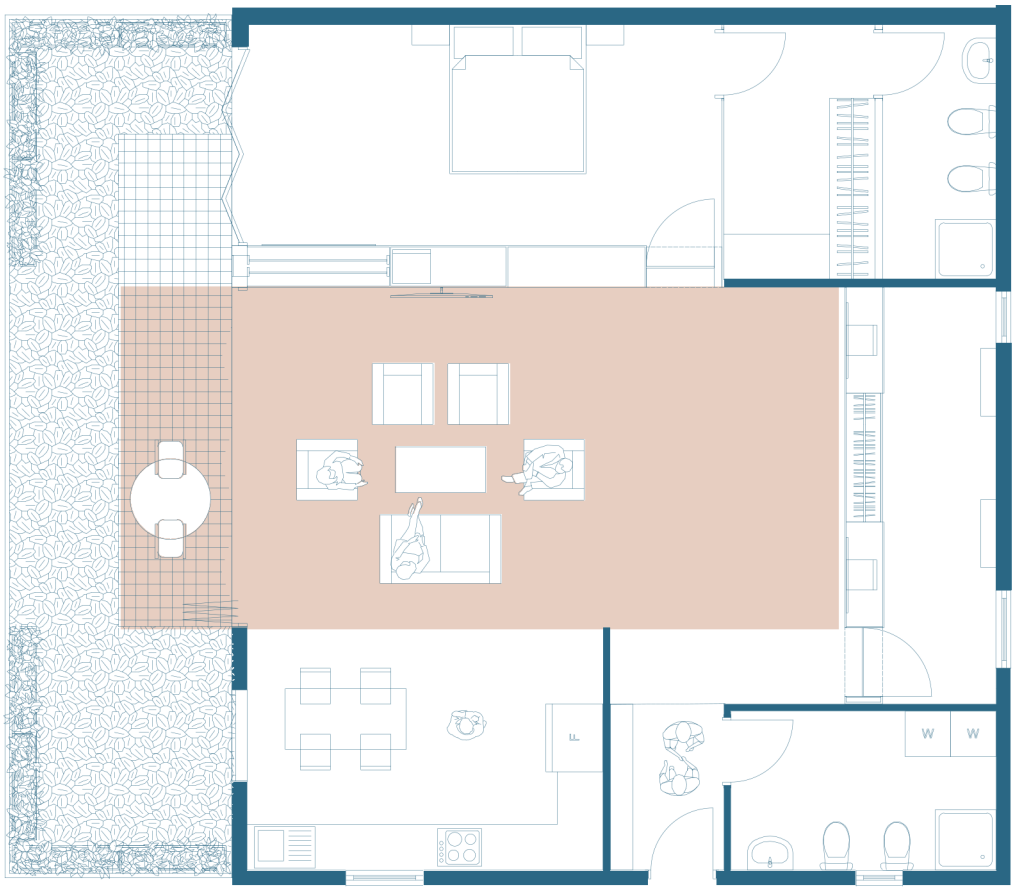
It's a Sunday afternoon and Rebecca has taken her canvas out in the balcony to paint. Antonio reads a book on the sofa while Joey plays video games on his laptop. Chris has opened the panels to work out.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic

New Proposed Plan 1:100 - Sports Mode

After a tiring day, Rebecca is stretching doing Yoga. She opens the panel to create a bigger booth while Antonio pulls the rod out in the balcony to work out. Kids wrestle in their room.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic



New Proposed Plan 1:100- Party Mode

Rebecca has called few of her friends over for a party. The unit has been moved back to the edges, the beds have been folded into the walls. The glass panels have been folded, to incorporate the balcony with the living room.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic

New Proposed Plan 1:100- Isolation Mode

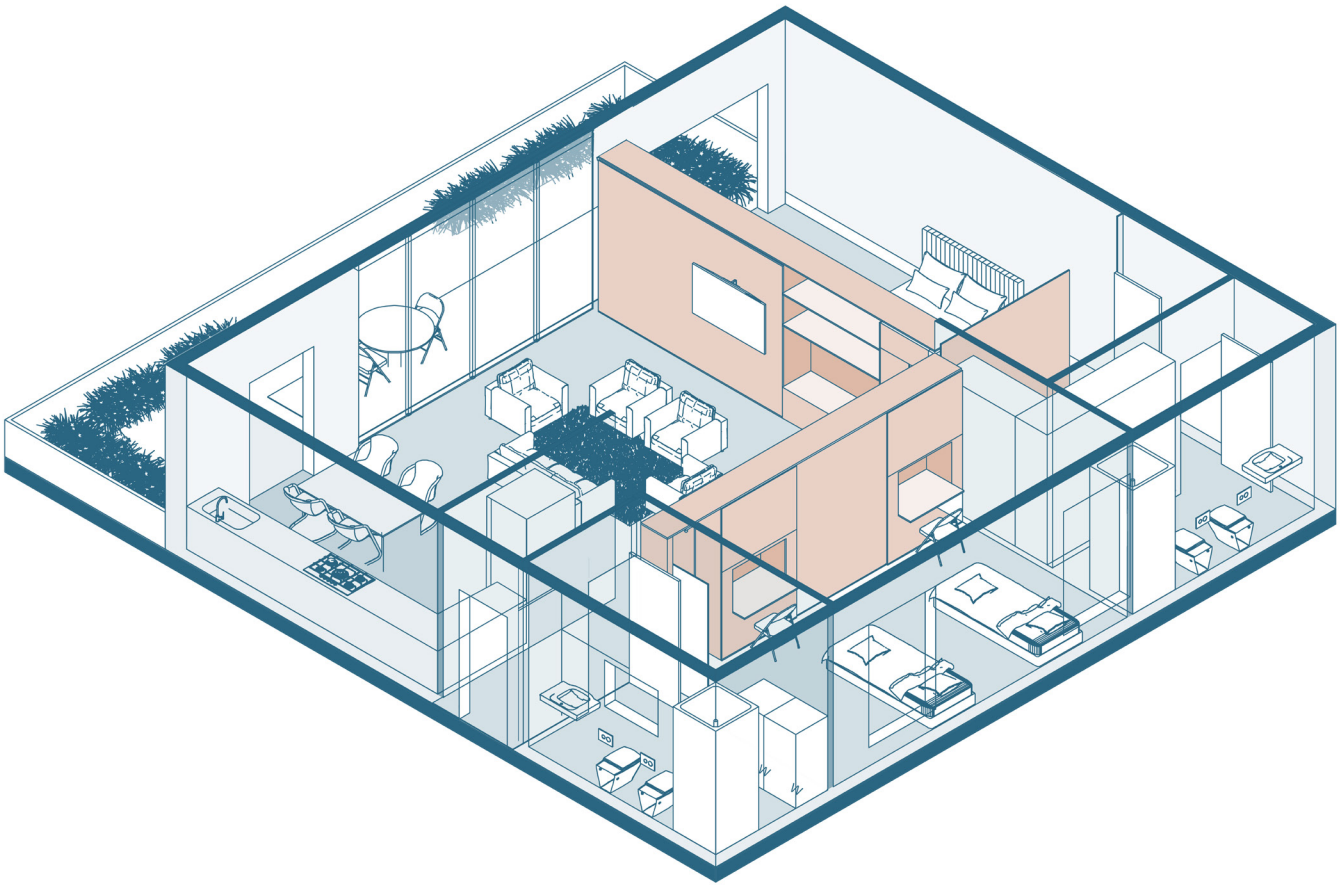
The panel has been moved in between Joey and Chris for Joey to Isolate.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic

New Proposed Plan 1:100- Isolation Mode

The panel has been moved in between Joey and Chris for Joey to Isolate.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic



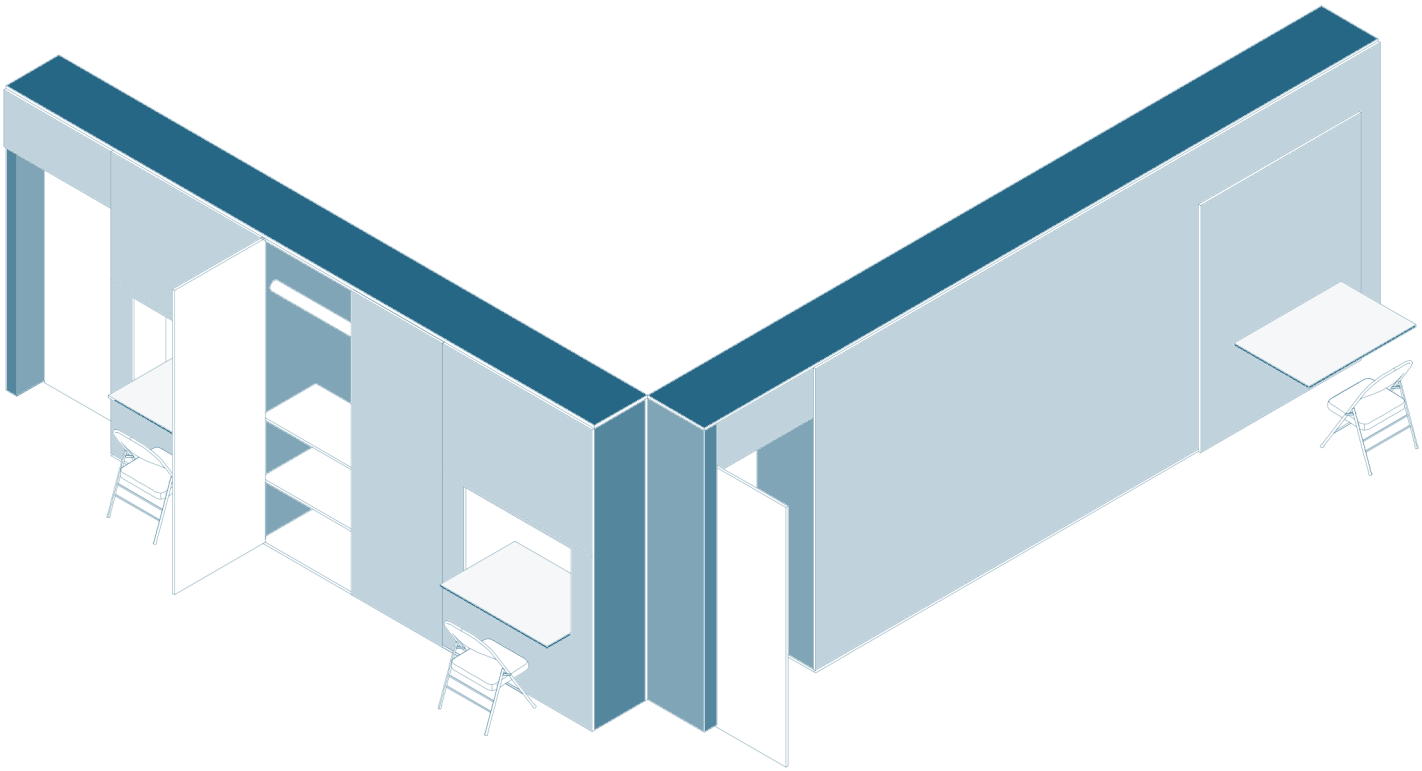
Isometric 1:100

The isometric shows how the flexible unit sits between both rooms and creates a L. The part that sits between the kids room is movable while the one between master room and living is fixed.

Section 1:100

The Section cuts through the Living and Master bedroom.

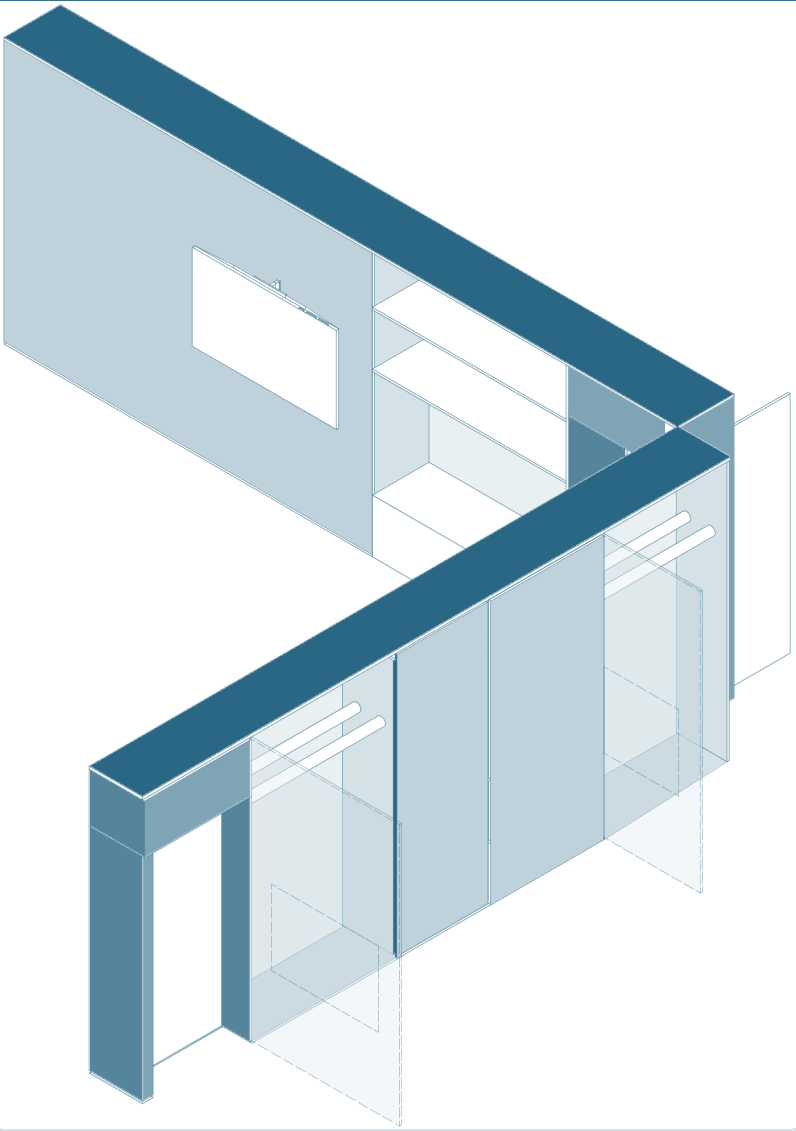
Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic



Unit Diagram 1:50

The isometric shows the flexible unit in work modes. The tables have been folded out from the unit and the panel has been moved in between for privacy.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic



Unit Diagarm 1:50

The isometric shows the tables folded back, into the panels and the panels have been folded out to create sports mode. In between sits the wardrobe for kids. On the back side we see shelves for the living room.

Typology 2:- 2- Bedroom Unit (21st Century) Post Pandemic

Interior Render of The Unit.

The image shows the colour that we have chosen for tis unit is blue. Everything else remains white and light.

05.3 CO-LIVING TYPOLOGIES

SUMMARY

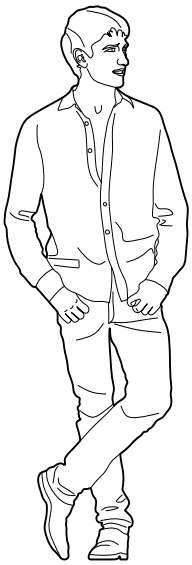
For co- living typologies we have four users. Three are students from different parts of the world studying in Europe. The case studies will be reviewed and revamped accoring to the needs of the personas.

Persona 1:- Meredith
Personality Type:- Introvert
Occupation:- Student
Age:- 20-39 years
Location:- Europe
Hobbies:- Reading Book

Meredith is a medical student studying in Europe and she needs a private table to study.

Persona 2:- Harris
Personality Type:- Extrovert
Occupation:- Student
Age:- 20-39 years
Location:- Europe
Hobbies:- Playing Games

Harris is an engineering student who is attending classes from home.



Persona 3:- Erhaan
Personality Type:- Ambivert
Occupation:- Unemployed
Age:- 20-39 years
Location:- Europe
Hobbies:- Photography

Erhaan has graduated from university and is looking for a job. He is moving in between places.

Persona 4:- Chiara
Personality Type:- Introvert
Occupation:- Student
Age:- 20-39 years
Location:- Europe
Hobbies:- Painting

Chiara is an architecture student. She likes to destress by doing Yoga.

