A VISIONARY APPROACH TO URBANIZATION BY MAXIMIZING DENSITY AND QUALITY OF LIFE

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ABSTRACT

The aim of this research is to develop a new way of living that actively tackles the challenges presented by the ongoing urbanization of our cities, through answering the research question: How can we create a way of living that maximizes both density and quality of life? The notion of densification consists of a set of interrelated variables which are heavily reliant on each other for their assessment, significance and usefulness. The notion of quality of life is used not only to refer to several physical characteristics, but also to describe the relationships and dynamics among those physical characteristics, making the concept complex and interwoven. Casestudies are assessed based the parameters of maximum density (volume, efficiency and effort) and maximum subjective quality of life (identity, range and speed). By comparing the results with the implemented design elements, the research question can be answered. The main principles for a way of living that maximizes both density and quality of life are: optimizing floor space, providing adaptable environments, offering a diverse range of housing types, promoting facility sharing, and improving outdoor spaces.

KEYWORDS: *Urbanization, Density, Quality of life, Visionary*

I. Introduction

Urbanization is one of the most pressing challenges currently being faced by cities all over the world. More than half of the world's population (54%) resides in urban areas. This urbanization is expected to continue to grow to 68% by 2050 (UN, 2018). Scientists even refer to the 21st century as the 'urban age': the age of the metropolis, characterized by social, spatial and economical complexities caused by extreme urban growth.

The high demand for housing caused by urbanization needs to be accommodated, but available space is limited. Many cities and communities have responded by growing outwardly. This is not the most desirable way to expand, because besides claiming valuable land, this physical expansion increases pressure on the transportation facilities and the environment. Therefore, intrinsic growth of cities is considered as a better way to achieve a sustainable urban densification. This is often referred to as striving for a 'compact city'. This concept represents a city that makes maximum use of the existing urban environment, combines functions and builds in high density close to the existing environment. (Jenks, M, et. al, 1997) Because more people will make use of the same amount of space, there will be greater pressure on the built environment. Urban living is frequently associated with 'higher levels of literacy and education, better health, greater access to social services and enhanced opportunities for cultural and political participation.' (UN, 2018, p.3) However, rapid and unplanned urban growth often results in urgent environmental, social and economic issues, and it contributes to severe housing shortages in many global cities. By 2025, one fifth of the world's population is expected to lack access to safe, suitable and affordable housing. (Florida, 2017)

Nonetheless, the current debates on densification are mostly about constructing as many houses as possible, as rapidly as possible. It's important to slow down and ask ourselves: what kind of environment are we creating? The design and governance of the actual development of this densification has a major impact on the quality of life in the urban environment. We need to make sure that densification produces attractive, vibrant communities rather than overcrowded, stressed, and polluted cities. As more and more people live in cities and the goal is to densify inward rather than urban sprawl, the quality of life of these people is of increasing importance.

The aim of this research is to develop a new way of living that actively tackles the challenges presented by the ongoing urbanization of our cities. A way of living that does not fight against densification, but rather embraces it. It explores how we can achieve maximum densification of a city while at the same time creating the highest quality of life for its citizens. This results in the following research question:

How can we create a way of living that maximizes both density and quality of life?

Research into the relationship between the concepts of density and quality of life has a long tradition. In the history of architecture and urbanism, many visions have been developed of places that enhance the quality of life (Mallgrave, 2009). Very often, designs for livable and personal environments have led to societies defined by anonymity, and public spaces turned out as stages for people to express their displeasure and endanger the safety of others (Blair & Hulsbergen, 1993; Helleman & Wassenberg, 2003). It could be argued that many well-intentioned concepts of a high quality of life became obsolete shortly after their creation. Moreover, since the beginning of the twentieth century, the introduction of regulations for a high quality of life has acted as a set of restrictive rules. They offer neither freedom nor creativity for architectural expression and innovation. Therefore, this research does not focus on the principles for maximum quality of life as stated in the building regulations, but follows a visionary approach. Through visionary thinking, we can challenge long-standing traditions and pave the way for innovative approaches. As Robert Klanten and Lukas Feireiss (2011) state, utopian visions are 'one of the most important catalysts for fundamental change'. This paper explores visionary predecessors, as they contain many interesting concepts of density and quality of life.

This research contributes to social issues and scientific knowledge reagrding urbanization. Moreover, this study provides input for the discussion on the development of contemporary cities by providing new insights. The design solutions provided can therefore be applied to urbanizing cities around the world.

II. Methods

To answer the research question, this research is divided into multiple sections. An overview can be found in figure 1. Each section focuses on a question that is answered before moving on to the next section.

Part 3.1 addresses the concept of densification. First, the definition of density is determined through literature research. Next, by analysing a standard house, the amount of space we actually use and the amount of space that is redundant is calculated. Finally, the concept of density is translated into a number of parameters on which case studies will be assessed.

Part 3.2 deals with the concept of quality of life. As with density, the definition of quality of life is determined through literature research. Subsequently, analyses are used to answer the question of what a maximum quality of life will entail. Based on this information, parameters are defined on which the case studies will be tested.

Part 3.3 covers the case studies. Three different types of projects have been chosen: predecessors of adaptable living environments, contemporary adaptable living environments and micro-living environments. The cases are analyzed based on the parameters of density and quality of life as defined in part 3.1 and 3.2. Following, the results are compared with the design elements implemented in the cases and consequently it can be determined which design

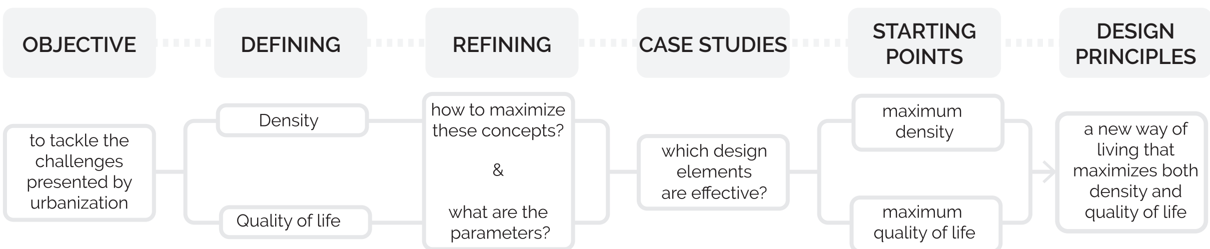

Figure 1. Methodology

solutions are effective.

Part 3.4 contains starting points for the design of a new way of living that maximizes density and quality of life. These are obtained by a combination of literature research and the results of the case studies.

III. Results

What previous studies have shown is that the relationship between density and quality of life is complex. For example, the research by Searl (2010) into the consequences of residential density, revealed its multi-dimensional character. Searl states that, on the one hand, urban densification can have a negative impact on the quality of life, especially in suburban areas where lower density and greater subdivisions are perceived as positive. On the other hand, the densification of these areas can be seen as an opportunity to improve the quality of life.

Answering the question how the density and quality of life can be maximized requires some discussion about what both concepts entail. Therefore, the concepts will first be discussed separately in the following paragraphs.

3.1 Density

3.1.1 Defining density

Density, specifically in relation to urban space, has various meanings and measurement methods. An integrated model of these definitions and measurements is missing, causing a great deal of confusion. The notion of density originates from physics as the quantity of mass per unit volume. As applied to the urban context, the density refers to certain quantities per unit area. These quantities can range from floor area, building volumes, dwellings or people, and the scale can range from a small area to an entire region. All measurements can be either net or gross: the 'net density' being measured at the site and the 'gross density' integrating the larger context of public space. Furthermore, a distinction can be made between the 'external density' at the level of the neighborhood and the 'internal density' at the level of the occupants per room or floor area (Dovey, 2014). There is a strong correlation between these complex series of variables. Figure 2 shows the relation between these variables in three different domains: building density, population density and open space. This allows us to make an assessment of how density

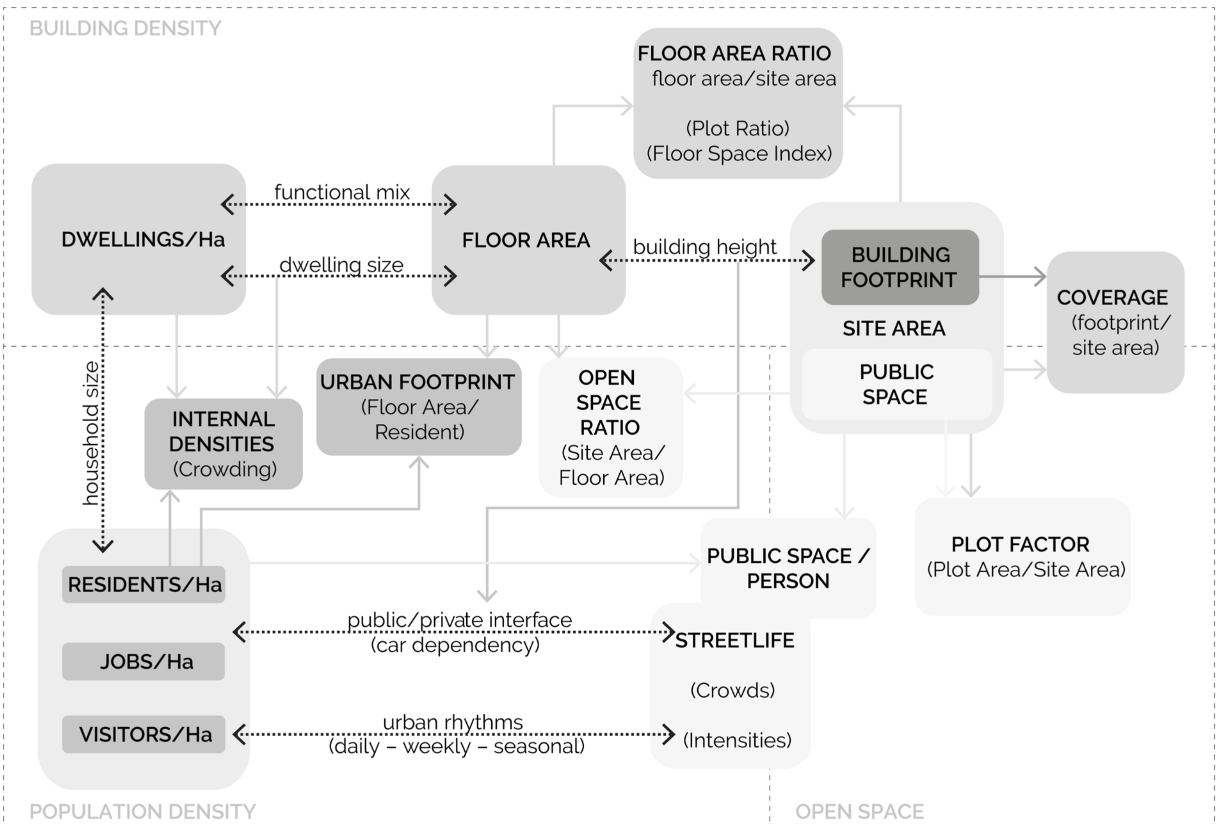

Figure 2. Dimensions of density (own image, based on Dovey 2014)

should be defined, measured and interpreted in order to maximize it.

First, the building density generated by a certain urban structure is examined. Buildings occupy a certain ‘footprint’ within a ‘site area’, as shown by the dark grey box in the diagram. Moreover, the ‘floor area’ is influenced by the relationship between the footprint and the ‘building height’. A disadvantage when determining the floor area based on the footprint and the building height is that there are exceptions, such as buildings with floors below ground level or sloped walls. However, this method is valid for a large percentage of buildings in most cities. The floor area can be converted into the density of ‘dwellings/hectare’ by combining it with the ‘dwelling size and the percentage of dwellings in the ‘functional mix’. This principle can be explained by an example; a small floor area can have a high housing density if there are lots of small houses, such as in slums. In addition, a very dense area can have a low housing density when the dwellings only make up a small part of the functional mix. An example of such an area is the Central Business District in Singapore, see figure 3. This area is one of the most densely developed places in the world, but has few dwellings in the functional mix. Two other measurements of building density related to the footprint of a building are the ‘coverage’ and the ‘floor area ratio’.

Figure 3. Central Business Distric, Singapore
Source: https://www.straitstimes.com/business/banking/how-singapore-is-wooing-worlds-biggest-money-managers-with-new-law

Second, the density of the population is assessed, including both the internal and external density of residents, jobs and visitors. The most important factors of population density are ‘residents/ hectare’, ‘jobs/hectare’ and ‘visitors/hectare’. The connection between the population and the building-density is made by the ‘household-size’, as this bridges the gap between the residents/ hectare and the dwellings/hectare. An example of a country with a large household size is India with an average of 5.4 persons per household compared to an average of 2.2 in the Netherlands (Arcgis, 2018). The ‘internal density’ is based on the dwellings/hectare, the residents/hectare and the average dwelling size. The ‘urban footprint’, one of the most well-known indicators of density, is derived from the floor area and the residents/ hectare.

Figure 4. Public space in Moscow
Source: https://designyoutrust.com/2018/01/bublik-circular-apartment-building-moscow-pinnacle-brutalism/

Last, the density of the buildings and population is related to the level of open space. The ‘open space ratio’ measures the ratio between the public space and the floor area. This indicates how a larger floor space adds pressure on public space, both in terms of infrastructure and recreation. However, this measurement makes no distinction between private and public open space. The ‘plot factor’ refers to the relationship between the plot area and the site area, also known as the link between the public and private space. Both open space ratio and plot factor are unrelated to the population density. In order to define the population density in open space, the ‘public space/person’ is needed. One of the cities with both a high population density and a high public space/ person is Moscow, see figure 4. The last measurement in the diagram is the ‘streetlife’, this combines the overall population density with the open space and overlaps with the public space/person.