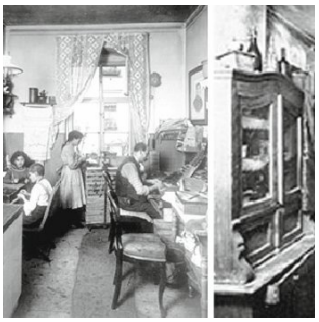
Typology 3:- Co-Living Unit (19th Century)

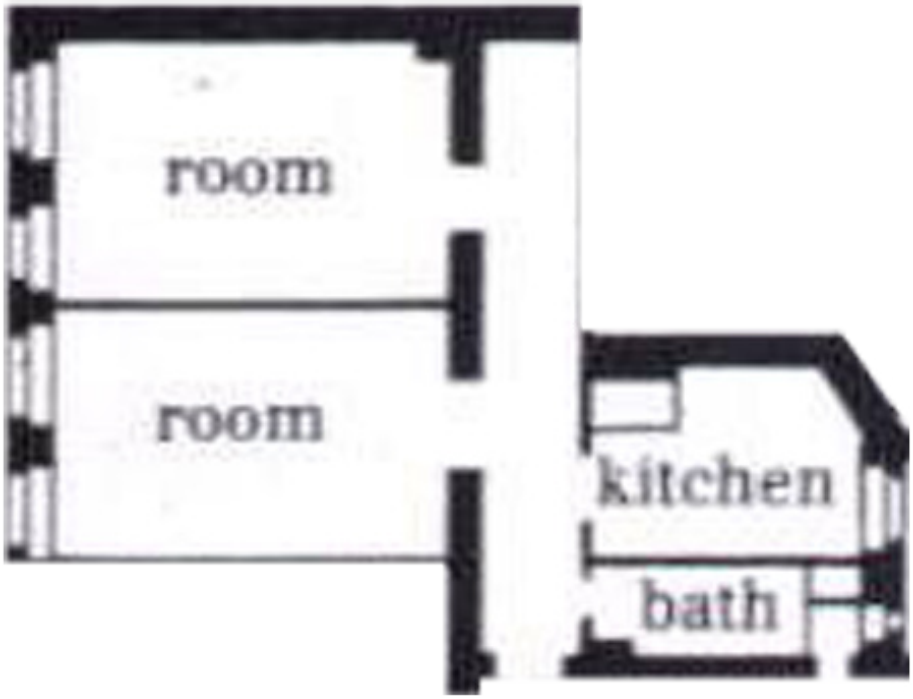
Case Study Information

Project Name :- Berlin Tenements

Year Built :- 1880

Location, Berlin, Germany (Europe)

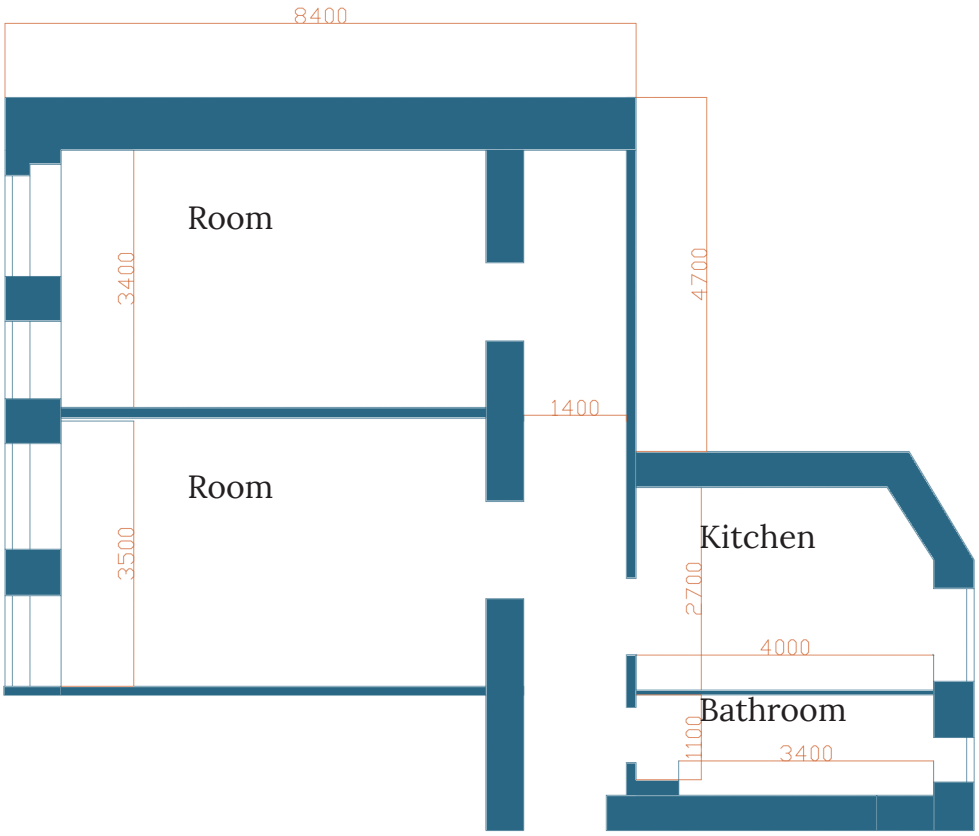




Original Plan Photo.

For the co-living typology we have taken a double room apartment from the tenements, which we will reconfigure according to the needs of our users. As the space is less, we might only be able to design for three users. The technical spaces remain intact as well as the windows.

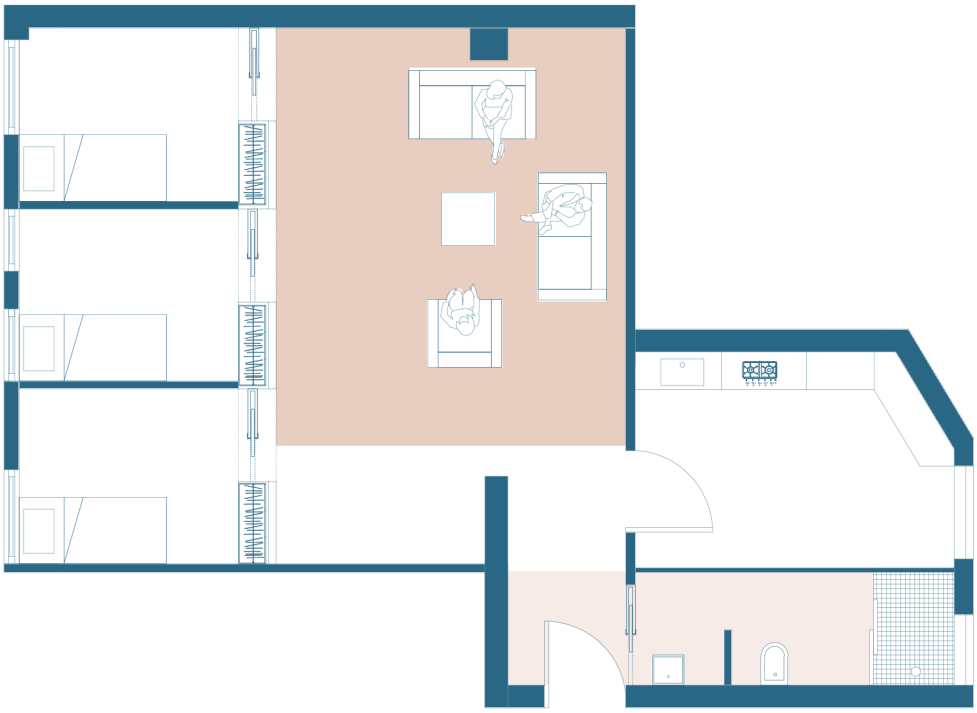
Typology 3:- Co-Living Unit (19th Century)



Original Plan Redrawn (1:100)

The original plan has been redrawn to scale to better understand the functionality of the spaces and how we can revamp them.

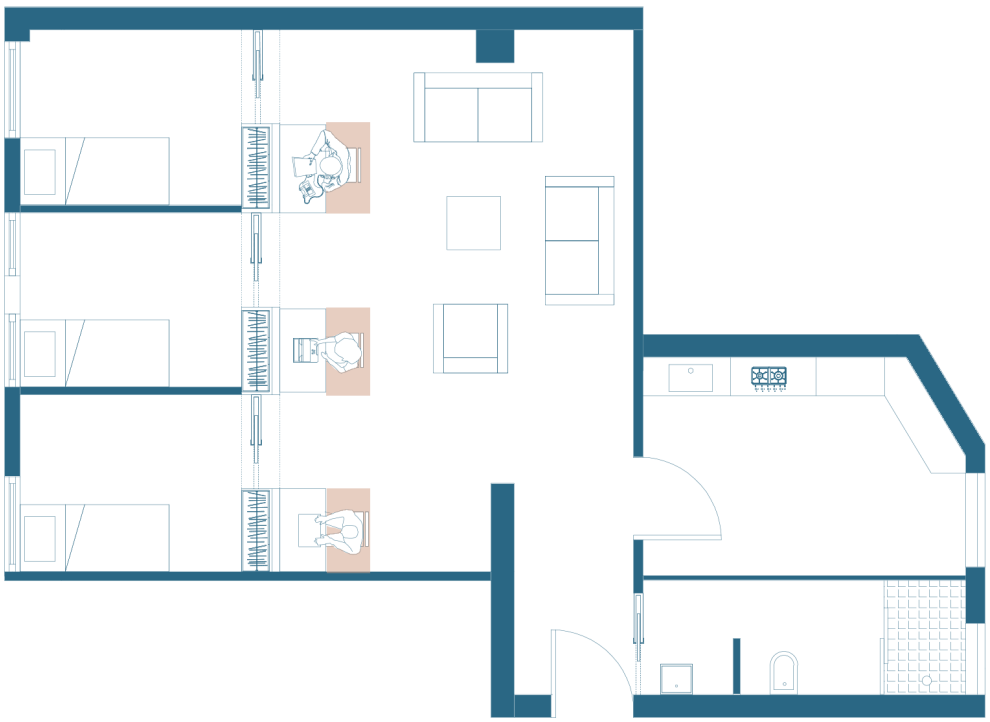
Typology 3:- Co-Living Unit (19th Century)



Updated Plan 1:100 - Sanitization Station and Relax Mode

The bathroom has been kept where it was as it works best to have it in the entrance. The interior walls have been demolished to create a three single bedroom apartment with a living room. All rooms have windows. The flexible unit is movable and is divided in three parts. The typology only has the capacity to inhabit three occupants because of its size. Hence, for the 19th century co living typology we are considering 3 occupants and not four.

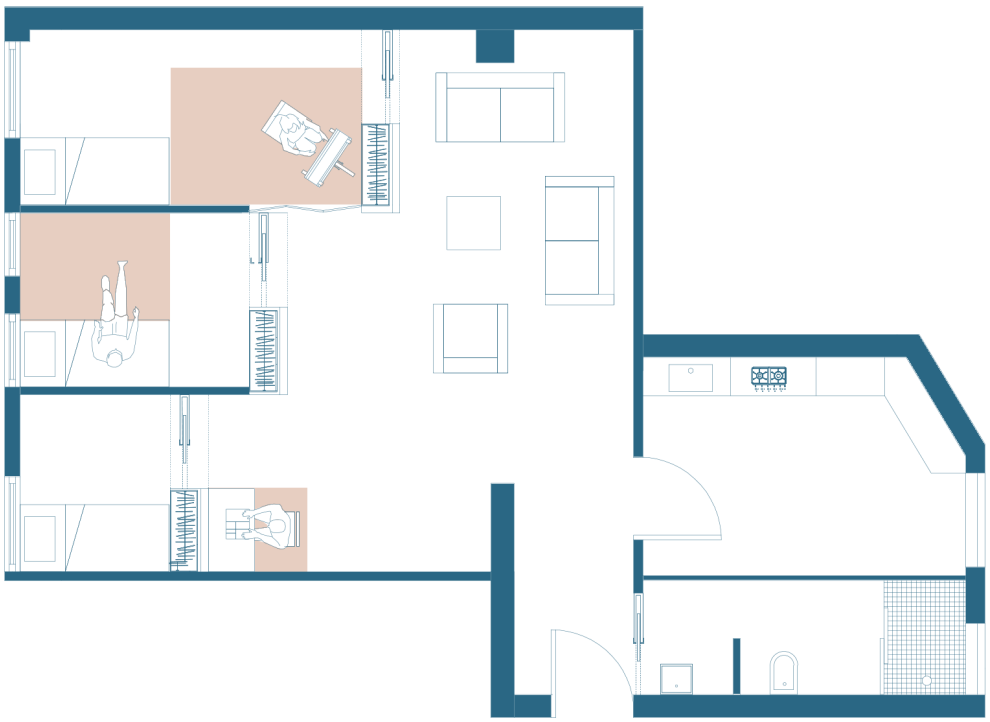
Typology 3:- Co-Living Unit (19th Century)



Updated Plan 1:100 - Work Mode

It's a Monday morning, Harris is working on his assignment where as Meredith is attending her lecture and Chiara is working on the drawings on her table. The tables have been folded out from the flexible unit.

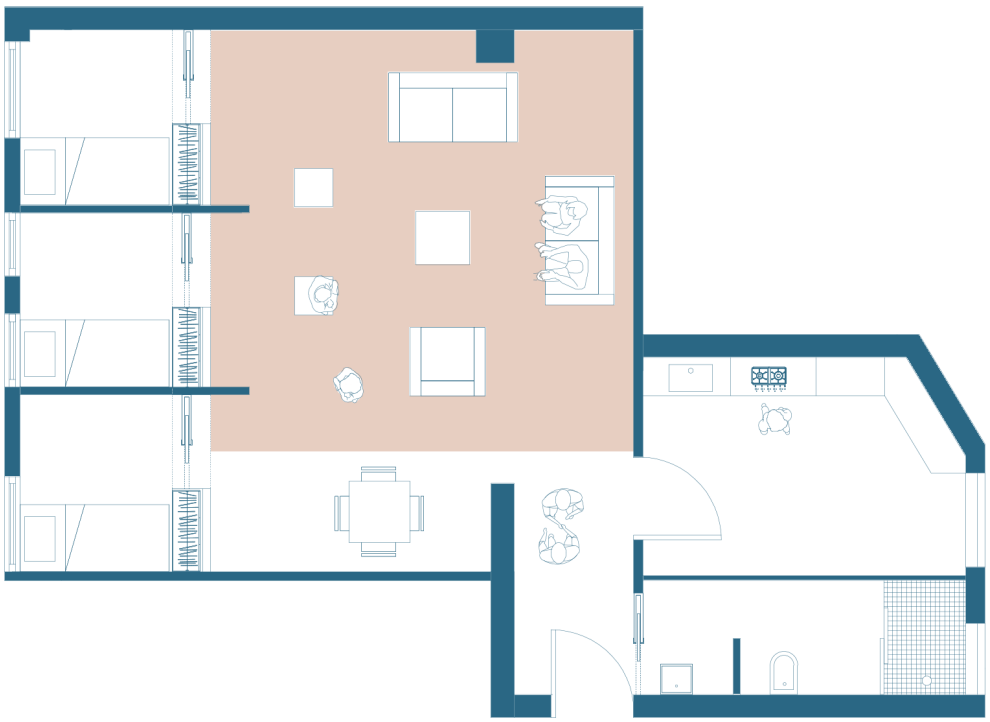
Typology 3:- Co-Living Unit (19th Century)



Updated Plan 1:100 - Hobby Mode

It's a Sunday afternoon and Chiara is painting in her room. She has extended the unit out to create a bigger space to place her canvas. Meredith is reading a bok on the table while Harris stretches in his room.