All of the aforementioned density measurements are heavily reliant on each other for their assessment, significance and usefulness. Therefore, the notion of density cannot be restricted to a single part of the diagram and can best be interpreted as a set of interrelated variables. Consequently, in order to maximize the density to accommodate the ongoing urbanization, we need to address the concept of density as a whole.
The next step is to compare the density of

different urban morphologies. Four urban conditions of one hectare have been selected to be examined on the basis of the variables of density, an informal settlement, suburban, urban (low-rise) and high-rise conditions. Information about these conditions, such as the average dwelling and household site, is derived from a research of Kim Dovey and Elek Pafka called 'The Urban Density Assemblage' (2014). The comparative density variables of the selected morphologies are graphically illustrated in figure 5. A distinction has been made between the building density, population density and open space. The graph shows that only the suburb has some consistency of density regarding the different variables. The high-rise has a high building density, but a low population density. Moreover, the informal settlement has almost the opposite density of the high-rise with a lower building density and a higher population density.

Within this research the goal is to maximize the density in order to accommodate the ongoing urbanisation. This involves more residents on the same surface area of the city thereby preventing urban sprawl and its negative impacts. Therefore, the aim is to increase the building density by means of a high dwelling density, a high external density and a high internal density. When we look at figure 2, we notice that the floor area and thus the dwelling size play an important role. To maximize the building and population density, the dwellings/hectare should be increased by means of smaller dwelling sizes. The following paragraphs zoom in on the scale of one dwelling.

3.1.2 Current use of space

To explore whether the floor area of dwellings can be reduced, the current use of space is first addressed. Using data from the American Time Use Survey (2016), it was possible to analyze what people do throughout the day. This research provides an overview of the daily routine and how it varies according to gender and age group. Participants explain how they spent the 24 hours prior to the survey. The results are then processed and weighed so that the days and demographics closer represent the actual population. A minor drawback of this method is that it is based on people's memory to measure time usage because it is based on a survey.

We can conclude that the standard timeline is valid, see figure 6. Most people sleep at night regardless of age and sex and around 8 o'clock travelling gets darker as more and more people go to work. After that, work-related

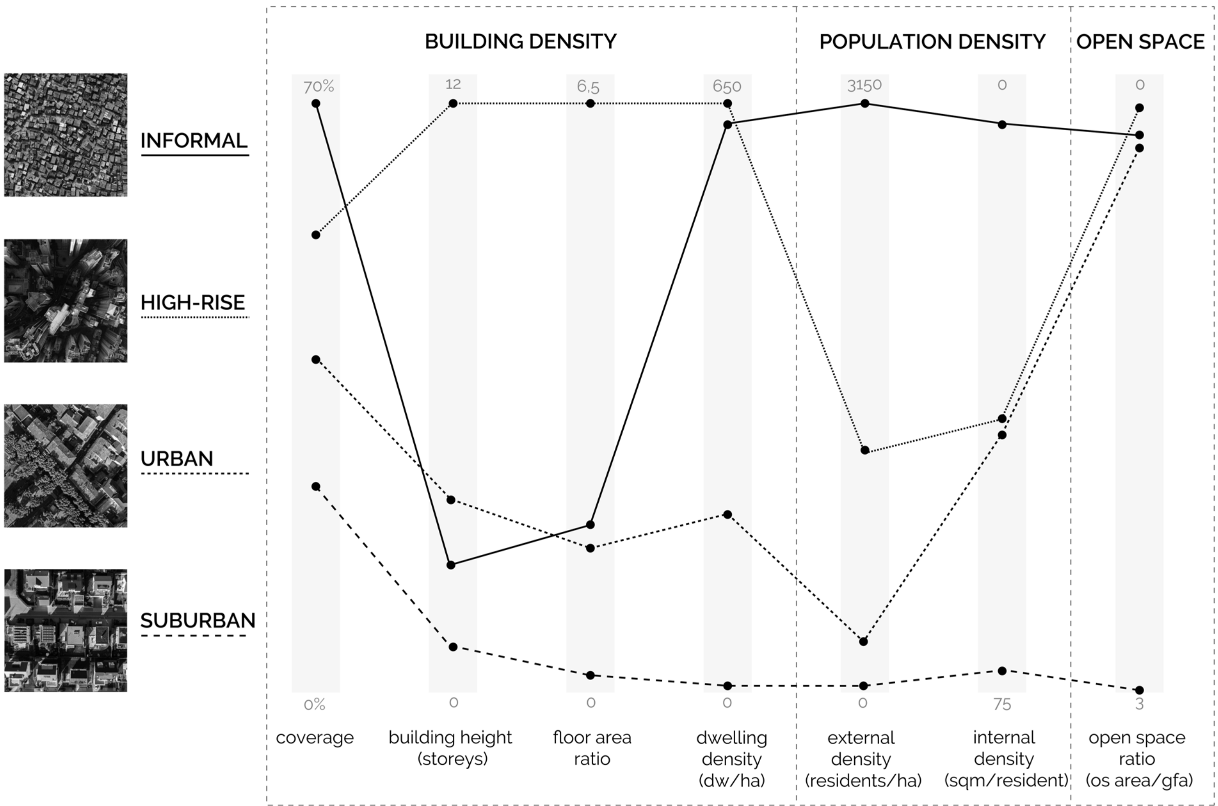

Figure 5. Comparing the density of urban environments (own image, based on Dovey 2014)

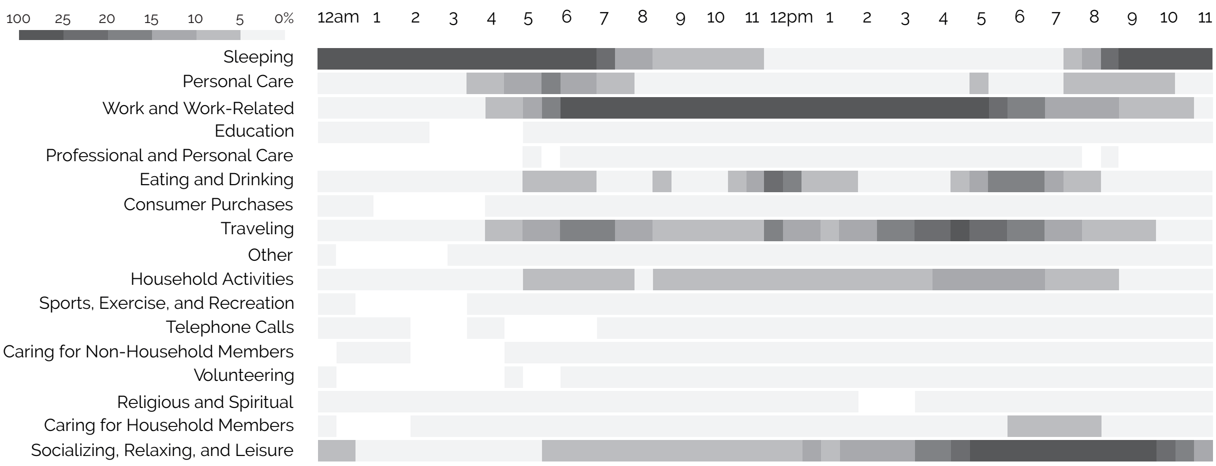

Figure 6. How people spend their day

activities take up most of the time. Around 5 o'clock the opposite happens, and people return home.

These activities were then projected onto a standard family home in the middle price range, based on a family with two working parents and two school-aged children. The complete analysis is included in appendix A.
This analysis is intended as a visual case study showing how much unused space there is in today's dwellings. It starts with everyone being asleep, then one parent goes to work and the children go to school. The other parent works at home. At the end of the day, everyone returns home, they have dinner together and finally everyone goes back to bed. When a room is occupied, it is grey. This allows the 'surface-time' to be calculated, by multiplying the surface area in square meters and the occupancy time in hours. Appendix B shows the calculations. In total, the dwelling has a floor area of 108 m2 and is used 24 hours, resulting in a total surface-time of 2592 m2h. The surface-time of the rooms used is 815 m2h, implying that only 30% of the total surface-time is utilized, as illustrated in figure 7.

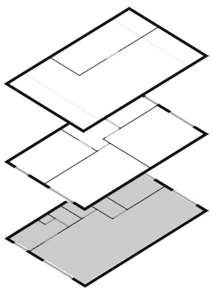

Figure 7. 30% of the total surface-time is utilized

By analyzing the minimum required space per activity, dwellings can be designed more efficiently. This allows dwellings to take up as little space as possible and thus to maximize the density. To study the required area or volume per activity, the results of a research by S. Gargaretas (2013) were used. This research explores the movements and behavior of the people during daily activities, using Microsoft Kinect Motion Tracking technology, resulting in a model of the space we actually use. When we compare the occupied surface-time of dwellings with this model, we can conclude that there is a lot of potential for improvement in the layout of current dwellings.

3.1.2 Parameters of maximum density
The previous paragraphs showed that the density can be maximized by reducing the floor areas of dwellings. There is a lot of unused surface-time in the current dwellings and we occupy a very small volume during our daily activities. Dwellings designed for maximum density have three important characteristics: a small volume, a high efficiency and low effort. The small volume means that the dwellings do not take up more space than necessary and the high efficiency ensures that the space is well organised and therefore does not have any wasted or unnecessary space. Furthermore, it is important that the dwellings require as little effort as possible from the occupant compared to a standard way of living. In order to translate these principles into starting points for a design, the case studies will be assessed based on these three parameters of density: volume, efficiency and effort.

3.2 Quality of life

3.2.1 Defining quality of life

Quality of life is not an unambiguous term with a clear or agreed definition, but rather a complex concept. There have been many attempts to define what constitutes quality of life. It dates back to philosophers like Aristotle (384 -322 BC) who wrote about 'the good life' and 'living well' and how government policies could contribute to it. Later, in 1889, James Seth introduced the term 'quality of life' in a statement: 'we must not regard the mere quantity, but also the quality of ''life'' which forms the moral end' (S. Marshall, D. Banister, 2007).

The notion of quality of life in an urban environment is used not only to refer to several physical characteristics, but also to describe the relationships and dynamics among those physical characteristics. Therefore, the quality of life is not linear, but can be seen as complex and interwoven. An in-depth study of the literature on the quality of life of Mulligan et al. (2004) confirms this finding, as it suggests that the quality of life is the level of satisfaction a person obtains from the surrounding environmental conditions. These conditions depend on scale and can influence the behaviour of individuals, groups and businesses. The approach presented by Campbell et al. (1976) suggested that quality of life could be divided into several domains. As proposed by Marans and Rodgers (1975), these domains are:

- House well-being
- Neighbourhood well-being
- Economic well-being
- Social well-being

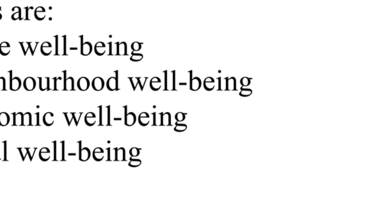

Figure 8. Domains of quality of life

The urban quality of life of a particular place cannot be understood through just one aspect, but through the relationship between the several aspects. These aspects are interwoven and dependent on each other, as shown in figure 8.

Apart from distinguishing these different domains of quality of life, there are two different ways to look at these domains (Aminian, 2019). The objective dimension relates to the way in which the physical environment can influence behaviour positively or negatively and thus improve or reduce the quality of life (Pacione, 2003; Raman, 2010). The subjective dimension is about people's perception of how their environment influences their experiences of life and how it shapes their cogenitive interpretation of the quality of life. (Losciuto & Perlo, 1967). When we combine the objective and subjective quality of life with the different dimensions, figure 9 arises.

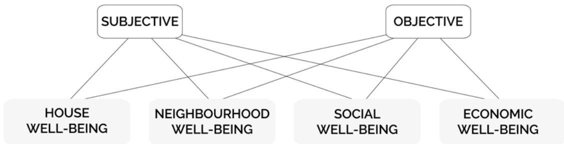

Figure 9. Objective and subjective dimensions

3.2.2 Ideal situation

The objective dimension of a maximum of quality of life is explored through literature research and has been categorized according to the domains as formulated in paragraph 3.2.1

- House well-being

The housing domain should offer all residents a well-connected, functional, comfortable and affordable living space close to the city's facilities. There should be policies to diversify the development of housing and to increase the usability and flexibility of the dwellings. It preserves, maintains and upgrades the existing stock, creates possibilities to add new housing and support rehabilitation of neighbourhoods and growth. The housing domain should stimulate the development of adaptive dwellings in order to foster a more dynamic and varied supply.

- Neighbourhood well-being

The neighbourhood should define areas appropriate for the development of cultural events and entertainment facilities, such as theaters, restaurants and museums. Culture enhances the quality of life for both the individual and the community as it shapes a neighbourhoods's identity. A basic infrastructural network is crucial for a comfortable and efficient environment, not only concerning traffic, but also water, sewage, electricity and waste management. In addition, the neighbourhood must ensure the preservation of nature, as the presence of green spaces and parks is essential for the quality of life.

- Economic well-being

The urban environment should encourage a competitive, open, healthy and sustainable economy by supporting local businesses and promoting mixed-use development. It should give all residents a chance for rewarding work. It minimizes economic inequity by offering equitable access to economic activities, services and facilities and a variety of types of housing, rental options and price rates.

- Social well-being

The environment should guarantee fair conditions for all communities, especially those prone to poverty and social exclusion. It fosters cultural, ethnic and religious diversification and stimulates every individual to contribute to the continuous development of the environment. Its design should strengthen a safe environment and ensure close relationships and human interaction through public meeting places.