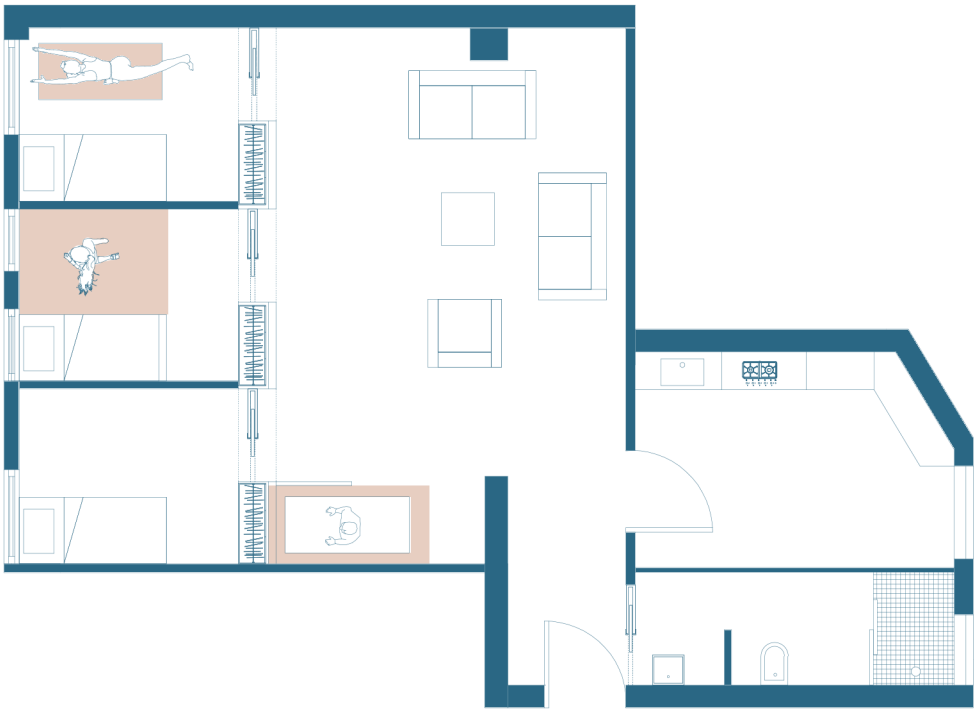
Typology 3:- Co-Living Unit (19th Century)



Updated Plan 1:100 - Party Mode

It's the weekend and Harris has invited friends from his university over. The units have been pushed back to create a bigger space for the party. Since there isn't a possibility of having a window in the lounge, the unit height has been kept short for light and air to flow easily.

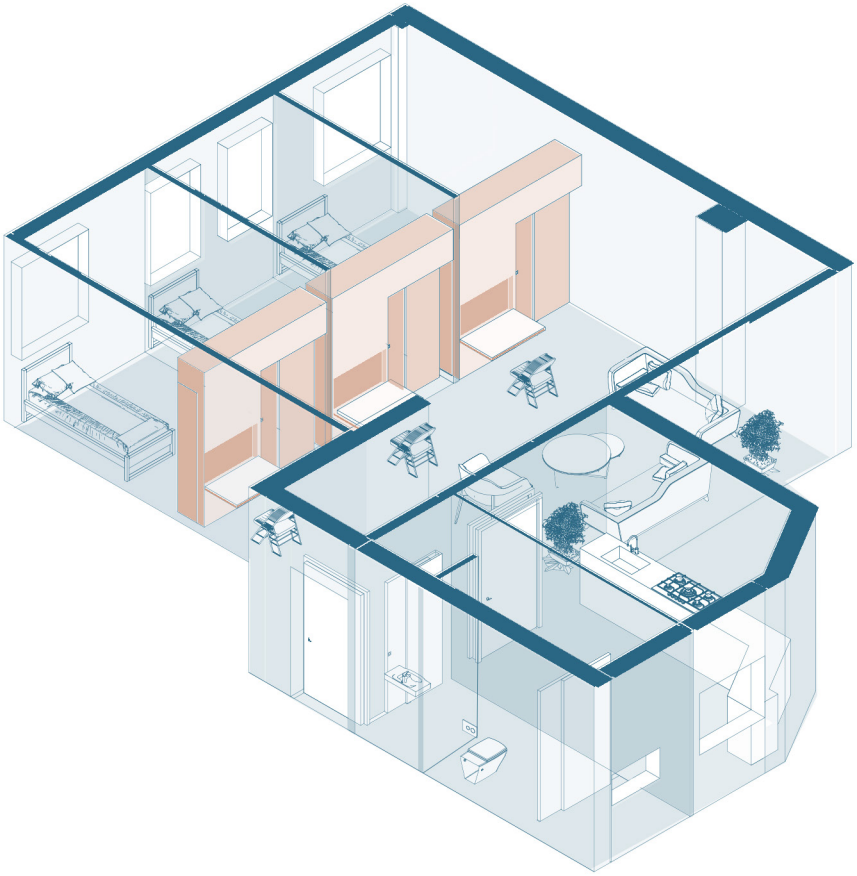
Typology 3:- Co-Living Unit (19th Century)



Updated Plan 1:100 - Sports Mode

After a tiring day of attending lectures, Chiara is destressing by doing Yoga in her room while Harris has opened the panel to create a space for working out. Meredith dances in her room.

Typology 3:- Co-Living Unit (19th Century)



Isometric 1:100

Isometric shows how the unit sits between the rooms and the living rooms.

Section 1:100

The section cuts through the kitchen and the one room to show how the unit sits.

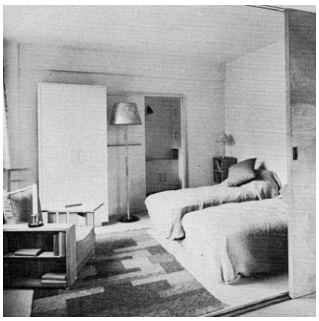
Typology 3:- Co-Living Unit (20th Century)

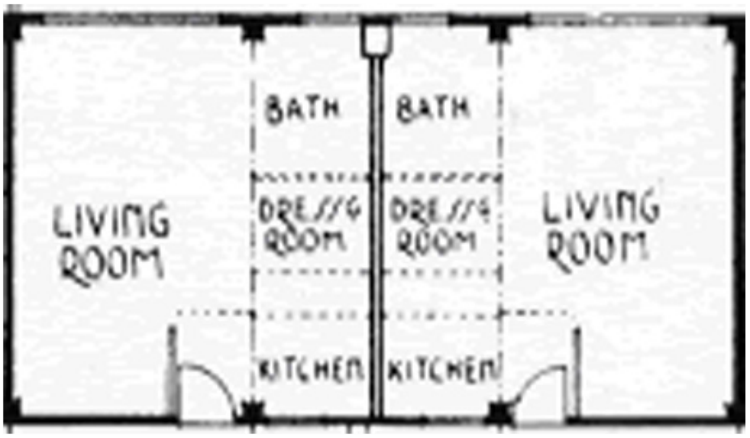
Case Study Information

Project Name :- Lawn Road Flats Hampstead

Year Built :- 1934

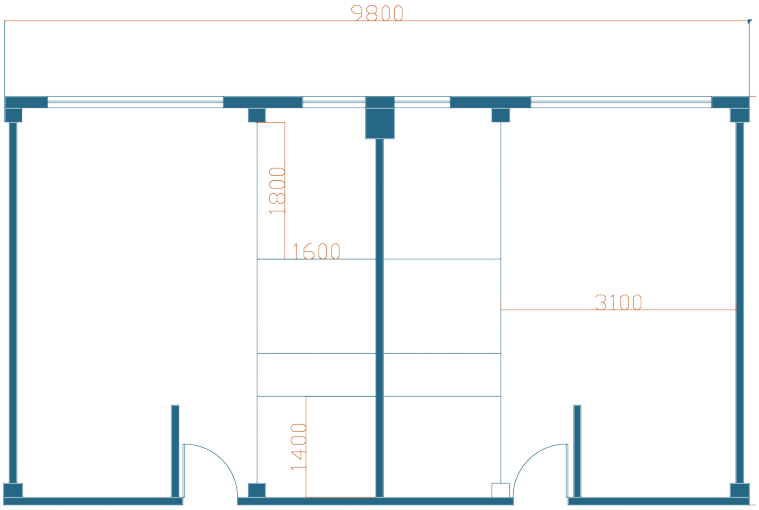
Location:- London, UK (Europe)





Original Plan Photo

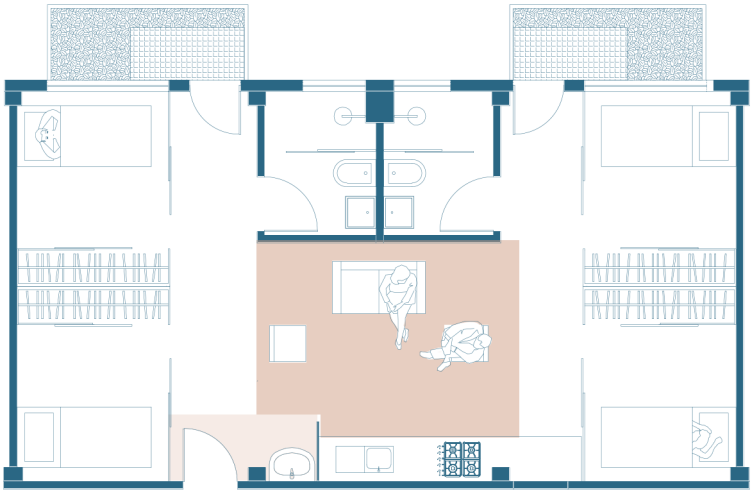
The original plan is taken from the photos. For the co-living typology we are taking two single units.



Original Plan Redrawn (1:100)

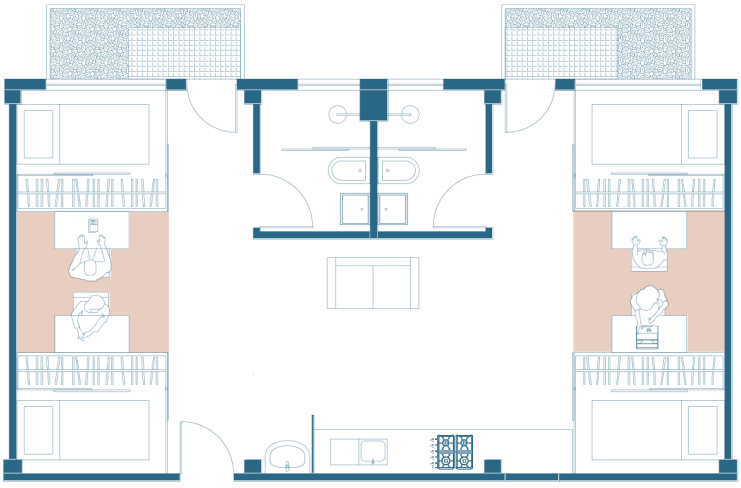
The original plan has been redrawn to understand the scale of the typology. Two apartments have been combined to create a co living typology.

Typology 3:- Co-Living Unit (20th Century)



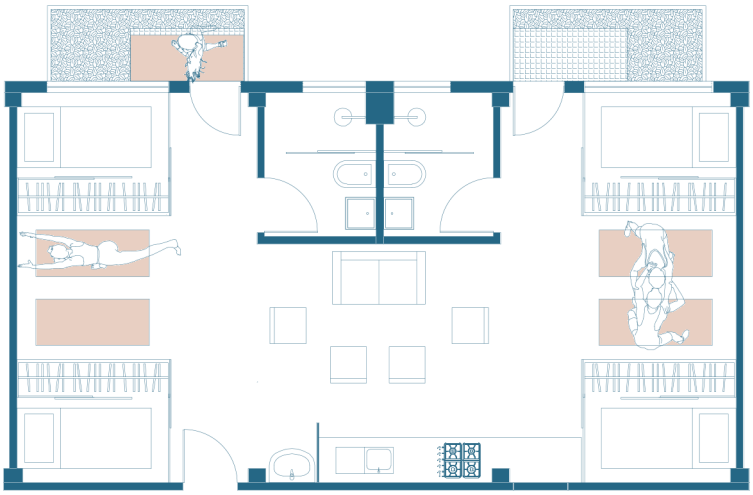
Updated Plan 1:100 -
Sanitization and Relax Mode

The interior walls have been demolished. A sink has been added for sanitization. The bathrooms have been kept intact. The apartment has four rooms which have a flexible unit in between them that can be moved to create work space.



Updated Plan 1:100 - Work Mode

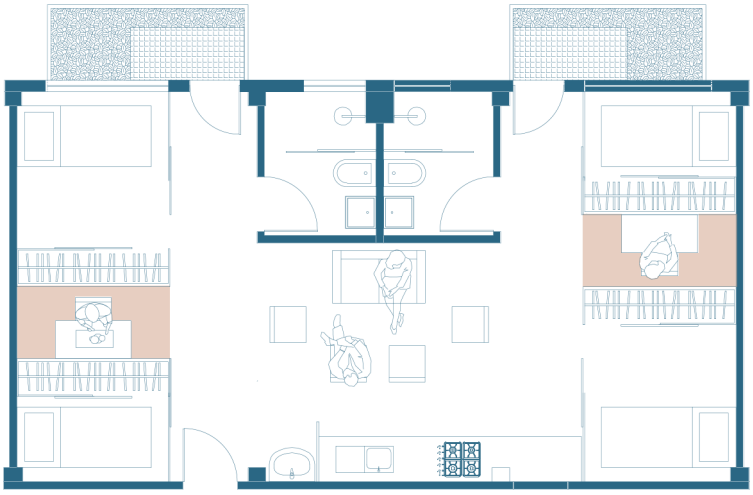
It's a Monday morning and all three are attending lectures while Erhaan applies for Job. The flexible unit has been moved to create a working space.



Updated Plan 1:100 - Sports Mode

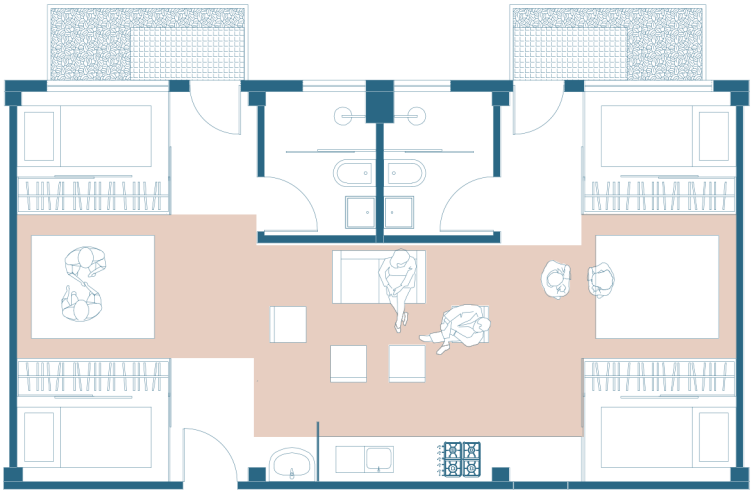
After a tiring day, Chiara has started yoga in the space by moving the units apart. Harris and Erhaan are trying a new sport as Meredith moves in the balcony.

Typology 3:- Co-Living Unit (20th Century)



Updated Plan 1:100 - Hobby Mode

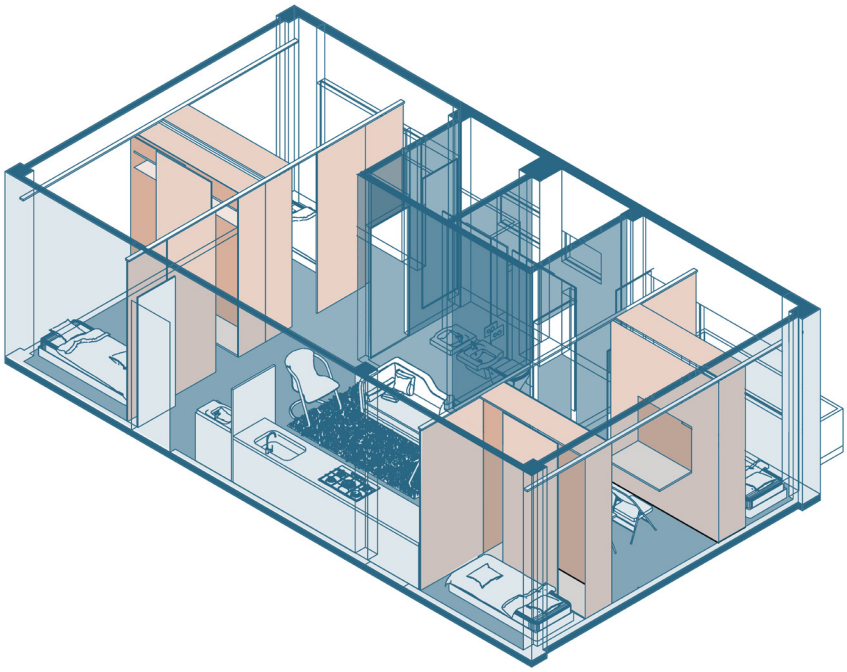
Meredith reads book in the lounge and Erhaan acompanies her. Chiara is working on the drawings while Harris plays video games.



Updated Plan 1:100 - Sports Mode

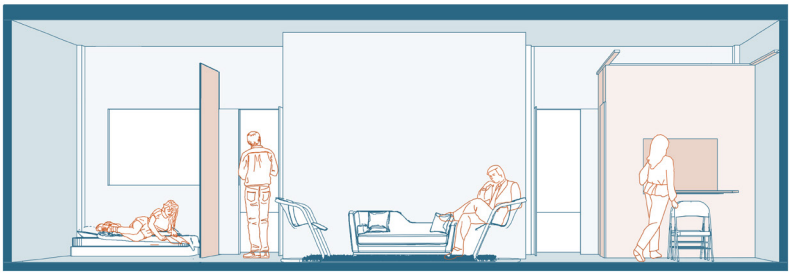
It's a Friday night and Harris has invited friends over. The unit has been moved in to create a bigger space. Since some of the apartments have a balcony, we have added two balconies.

Typology 3:- Co-Living Unit (20th Century)



Isometric 1:100

The Isometric shows how the units sits between the rooms. One is opened and one is closed to show it. Since two rooms have no windows, the height has been kept lower for light and air to flow easily.



Section 1:100

The section cuts through the room and the unit and shows the living room in the elevation.

Typology 3:- Co- Living Unit (21st Century)

Case Study Information

Project Name :- Bosco Verticale

Year Built :- 2014

Location:- Milan, Italy (Europe)

Original Plan photograph

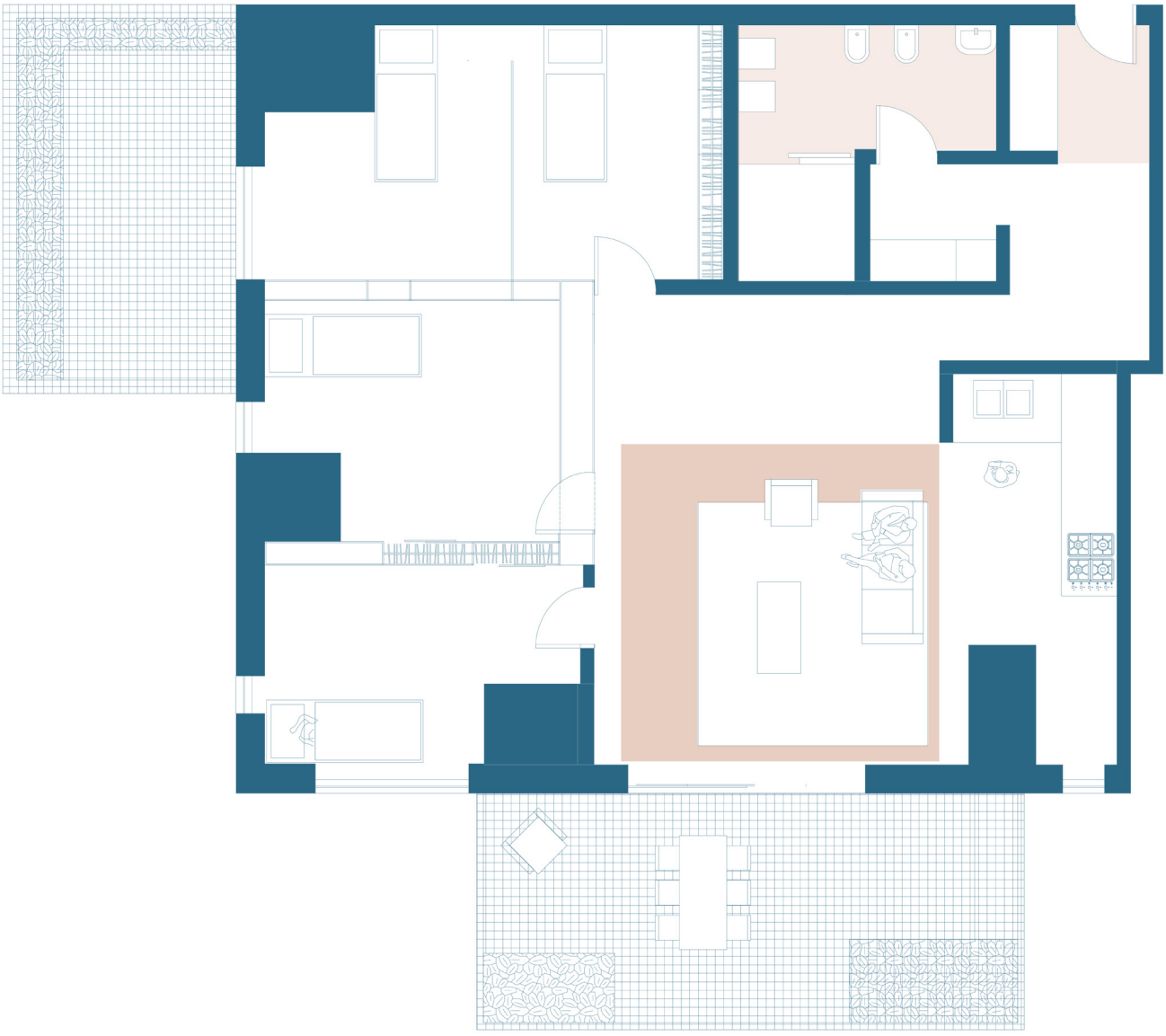
The Original Photo of Bosco Verticale shows the apartment and its functionality.

Typology 3:- Co- Living Unit (21st Century)

Original Plan redrawn (1:100)

The Original Plan was drawn with the help of the image of the plan. The Bosco Verticale is a luxurious residential building with spacious rooms.

Typology 3:- Co-Living Unit (21st Century)



Updated Plan 1:100 - Sanitization and Relax Mode

The Updated plan has been changed by removing the toilet in between the rooms and replacing it with a double room. The flexible unit sits on the edge of each room and between all three rooms. It provides them with basics such as wardrobe and a fold-able table and exercising equipment. The panel that can be folded out to divide the room when needed is of a height 2100mm that allows light and air.

Typology 3:- Co-Living Unit (21st Century)

Updated Plan 1:100 - Work Mode

It's a Monday Morning, Harris, Chiara and Meredith are attending lectures in their respective rooms while Erhaan applies for jobs. The tables have been folded out from the flexible unit.

Typology 3:- Co-Living Unit (21st Century)

Updated Plan 1:100 - Hobby Mode

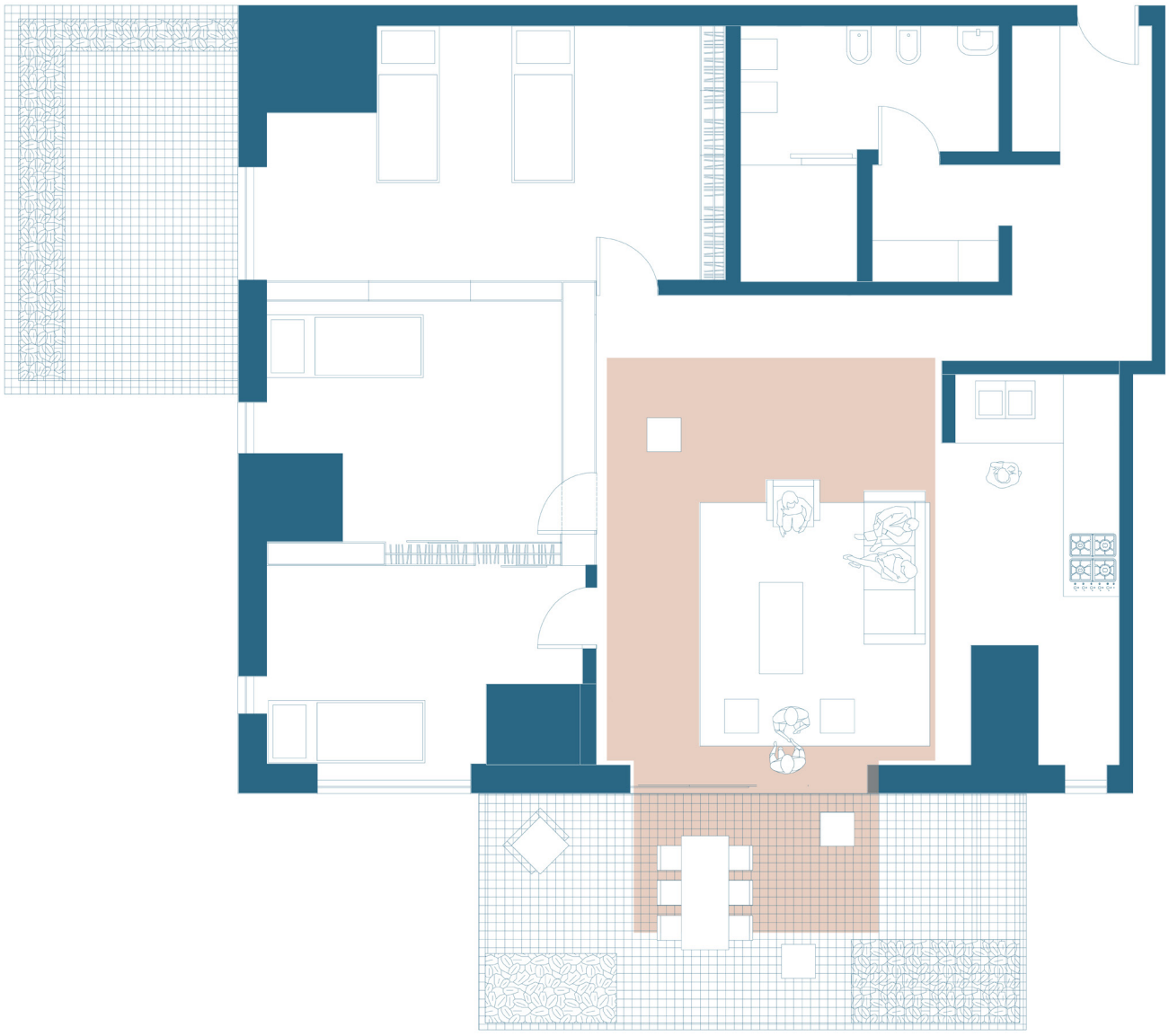
It's a Sunday afternoon and Chiara has opened the panel to create space for her to put her canvas and paint. Meredith is reading a book on the table while Harris wakes up from the sleep. Erhaan is working out in his room.

Typology 3:- Co-Living Unit (21st Century)

Updated Plan 1:100 - Sports Mode

After the tiring day Chiara, Harris and Meredith are working out in their room. Chiara is doing yoga while Meredith is dancing in her room. Harris and Erhaan have opened the panel to work out with the help of rods.

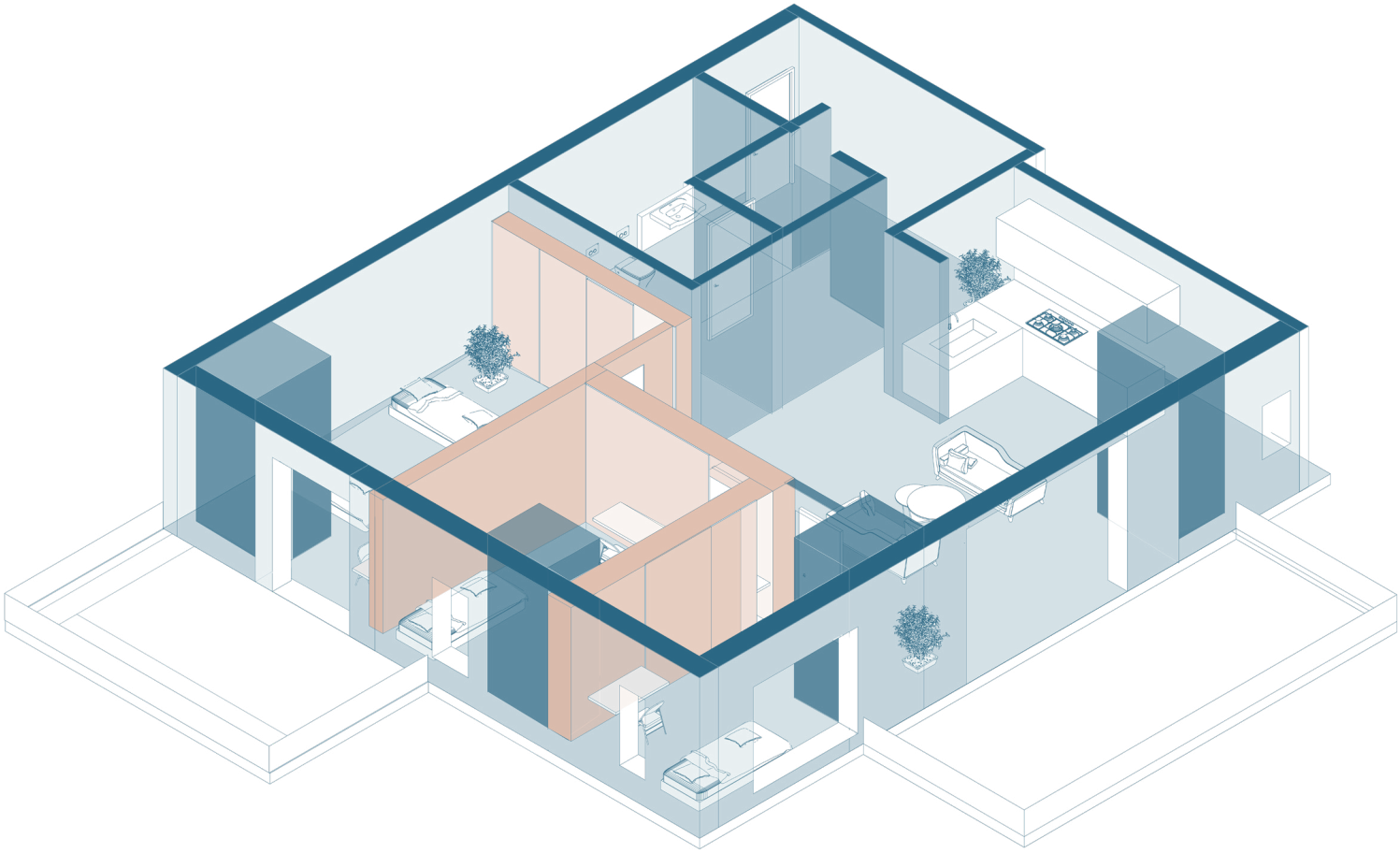
Typology 3:- Co-Living Unit (21st Century)



Updated Plan 1:100 - Party Mode

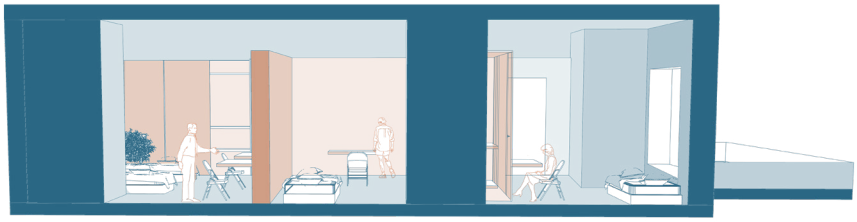
It's a Friday evening, Harris has invited friends over, the glass window has been moved to incorporate the balcony with the lounge.