The subjective dimension of a maximum quality of life is much more difficult to define, because it is highly dependent on the person's character, perception of life and socio- cultural habits. As individuals, we often don't share similar preferences. According to Myer Briggs (1998), how people experience the environment can be explained according to different personality types. Five personality aspects can be distinguished:

- Mind: shows how we interact with our surroundings
- Energy: determines how we see the world and process information
- Nature: determines how we make decisions and cope with emotions
- Tactics: reflects our approach to work, planning and decision-making
- Identity: shows how confident we are in our abilities and decisions (16Personalities, 2013)

When combined, these aspects define a personality type. Each of these aspects can be seen as a two-sided continuum, with the neutral option in the center. An example of the mind aspect is that an introverted person prefers solo activities and gets exhausted by social interaction and an extroverted person favors group activities and gets energy through social interaction (Briggs, 1998). An endless variety of combinations of these personality aspects are possible and therefore everyone has a different subjective experience of the environment. In order for the living environment to fully match the preferences, i.e. to maximize the subjective quality of life, a way of living is needed that can adapt in a certain way to the desires of the residents.

3.2.3 Parameters of maximum quality of life

The characteristics of a maximum objective quality of life are given in paragraph 3.2.2 and the characteristics of a maximum subjective quality of life will be defined through the case studies. The living environment should be adaptable, because every individual experiences the environment differently. This implies that the resident should be able to customize the dwelling according to his preferences and identity. Furthermore, these adjustments should not be limited to a certain grid or framework. In order to translate these principles into starting points for a design, the case studies will be assessed based on these three parameters of quality of life: identity, speed and range.

3.3 Case studies

Three different types of projects have been chosen based on their characteristics: predecessors of adaptable living environments, contemporary adaptable living environments and micro-living environments. The cases are assessed based on the parameters of density and quality of life as defined in paragraph 3.1.3 and 3.2.3:

- Density: volume, efficiency, effort
- Quality of life: identity, range, speed

These parameters are put face to face in spider diagrams, visualizing the greatest potentials of the various cases. A number of interesting results are discussed below, the total overview of the case studies can be found in appendix C.

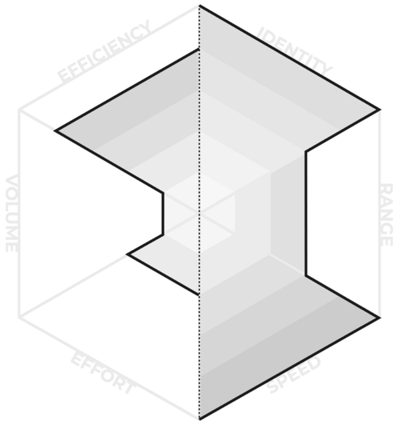

Figure 10. Assessment of New Babylon

New Babylon is a model for a new society in which production is fully automated, resulting in a surplus of free time. It is based on an immense volume, consisting of a large number of 'sectors'. Within these sectors, everything can be adapted to the needs of the individual, following the speed of the user. To make the changes efficient, it is based on neutral structures, normalization of dimensions and standardization of production. The range is relatively large due to the size of the structure and the location on top of the existing cities.

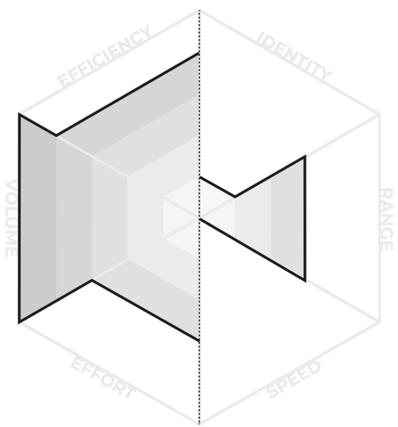

Figure 11. Assessment of Diogene

The concept of Diogene stems from a fascination of Piano; the exploration of the minimum space in which a person can possibly live. The small volume was achieved by integrating the interior and making it foldable. This ensures that the space is organized as efficiently as possible, but also requires a relatively large amount of effort from the resident and limits the range. The Diogene will be mass produced and is not suitable for adaptation to the needs of the users, making the indentity low.

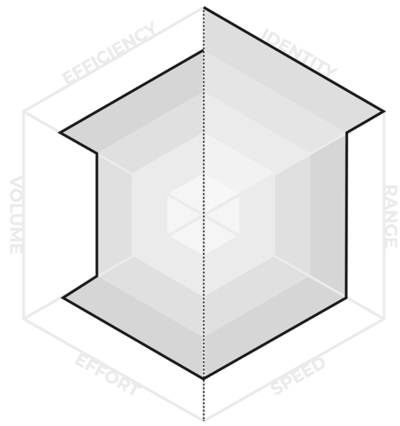

Figure 12. Assessment of Personalised Capsules

Personalised Capsules envisages an urban future based on the idea that the future home should provide a dignified space for each person, expressing his or her individual identity and needs. A projected interface helps the user to design his own home effortlessly using machine learning. The speed and range of the adaptation is high because it is built by small robots. The efficiency is considerable because each person ends up with a unique and personalized home, without unnecessary spaces. As a result, the volume of the homes can be kept to a minimum.

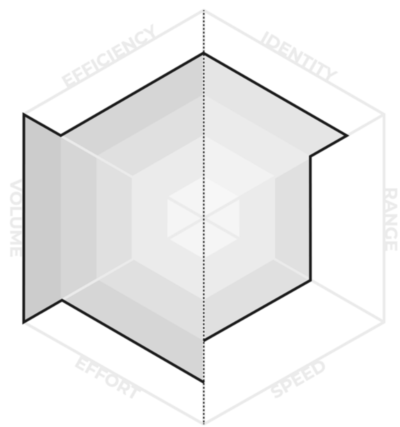

Figure 13. Assessment of Homed

This proposal of Framlab seeks to solve New York's homeless dilemma by covering the vacant walls with small housing pods. The hexagonal 3D printed modules connect to a scaffolding frame up against the side of a building. The pods will have furniture, appliances and cabinets that are efficiently integrated into the wood-clad interior. The 3D printing technology allows individual customization. Using the installation cranes at the top of the scaffolding, the pods can be quickly assembled, moved or removed.