Typology 3:- Co-Living Unit (21st Century)



Isometric (not scaled)

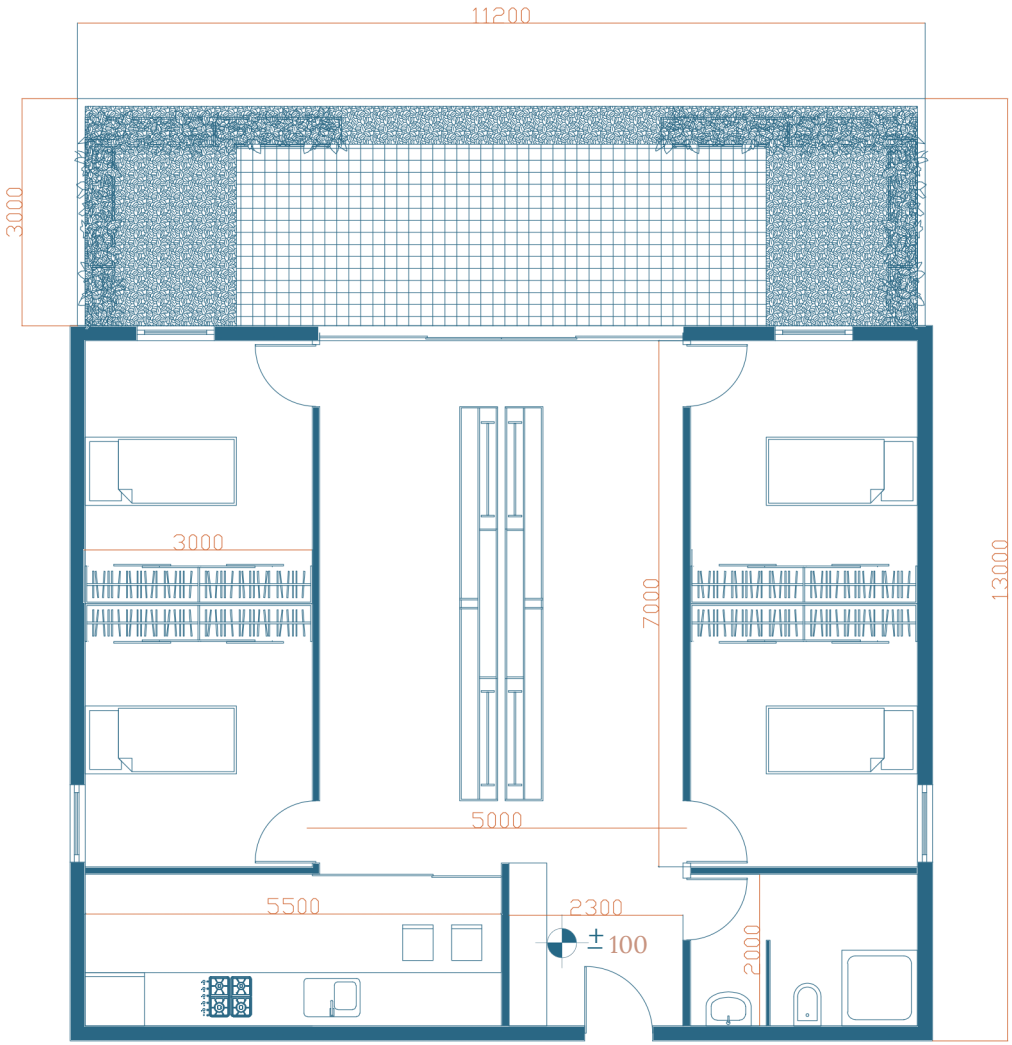
The Isometric shows how the flexible unit sits in the apartment.



Section 1:100

The sections cuts through the back wall and the unit to show how the unit sits in the elevation.

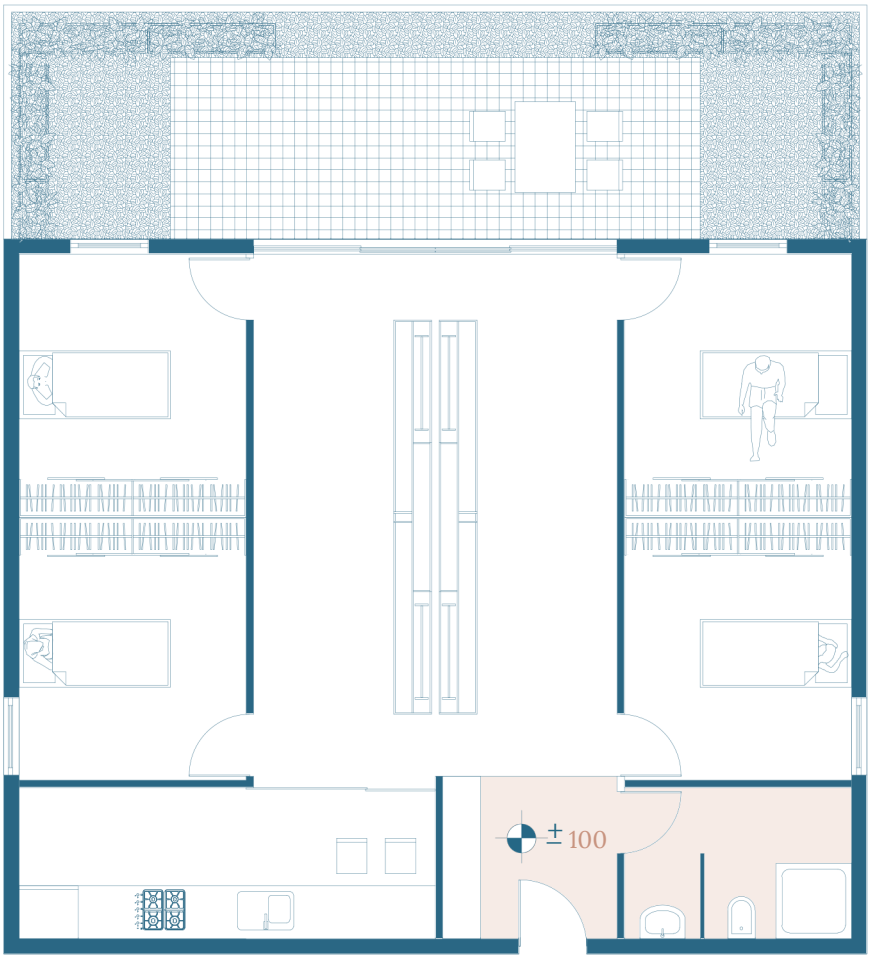
Typology 3:- Co-Living Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 - Dimensions

The plan highlights the dimensions of the spaces.

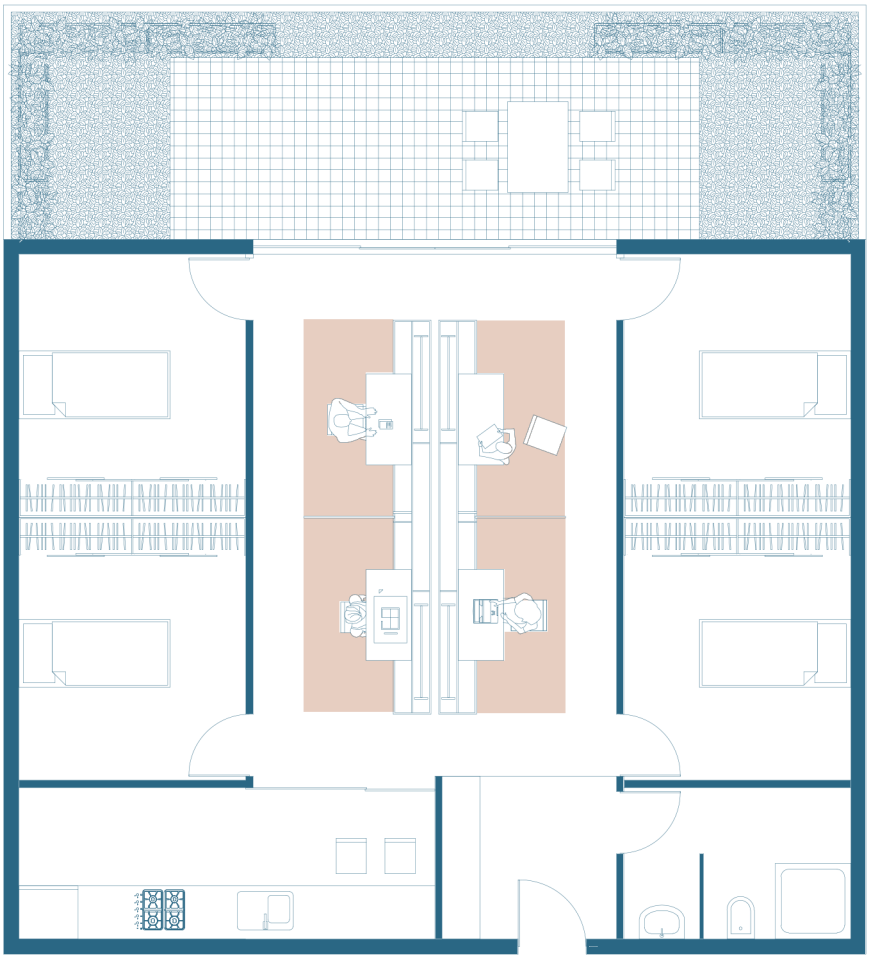
Typology 3:- Co-Living Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 - Sanitization and Relax Mode

In the new proposed Plan we have placed the flexible unit in the living room. Inspired by Genkan, a one step lower sanitization station has been added. A bigger balcony has been added which can be used for physical activities and as an urban garden.

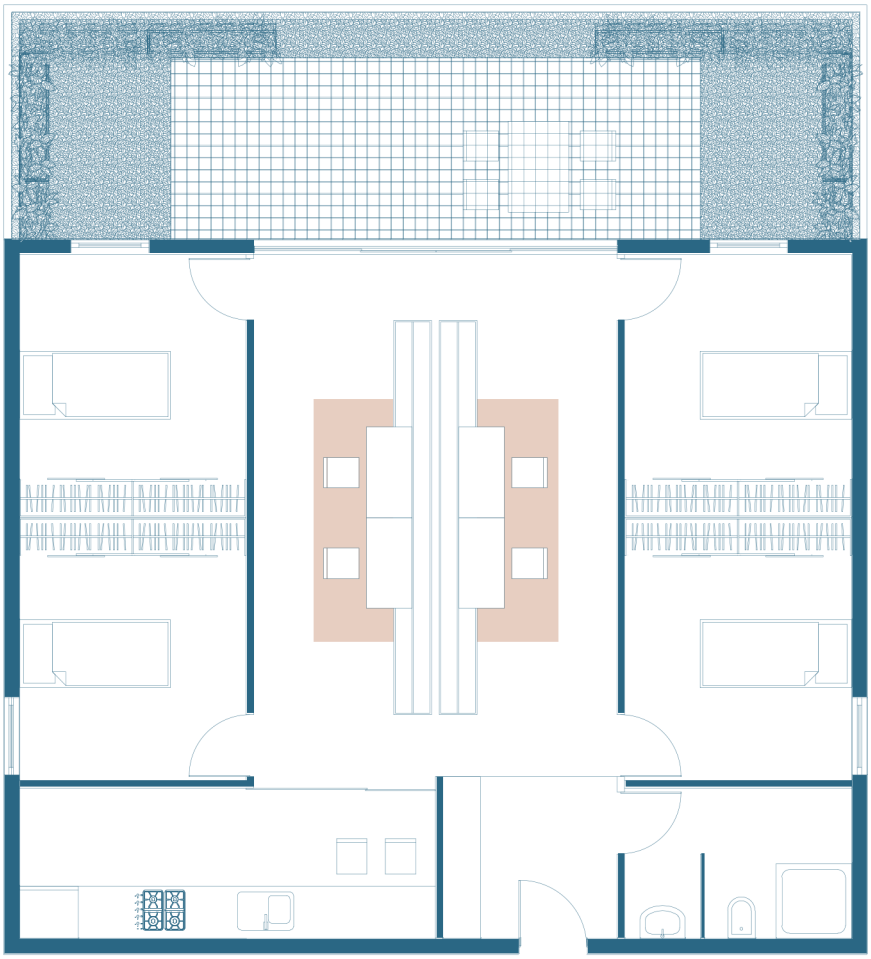
Typology 3:- Co-Living Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 - Work Mode

It's a Monday morning and all four are in the living room having their tables out, working on their assignments and attending lectures. A panel has been design to be moved in between for better privacy.

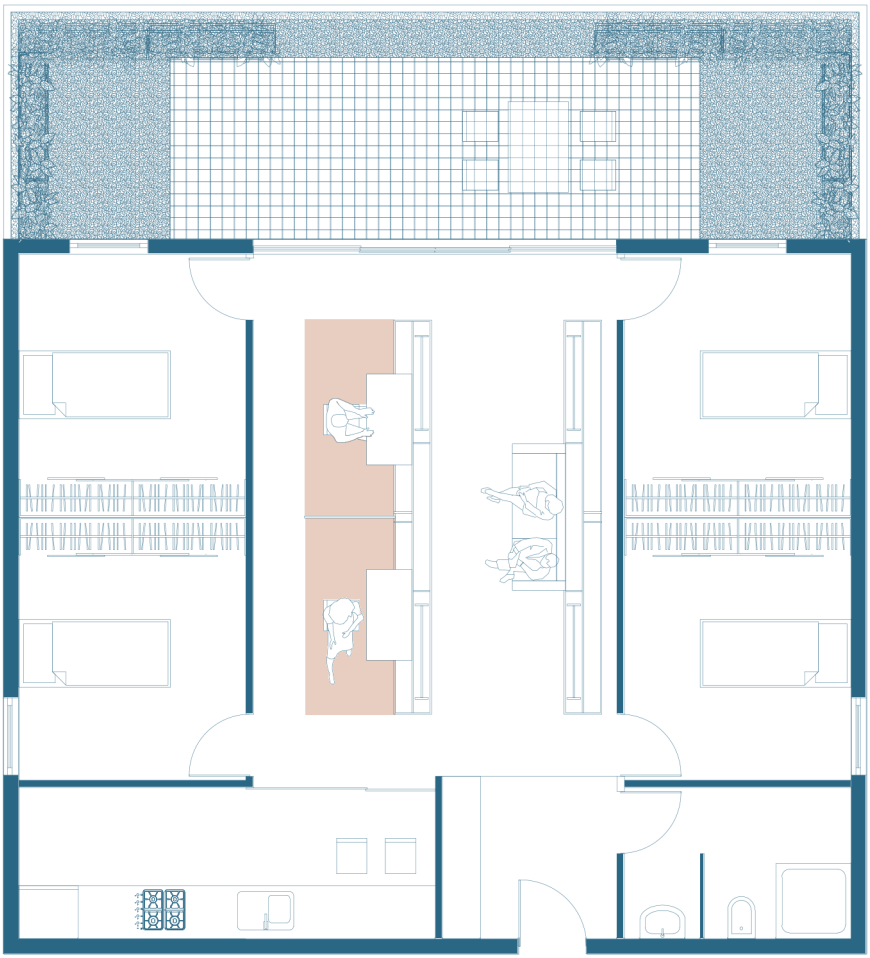
Typology 3:- Co-Living Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 - Co-Working Mode

The tables can be slided together for group study too.

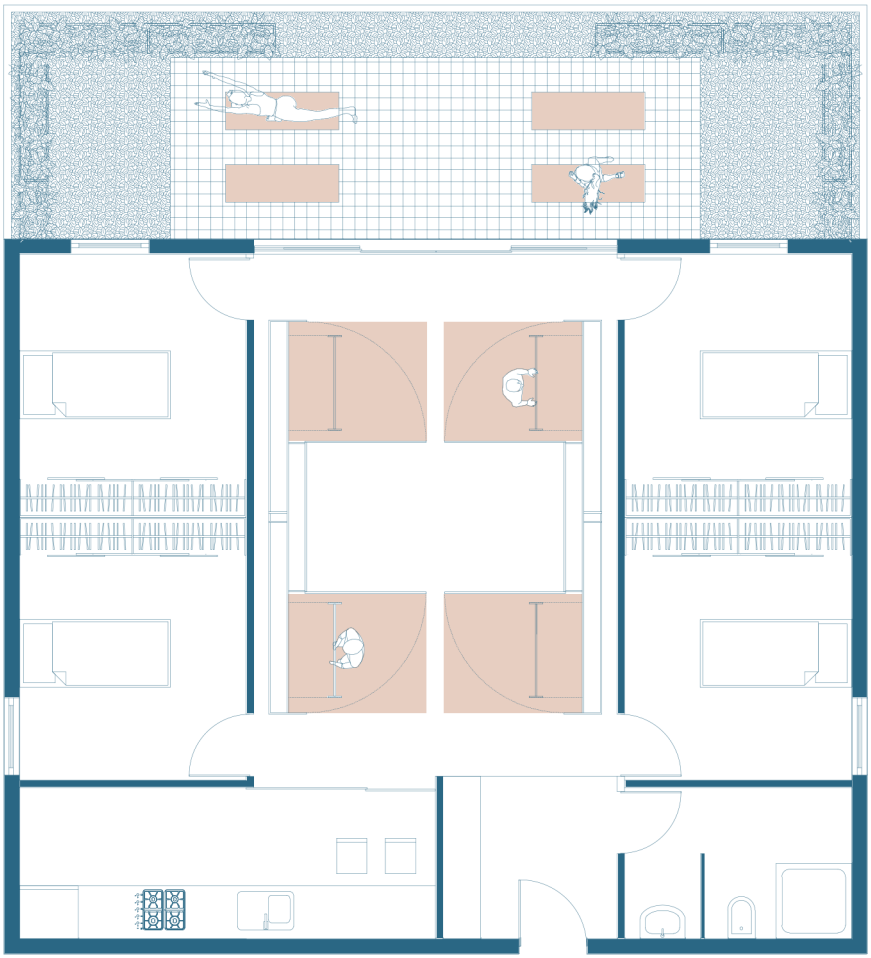
Typology 3:- Co-Living Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 - Hobby Mode

It's a Sunday afternnon, Chiara is thinking of starting to draw while Harris plays video games on the laptop. Meredith and Erhaan sit on the sofa and chat.

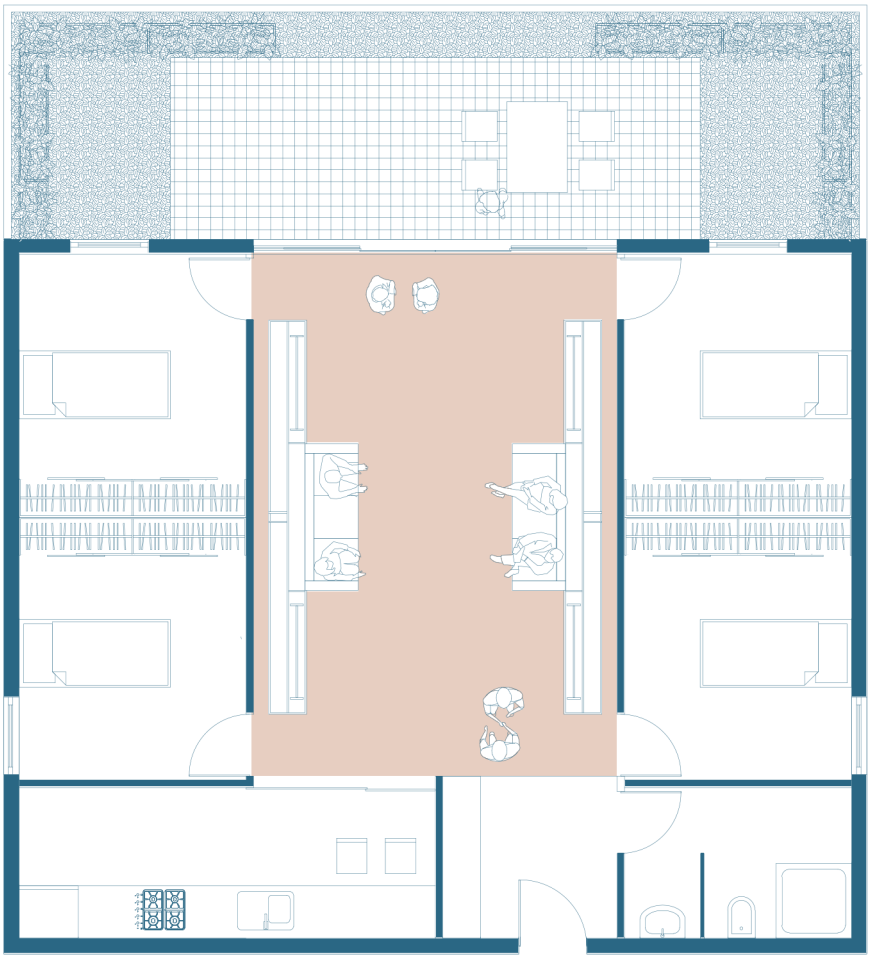
Typology 3:- Co-Living Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 - Sports Mode

After a tiring day, Chiara is de-stressing herself by doing Yoga and Meredith accompanies her Harris and Erhaan have moved the flexible unit back and opened the panel to work out.

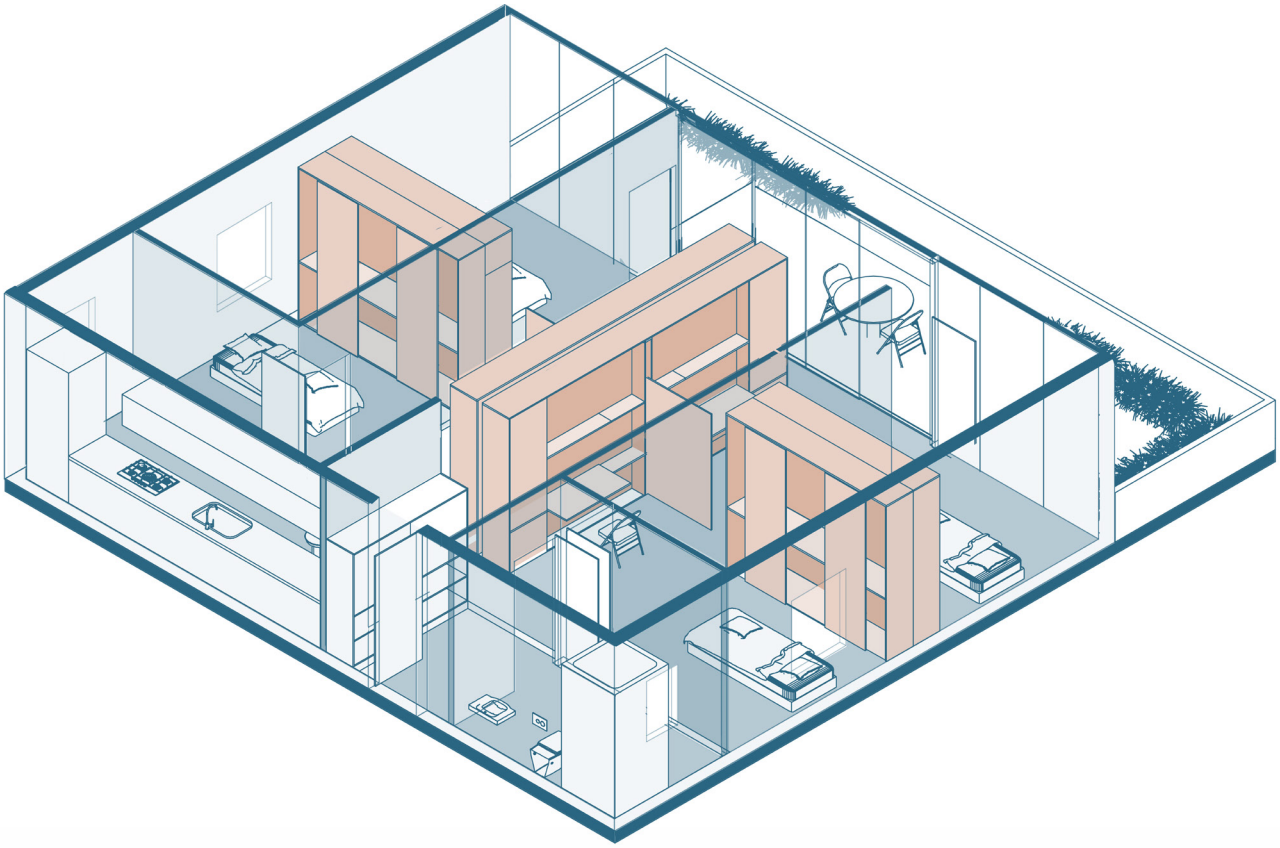
Typology 3:- Co-Living Unit (21st Century) Post Pandemic



New Proposed Plan 1:100 - Party Mode

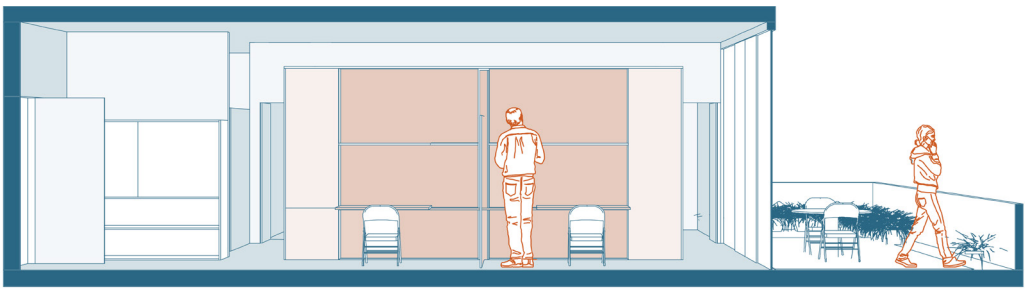
It's a Friday evening and Harris has invited few friends over. The flexible units have been slid back to the wall and the sofas have been folded out to create a living room.

Typology 3:- Co-Living Unit (21st Century) Post Pandemic



Isometric 1:100

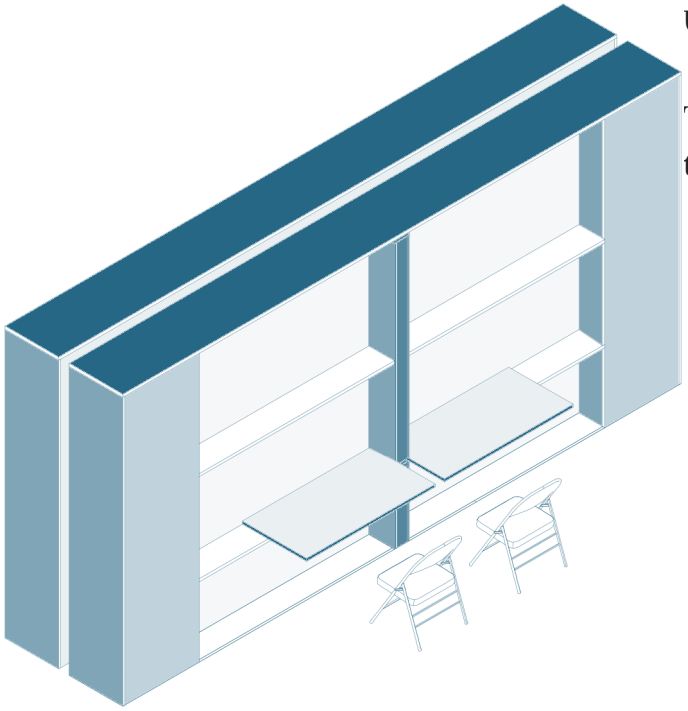
The Isometric shows how the unit sits in the lounge. The unit in between the rooms only works as a wardrobe.



Section 1:100

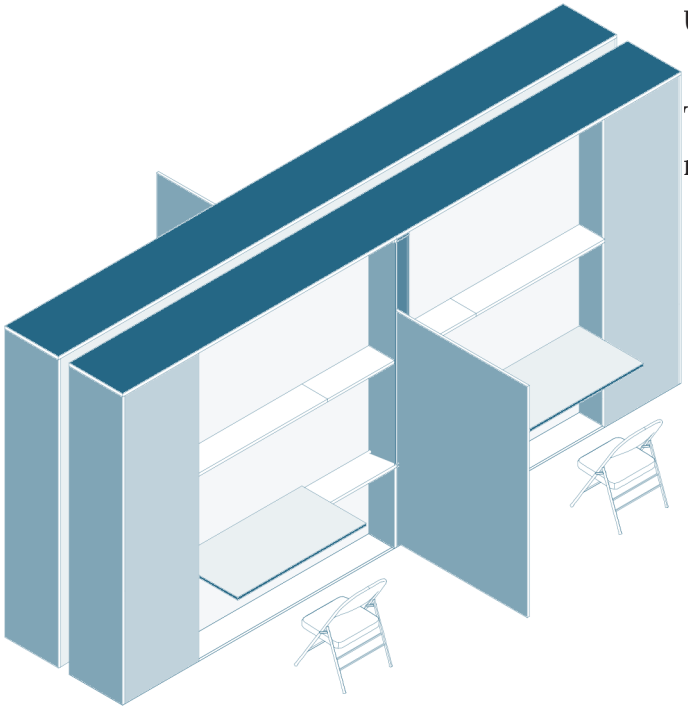
The section cuts through room, living room and balcony and shows unit in elevation.

Typology 3:- Co-Living Unit (21st Century) Post Pandemic



Unit Diagrams 1:50

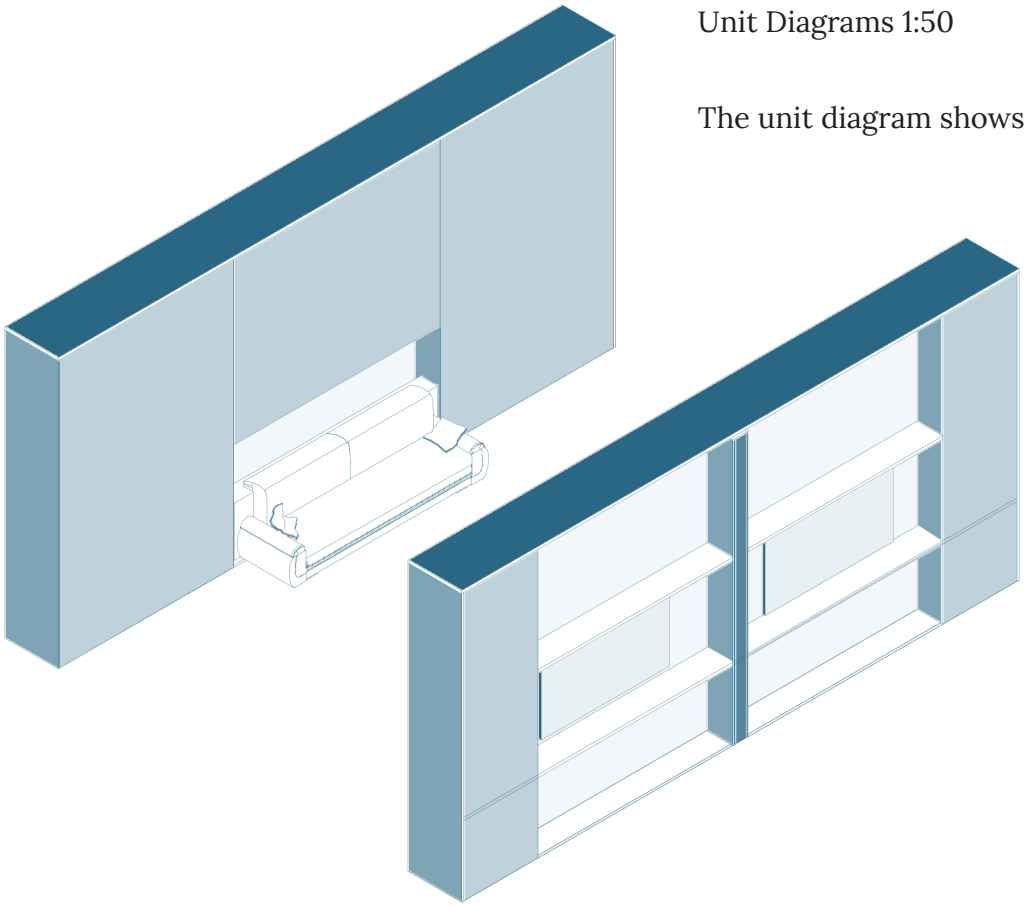
The unit diagram shows the co-working typology.



Unit Diagrams 1:50

The unit diagram shows the work/ study mode with privacy.