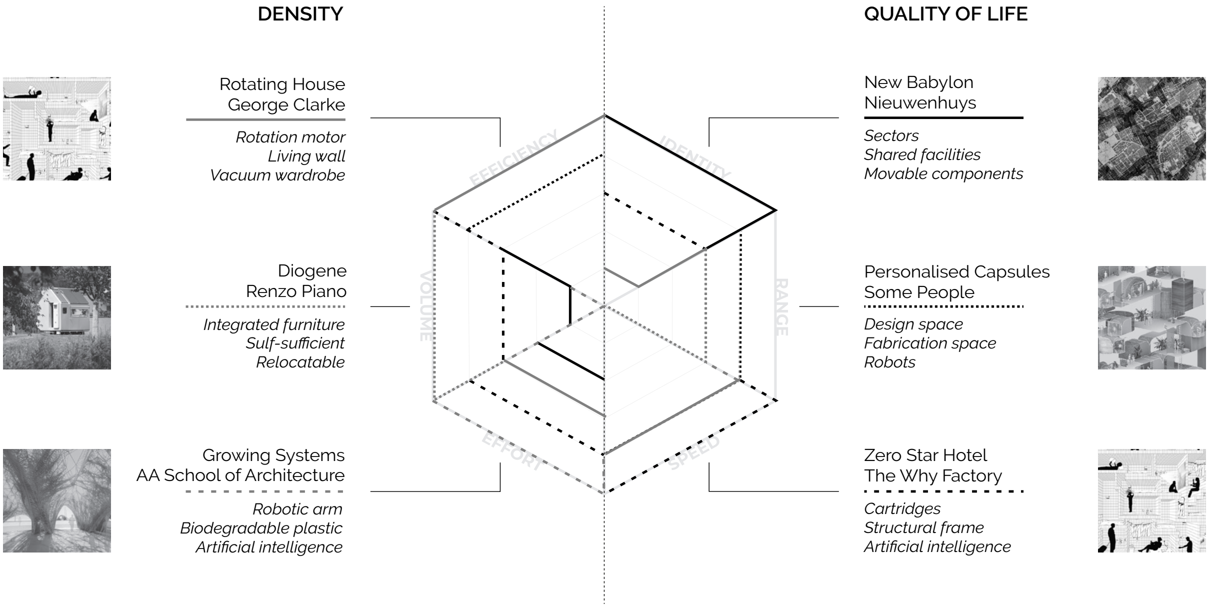

Figure 14. Overview spider diagram and effective design elements

The outcome of the case studies is compared with the implemented design elements and in doing so we can determine which solutions are effective. Figure 14 shows the results of the spider diagrams related to the design elements.

3.4 Design strategies

In this chapter, the outcomes of the literature review and the casestudies are translated into starting points for the design. A complete overview of these starting points, which makes a distinction between the notion of density and the notion of quality of life, is included in appendix D. This paragraph discusses a number of starting points that match perfectly or contradict each other. The continuous lines show the principles for maximum density and the dotted lines indicate quality of life.

1.4 f — Make spaces adaptable so they always fit in seamlessly with the usage and do not take up unnecessary floor area (e.g. guest room is only present when there are guests)

&

1.4 — Give the opportunity for people to have a place of their own by giving the ability to personalize their space.

For both density and quality of life it is important that the environment is adaptable. In the case of density, it means that the space can be arranged efficiently and in the case of quality of life, it entails that people can adapt the dwelling to their personal preferences.

1.4 e — Stimulate sharing facilites between residents as this reduces the total floor area required per person.

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3.1 — Increase multiculturalism and provide good relationships and daily interaction between people by providing public gathering places.

The quality of life benefits from sharing facilities because it encourages good relationships and interaction between neighbours. For density, this results in dwellings being downsized and therefore more dwellings can be realized.

1.4 a — Limit the volume occupied by a dwelling through integrated interior.

VS

1.4 a — Avoid prefabricated solutions in which the residents cannot make their own adjustments.

When the interior is integrated, the layout of dwellings can be optimized and thus the size reduced. For the quality of life, however, this often means that the possibilities for personalisation are limited. Therefore a balance between both concepts must be achieved.

1.3	Increase the percentage of dwellings in the functional mix, as this allows for more residents/hectare within the same floor area.

VS

4.3	Provide job opportunities and promote local business by attracting economic activity and mixed use development.

A maximum number of residents/hectare would require the full functional mix to consist of dwellings. However, this means that an important aspect of quality of life will be lost, namely the mixed use development. Here, too, a balance between the two concepts has to be found.

3.1	Increase the open space ratio, also known as the open space area/ total floor area, by reducing the area of open spaces and increasing the total floor area.

VS

2.3	Enlarge the recreational program by improving existing and adding new public parks, small businesses, marinas, beaches and other cultural amenities.

To improve the quality of life it is important to maintain open public spaces such as parks. This is unfavourable for the density, because then the open space ratio becomes smaller. However, there are other solutions to increase the density without taking up much of the open space. Again, a balance has to be found between both concepts.

IV. Conclusions

The aim of this research was to develop a new way of living that actively tackles the challenges presented by the ongoing urbanization of our cities. It explored how we can achieve maximum densification of a city while at the same time creating the highest quality of life for its citizens, through answering the research question:

How can we create a way of living that maximizes both density and quality of life?

Fist, both concepts were addressed separately. We can conclude that densification can best be interpreted as a set of interrelated variables. These are heavily reliant on each other for their assessment, significance and usefulness. In order to maximize the density, we needed to address the concept of density as a whole. When the occupied surface-time of dwellings is compared with a model of the minimum space required per activity, it appears that there is much potential for improvement in the layout of the current dwellings. To assess the density of the case studies, this concept was translated into three parameters: volume, efficiency and effort.

Regarding the quality of life, we found that this concept in an urban environment is used not only to refer to several physical characteristics, but also to describe the relationships and dynamics among those physical characteristics. Therefore, the quality of life is not linear, but can be seen as complex and interwoven. The quality of life can be divided into four domains: house well-being, neighbourhood well-being, social well-being and economic well-being. Furthermore, there are there are objective and subjective dimensions to quality of life. The objective dimension relates to the way in which the physical environment can influence behaviour positively or negatively and thus improve or reduce the quality of life. The subjective dimension is about people's perception of how their environment influences their experiences of life and how it shapes their cognitive interpretation of the quality of life. To assess the subjective quality of life of the case studies, this concept was translated into three parameters: identity, speed and range.

Next, the results of the case studies were compared with the implemented design elements in the cases and by doing so we could determine which design elements are effective. The results have been translated into starting points for a design. In order to answer the research question, we can conclude that there are a number of principles that are essential for a way of living that maximizes both the density and quality of life:

- Optimize the floor area per dwelling. This results in an increase in the number of dwellings per hectare. It involves considering dwellings as a sequence of activities rather than a collection of spaces, giving spaces multiple functions and applying prefabricated and/or integrated furniture.

- Offer adaptable environments. For density, this allows the space to be arranged efficiently and, in the case of quality of life, it means that people can adapt the home to their personal preferences. Ensure that the maximum possible frequency of adjustments is high and that the effort for the occupants is low. Make sure it is not limited to a framework or grid, but do give some guidance to the occupants.

- Offer a diverse range of housing typologies, including all price ranges and ethnic backgrounds. This ensures that each individual gets a well-located and comfortable home.

- Promote the sharing of facilities between residents. The quality of life benefits from sharing facilities because it encourages good relationships and interaction between neighbours. In terms of density, this means that dwellings can be downsized, resulting in more dwellings in total.

- Enhance street life, the recreational program and outdoor spaces. To improve the quality of life it is important to maintain open public spaces, such as parks. And by making the urban environment more attractive, this can become the new 'living room' and dwellings can be made more compact, which increases the density.

4.1 Discussion

This research contributes to social issues and scientific knowledge concerning urbanisation. Moreover, it provides input for the discussion on the development of contemporary cities by providing new insights. The design solutions offered can therefore be applied to urbanizing cities all over the world.

The conclusions drawn are based on the parameters of density and quality of life as defined at the beginning of this study. It appeared that both concepts are not unambiguous and consist of different variables. While the aim was to provide a comprehensive definition of both quality of life and density, given their complex nature, other interpretations are also possible. In addition to the theoretical framework provided by this research, a more practical approach towards the relationship between the two concepts would be valuable.