Typology 3:- Co-Living Unit (21st Century) Post Pandemic



Unit Diagrams 1:50

The unit diagram shows the relax mode.

Interior Render :- Co living Typology

The interior render shows how the living room works, the sofas can be folded out from the flexible unit. For students the colour we have chosen for them is a deep Orange.

5.4. Application of sustainable and smart technologies in the new proposed typologies

5.4.1. Colour theory

As discussed in chapter 3, colours in interior design have a psychological and physiological impact on the occupants, shaping how they perceive their environment.

Typology 1

The choice of color green was the best suited colour for the couple. It is a cool colour considered to be restful and transcends a sense of calmness and security. The colour symbolises growth, harmony and freshness. Since the typology is south-facing, a sunny room has bright light that can be tempered by a choice of cool colours. The chosen shade of green is emerald which is considered to be a bright and vivid shade of green. The remaining walls have lighter tones to balance out the green.

Typology 2

For Family, the preferred choice was Deep blue. The colour is beneficial to body and mind, it represents knowledge and power. It is associated with healing and health. The apartment is south facing and will have sufficient light in the living room and master bedroom, hence a choice of cooler colour works best. The remaining walls have been proposed to be white as the floor to balance the rooms.

Typology 3

For the co-living apartment that mainly consists of students, a deep orange has been proposed in the living room as it promotes enthusiasm, creativity and encouragement. As we have studied in chapter 3, use of orange colour in living rooms promotes socialising. The walls of rooms and the floor have been kept light to balance the unit.

5.4.2. Interior materials, finishes and details

The interior materials are important in determining the health impact on people in an indoor space. We have selected specific materials and finishes for our proposed typologies that can aid in creating a healthy residence that promotes the well-being of its occupants.

a. Panels (for transformable unit)

The range of sustainable components such as wood products available in the market has grown significantly in the recent years. Among wood panels, we have several types – Medium density particle boards (MDP), Oriented strand board (OSB), Plywood sheets, High density fibreboard (HDF) and medium density fibreboard (MDF).

Medium density particle boards (MDP) are considered to be of superior quality and most advanced in the manufacturing process as compared to other types of wood panels. These boards are composed of different sized particles such that the larger particles are positioned in the core layer of the panel while the smaller particles are arranged in the outer layers.

Due to the depletion of petroleum based resources and other environmental problems caused by the production of these panels, there has been a spike in the interest in the development

149. "The Use Of Nanocellulose In The Production Of Medium Density Particleboard Panels And The Modification Of Its Physical Properties :: Bioresources". 2021. Bioresources.Cnr.Ncsu.Edu.

of sustainable materials. Plant and wood based materials are the best source available for this. Cellulose, which acts as the reinforcing structure in plants, is abundantly available. It's properties such as low density, biodegradability, high mechanical strength and low cost make it an ideal material for development of sustainable products. [149]

The movable and transformable unit is made out of a low-emission Nano cellulose fibreboard. It is a non-toxic, fully recyclable and biodegradable material. It is composed of plant fibre such as flax, which is bound together using a fibrous substance – Nano cellulose - that is formed during bacterial fermentation. The required shape of the boards is made by compress moulding a mixture of water and the plant fibres. The production process of nanocellulose fibreboard is similar to that of MDF and therefore can be produced in the existing MDF factories with minimal alterations to the machines.

Coloured fibres in the board can be used to control the hue of the panels, which eliminates the need for any finishing such as paint on its surface. It is a sustainable material as it requires little energy for production. [150] For purposes of waterproofing the boards they are sealed using a low VOC vapour barrier sealant.

Image of nano cellulose fibreboard in different colours

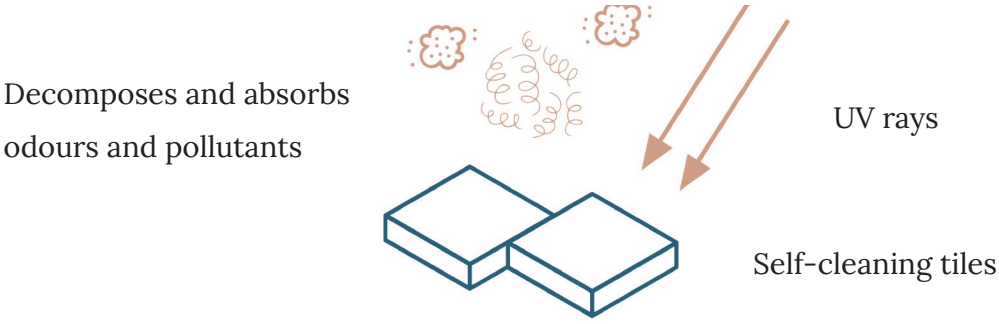
source : Treggiden, Katie. 2015. "Nanocellulose Fibreboard Is A Natural Replacement For MDF". Dezeen.

b. Flooring

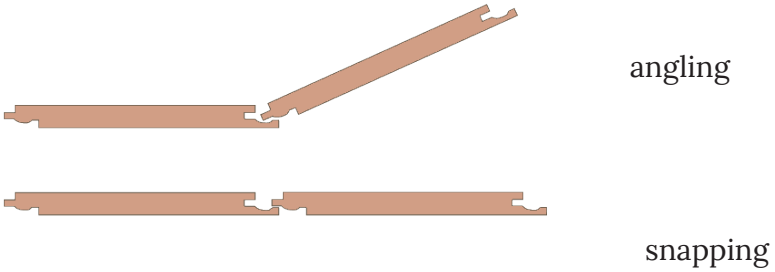
Photocatalysts have been widely used in the photodegradation of organic compounds and elimination of pollutants in the air. TiO2 is a strong photocatalyst and can be used as a coating on surfaces to benefit from its self-cleaning properties. Other advantageous properties of TiO2 include chemical stability, nontoxicity, hydrophilicity and low cost, which make it a sustainable and viable material for many industrial and environmental applications.[151]

The wet spaces and kitchen have white ceramic tiles that have a photo catalytic nano coating. This gives the material self-cleaning properties and enables them to eliminate odours and bacteria.

149. "The Use Of Nanocellulose In The Production Of Medium Density Particleboard Panels And The Modification Of Its Physical Properties :: Bioresources". 2021. Bioresources.Cnr.Ncsu.Edu.
150. Treggiden, Katie. 2015. "Nanocellulose Fibreboard Is A Natural Replacement For MDF". Dezeen.
151. Shakeri, Amid, Darren Yip, Maryam Badv, Sara Imani, Mehdi Sanjari, and Tohid Didar. 2018. "Self-Cleaning Ceramic Tiles Produced Via Stable Coating Of Tio2 Nanoparticles".



The rest of the flooring is a low VOC engineered hardwood that is installed using interlocking technology therefore eliminating the need for VOC emitting adhesives.

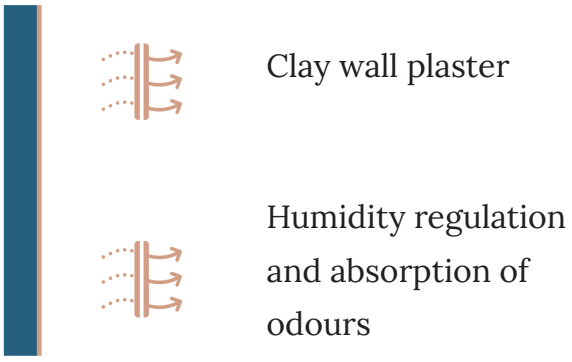


wClick lock system to install wooden flooring
source : "Install Uniclic Flooring Video | Onflooring". 2021.

c. Walls

The walls are finished using clay wall plaster which is an environmental friendly alternative to conventional plaster and paint that typically release harmful chemicals. Some clay plasters have even been developed to feature hygroscopic properties, whereby they passively regulate the humidity of an indoor space. This can help minimise mould and fungal growth. They also absorb odours making them ideal for application in bathrooms and kitchens. [152]

Clay is readily available and needs minimal processing to be used in construction, therefore requiring very little energy to be processed into a plaster. Since it has the property of being naturally sticky it does not need additional binders. It occurs in a range of colours that can be mixed with pigments to create any color required.[153]

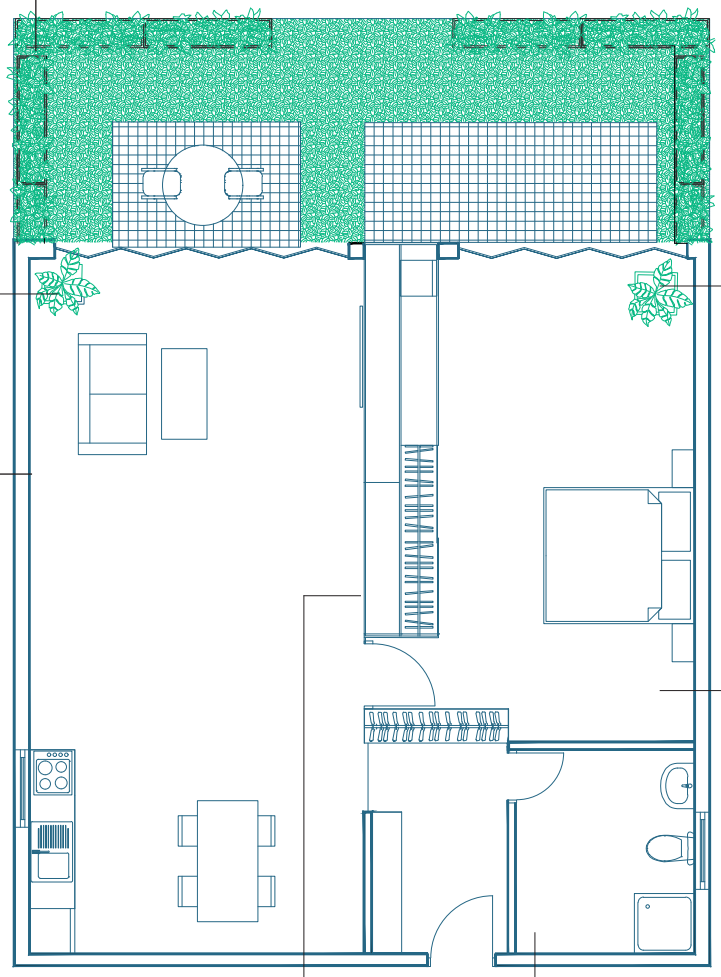


152. Council, Materials. 2021. " Wellbeing And Design: Materials For Healthy Interiors".
153. "What Is Clay Plaster? - Simple Construct". 2021. Simple Construct.

Materials diagram

Edible plants such as basil, rosemary, cilantro, and oregano as theyare used frequently in almost every kitchen.
Succulents are low maintenance,as they thrive in neglect.
These plants don't need regular watering and have low fertilizer needs.

Aloe Vera Plants release oxygen, works as an air purifier and absorbs moisture.



Snake Plants purify by absorbing toxins. They produce a large amount of oxygen to help you sleep better. They are easy to maintain.

Clay wall plasters are VOC free They display what is called hygroscopic behaviour: the ability to passively regulate the humidity of an indoor environment, minimising mould and fungal growth.

Low VOC engineered hardwoord flooring with interlocking installation (no glue needed)

Nanocellulose fibreboard are made from a composite of plant fibres such as flacks bound together using nanocellulose.
It is shaped using compress moulding.
It is biodegradable and 100% recyclable.

white ceramic tiles with photo catalytic nano coating. This gives the material self-cleaning properties and enables them to eliminate odours and bacteria.

d. Indoor plants

In chapter 3, we discussed the benefits of bringing nature and green indoors. It is important to choose the right plants for a home, as not all of them are suitable or beneficial for growth indoors. While there are many options available, for our proposed apartments we have selected plants that have shown to be most beneficial and are easy to maintain and grow.

The snake plant is known to produce large amounts of oxygen therefore improving the indoor air quality. Their large leaves are also able to remove harmful compounds from the air such as benzene and formaldehyde making them ideal for a healthy home.

Succulents are low maintenance as they do not regular watering and fertilizer schedules and give a pleasant, modern aesthetic. Succulents such as aloe Vera have beneficial properties such as moisture absorption, which can aid in regulating humidity.

Edible plants such as herbs are easy to grow in small indoor or balcony gardens, and the fresh harvest can be used directly in the kitchen.

5.4.3. Automation

The new habits and lifestyle changes developed due to the current pandemic crisis have increased the necessity for automation in the home for various uses. We propose the installation of various smart devices that can help in making homes more comfortable, healthy and sustainable.

Smart door locking systems that can be controlled via an app or face scanning ensure a touch-free access to the home. This way the user can avoid coming into contact with surfaces that other people touch, especially when having guests over. [154] Smart mailboxes at the entrance can be used to receive deliveries without coming into contact with other people. For increase privacy of the users we propose the installation of automated blinds that control visibility of the home from outside. [155]

For a more comfortable indoor environment, smart thermostats are installed that can monitor and adjust the humidity inside the rooms. Studies have shown that bacteria is weakened and spread a lot slower in humid air as it weighs down the microbes and pushes them to the floor where it is less likely to spread to a person. [156]

The use of Air filter devices that decontaminate the air from pollutants and other micro particles can help reduce the spread of virus and bacteria. Air purifiers are particularly helpful when natural ventilation is not possible without compromising the indoor temperature and humidity comfort

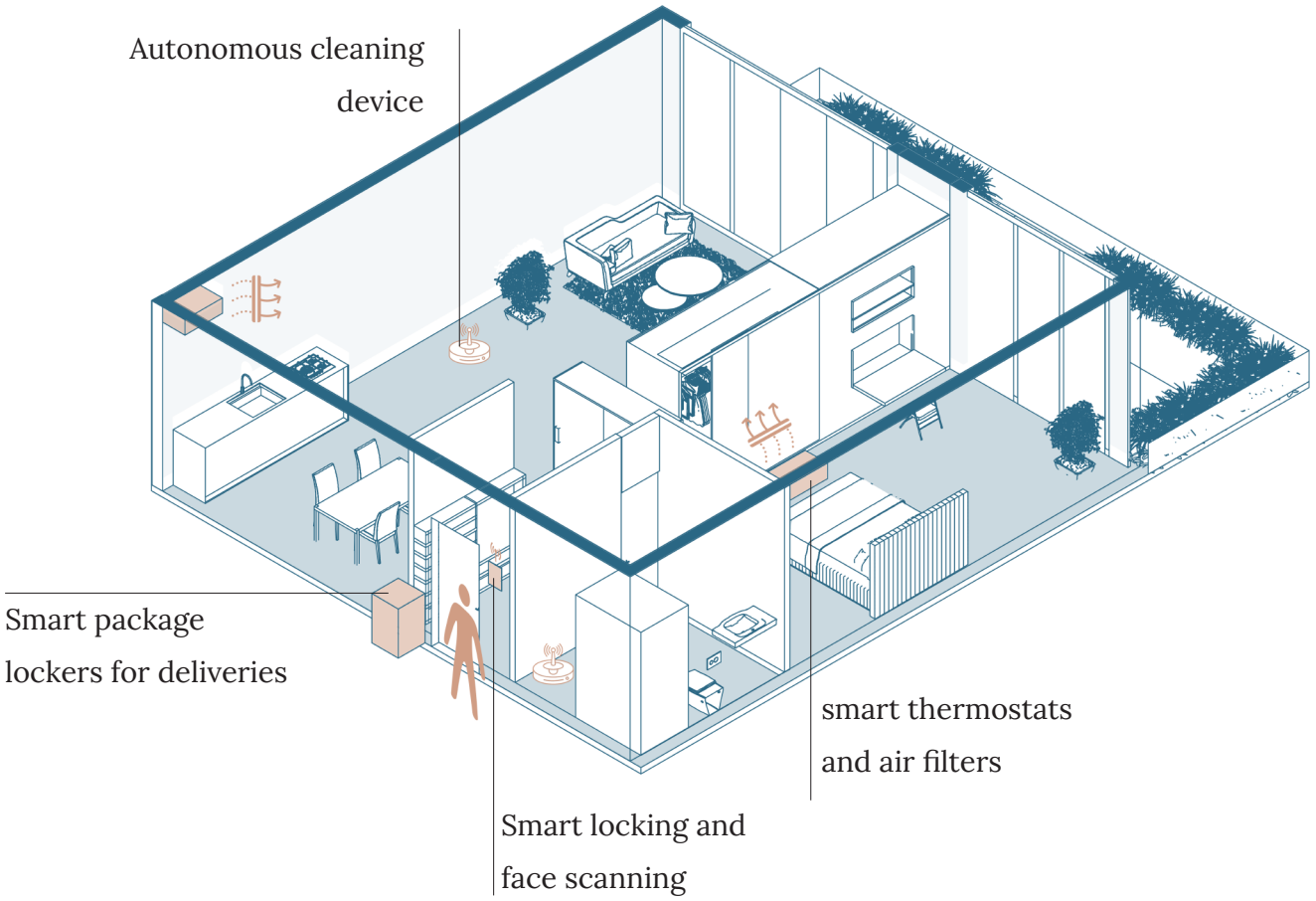
154. Can smart home devices help protect you from coronavirus? 2020, December 22

155. “The Post-Pandemic Smart Homes Technology Future [Infographic]”. 2021. Techglobex.

156. Can smart home devices help protect you from coronavirus? 2020, December 22

levels or when the outdoor air is more polluted and would contaminate the indoor environment.[157] Autonomous cleaning devices can be used, at least in areas that are frequently used by many people to keep them free of germs. This technology uses robots with artificial intelligence that can complete cleaning tasks on their own. [158]

Contactless appliances such as voice or motion activated lights also help reduce contact with surfaces and also save energy as they switch off when not in use. With the installation of all these smart devices, it is important to have a smart hub such as an application on the phone to control all of them. This would make all the devices operable without direct contact.[159]

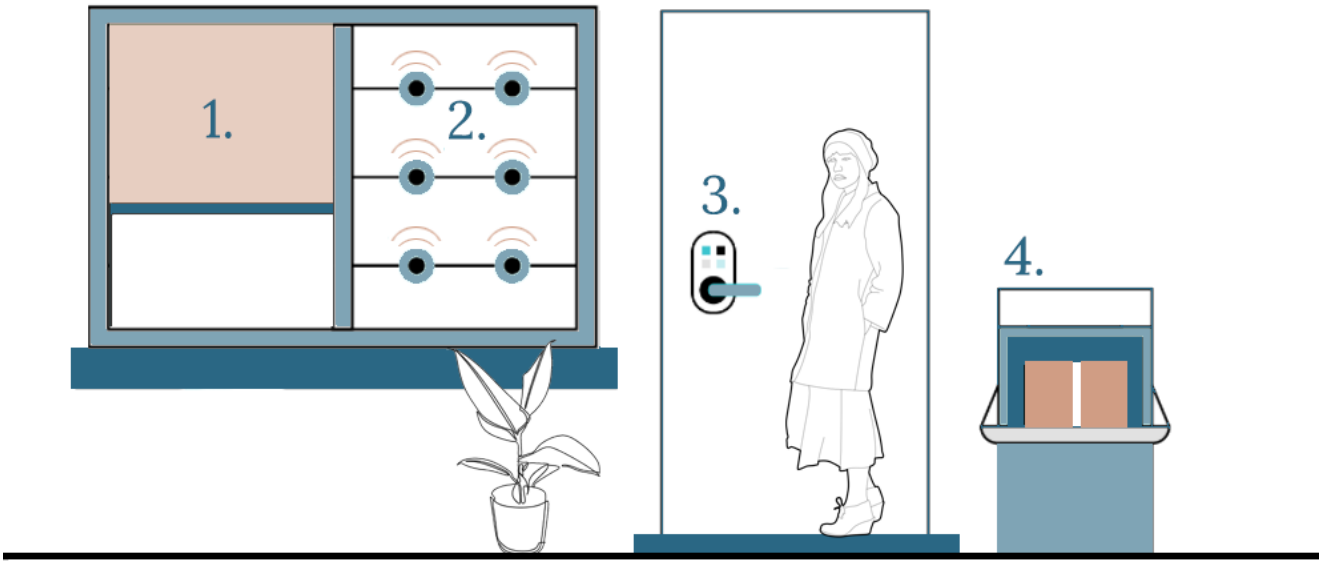


3D diagram showing automated systems in the home

157. “Air Cleaners, HVAC Filters, And Coronavirus (COVID-19) | US EPA”. 2020. US EPA.

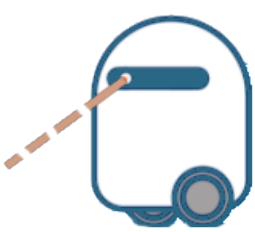
158. Team, SoftBank. 2021. “The Costs And Benefits Of Autonomous Cleaning Technology”.

159. Can smart home devices help protect you from coronavirus? 2020, December 22

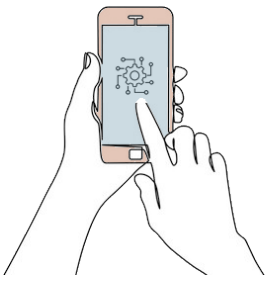


1. Automated blinds for increased privacy
2. Smart windows to reduce outdoor noise
3. smart locks that are remotely controlled
4. Smart deliveries in package lockers

5. Contactless voice activated lights
6. Humidity sensors to regulate indoor air



7. Autonomous cleaning devices

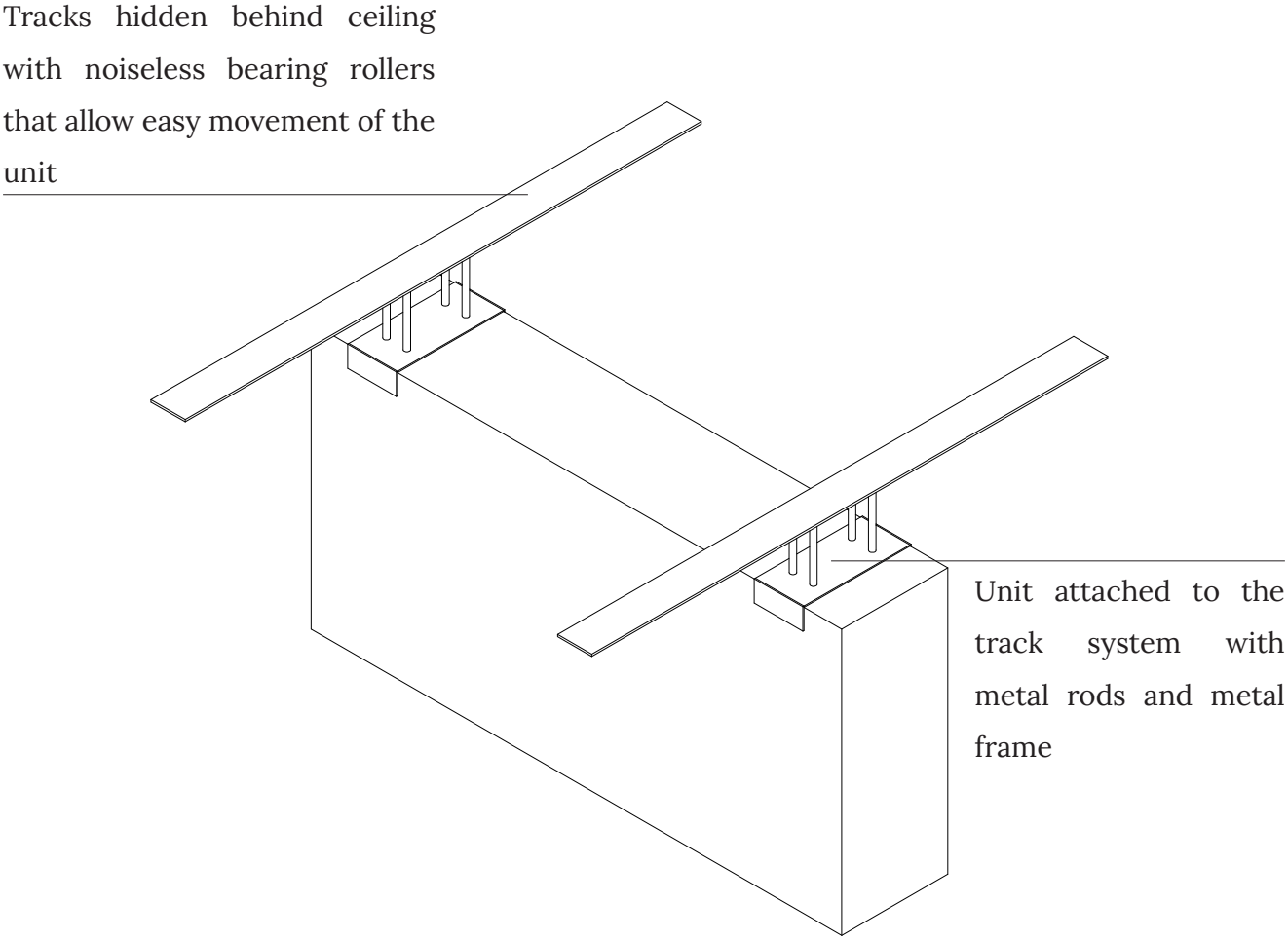


6. Smart hub to manage all devices remotely

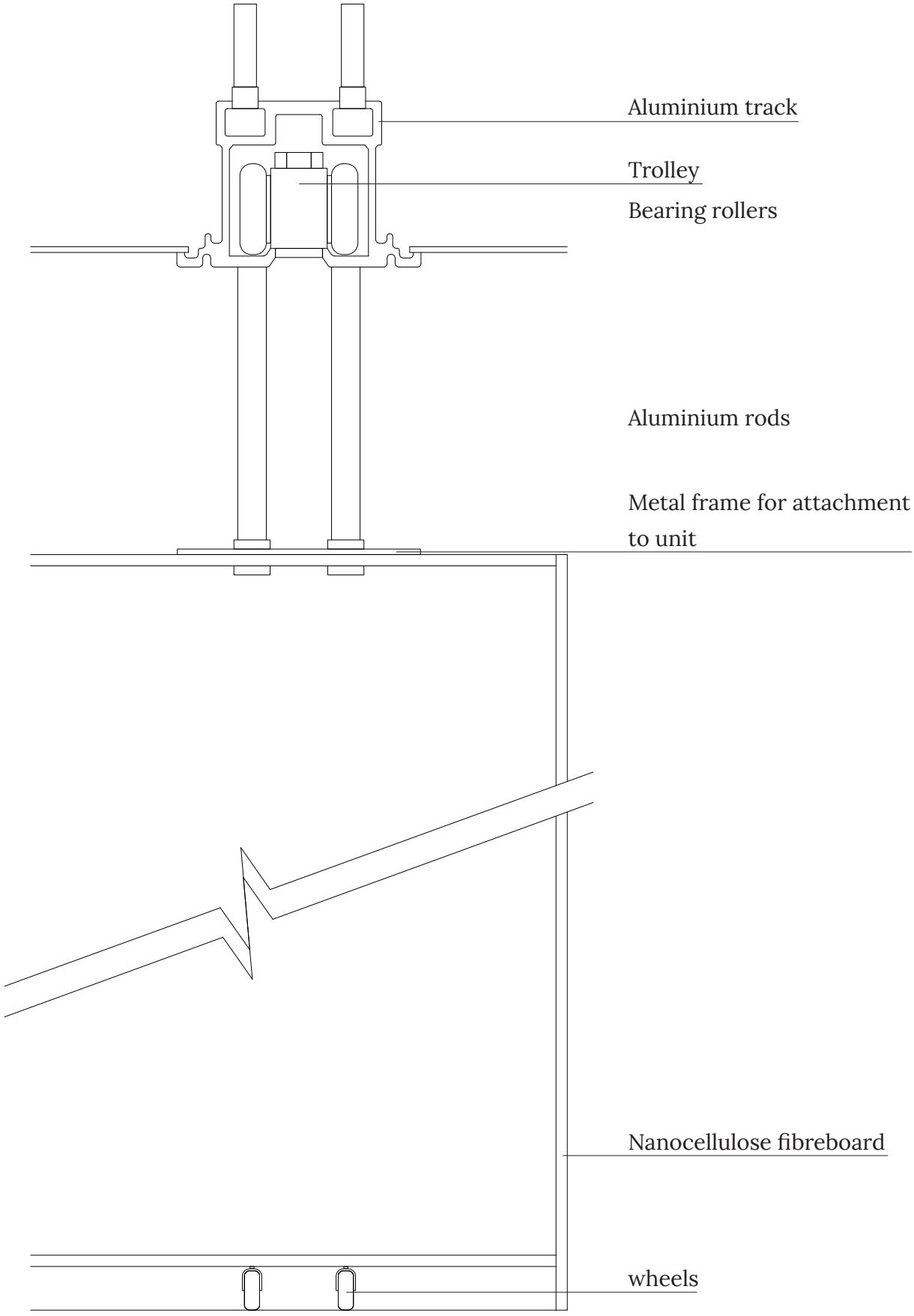
5.4.4. Usability

The movable, transformable unit challenges the idea of permanent divisions without discarding the option for partitioning and privacy. It also allows for a single space to be used in several different ways. The unit can be customised for different spaces and can provide many different functions depending on the needs of the users. The assembling of the panels and equipment is done on site accordingly.

The installation of the unit is only possible after the demolition of internal walls. The unit sits between rooms and acts as a wall that is multifunctional. The height is kept at 2500mm leaving a gap of 500mm from the ceiling to allow natural ventilation and light to all parts of the apartment.



3D diagram of movable system of the transformable unit



Detail section of transformable unit and moving system

Conclusion

Our research started from establishing the relation architecture and health has by looking throughout the century the role architecture has played in prevention of diseases. Each century, people have dealt with pandemics differently and have learnt a lesson that has later been applied for the betterment of the quality of our living. Somehow over the course of years with the increase in density in addition to the inflation, in the industrial and post-industrial city, houses have become tighter with fewer to no luxuries. For that reason, it was important to step back and analyse those lessons to better understand how we can be prepared for the future.

The 19th Century was the time of urbanisation, industrialisation and explosion of population, the societies evolved from rural to urban areas. It wasn't widely understood how the germs were passed so unsanitary habits were a norm. Packed areas were believed to be breeding grounds for diseases, so slums were eradicated and open public spaces came to be and widespread public services of aqueduct and wastewater collection, for the bathroom and the prevention of diseases.. We have seen through our research how bathrooms and living rooms evolved. Tenements came to be in the 19th century as a form of low cost housing and for our research we looked at tenements in Berlin built in industrial locations.

Moving to the 20th Century, we saw the increase in open air schools, vacation residences, social housing, hotels and gyms under the title of 'Modern Architecture'. Modern architecture's focus was on a more hygienic lifestyle meeting practical needs of the users. Sanatoriums were built to isolate sick people from the rest. The architecture focused on the power of light, air, nature, simplicity and rationality. Soon enough, these concepts were being applied to the domestic as well. Better understanding of microorganisms resulted in change in habits and domestic activities. Lawn Road Flats that were built in the UK were a great case study to understand the minimalist modernist approach architects had at the time by providing simple accomodation with maximum comfort.

The recent shift in the paradigm has put everything on pause and is forcing us to reevaluate our choices. For this purpose, our study in the 21st century (Pre Pandemic housing Model) focused on external and internal factors that affect the quality of living. While many of these factors can be tackled by efficient design strategies, architecture alone can not eradicate the challenges without the help of outside forces. For our Case study we looked at The Bosco Verticale as it is one the most talked about residential complexes in recent history. To better tackle the issue in front of us, we researched the spread of diseases and how design can counter and prevent their transmission by creating healthy environments..

Following this we conducted a survey across the globe to understand how people with different personalities, professions, ages and locations dealt with the current pandemic. It also helped us form our personas for different housing typologies.

All the case studies mentioned and highlighted were then revamped for current times to meet

the needs of the given personas. New architectural typologies were also put forward as seen in Chapter 5.

All of our research and design has led us to the conclusion that the new housing model needs to be flexible, affordable, better ventilated, have effective natural lighting, private outdoor spaces, work/studying spaces, private spaces and a model that focuses on the physical and mental health of its users. Technologies for health and home automation and flexibility of internal barriers are conditions for the ascending models of multifunctional shelters.

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