This study raises several questions for further research. It focusses only on the domains of house well-being, neighborhood well-being, economic well-being and social well-being, as these domains are strongly related to the built environment. It is likely, however, that there are other areas that influence the quality of life, such as religious well-being and political well-being. Additional research in these areas is needed to fully understand the relationship between density and quality of life. Furthermore, this study focused on the quality of life of one individual. It would be valuable to carry out research involving children and groups of people, such as households.

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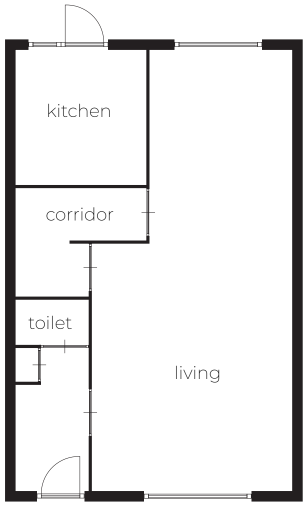
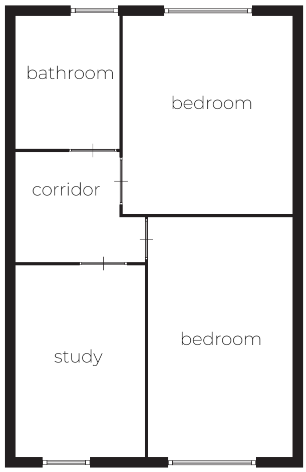
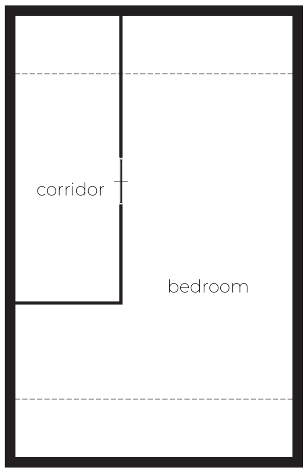
APPENDIX A - Use of space



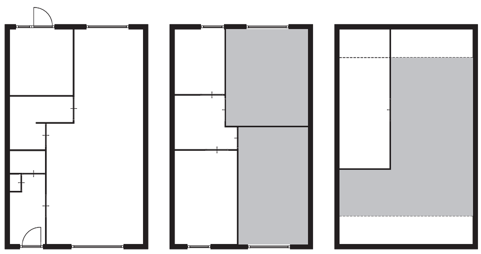
ground floor



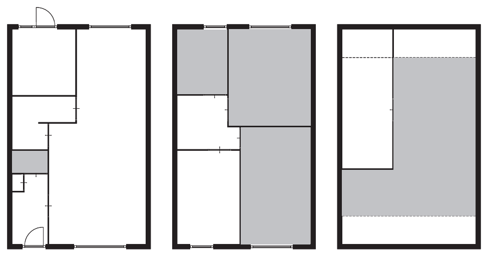
first floor



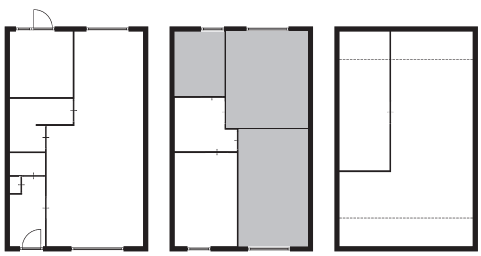
second floor



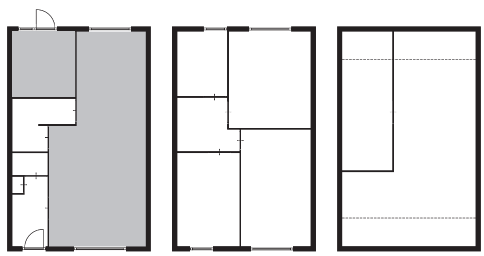
06.30 residents are asleep



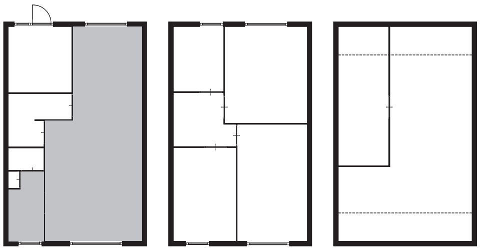
06.45 the morning routine starts



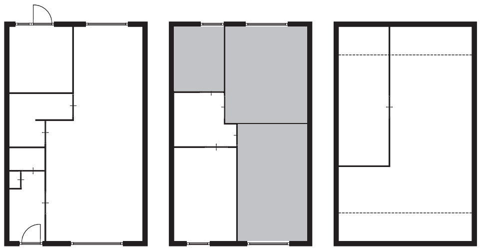
07.00 they take a shower



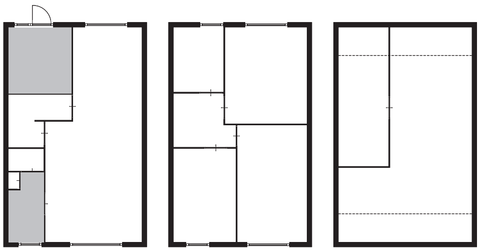
07.15 they have breakfast together



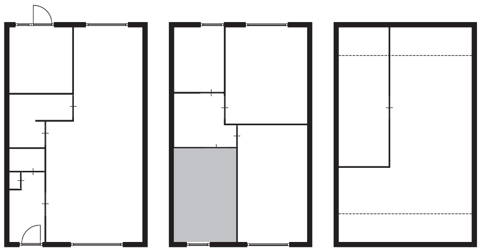
07.30 one goes to work



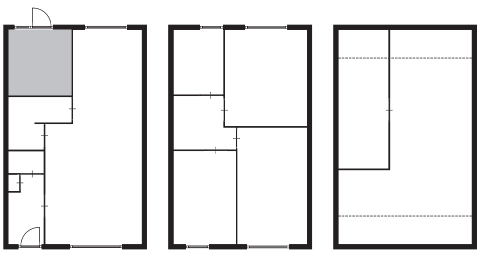
07.45 others get dressed



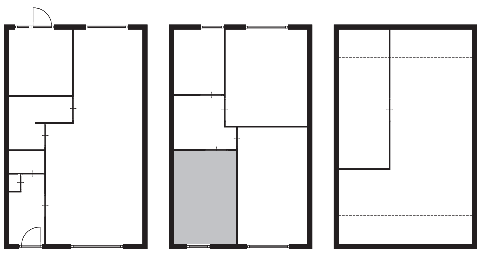
08.00 making coffee, kids go to school



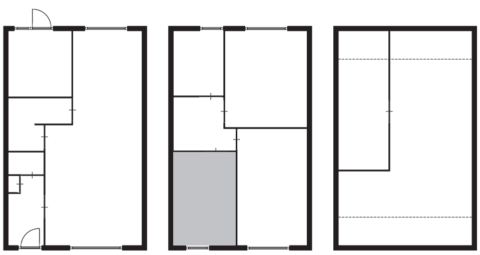
08.30 working from home



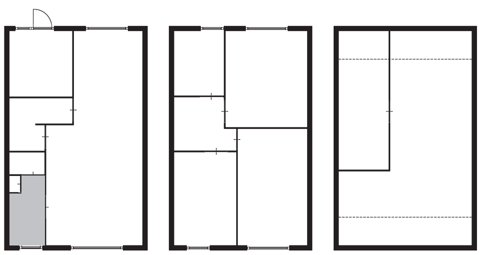
09.30 coffee break



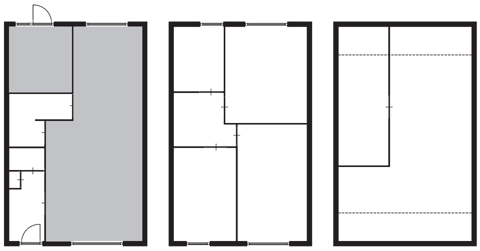
10.30 conference call



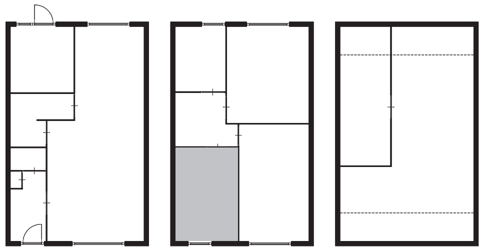
11.00 still working



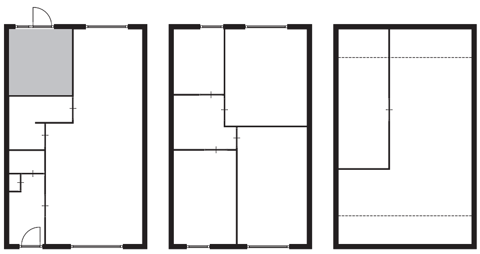
11.30 going to the store to buy lunch



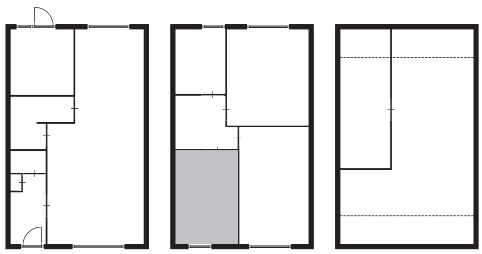
12.00 lunch break



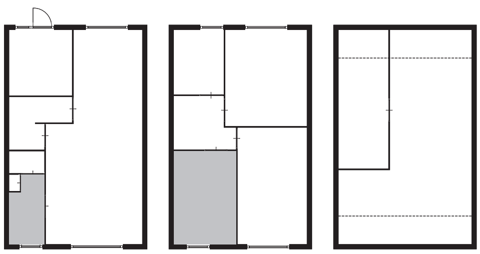
13.00 back to work



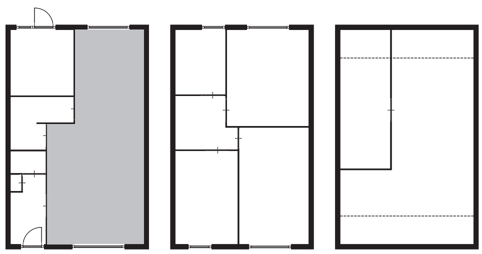
14.30 coffee break



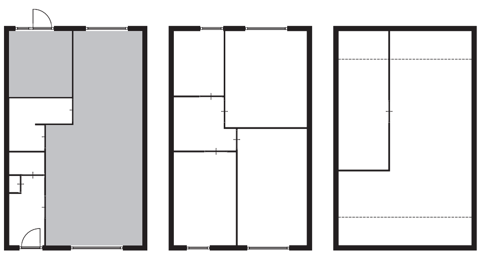
16.00 sending e-mails



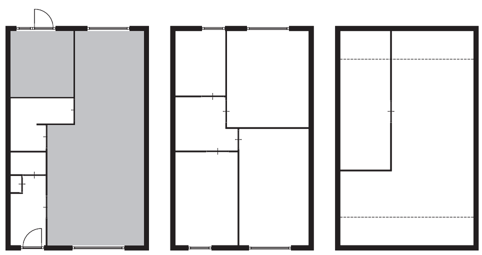
17.00 workday is over, kids back home



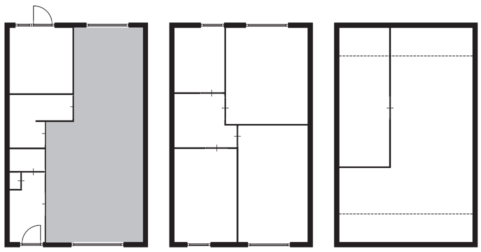
17.30 grocery shopping, kids watching tv



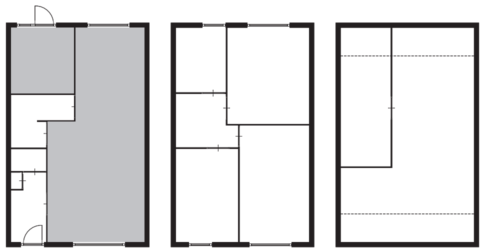
18.00 preparing dinner



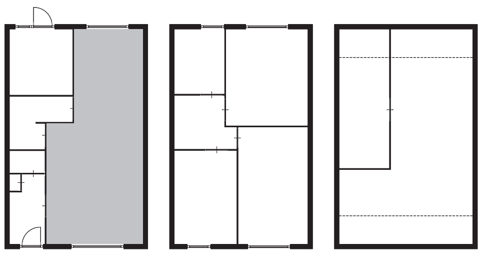
18.30 partner comes home



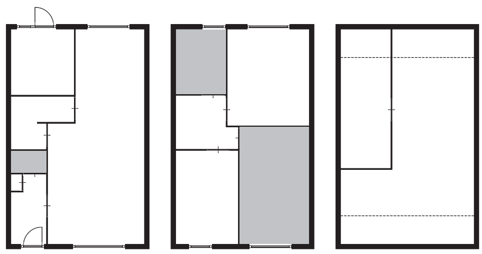
18.45 having dinner together



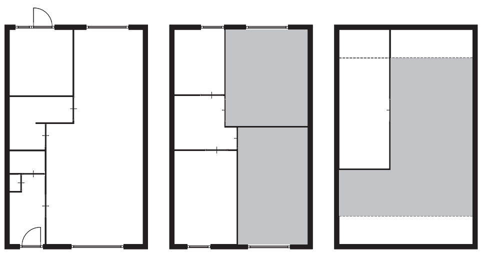
19.30 doing dishes, cleaning kitchen



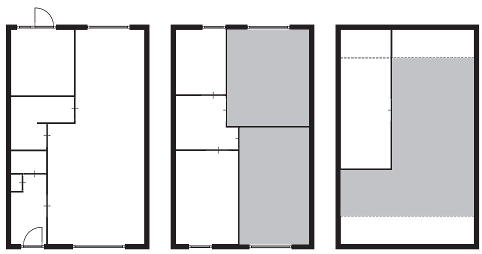
20.00 watching tv



21.30 the evening routine



21.45 watching a series in bed



22.30 all residents asleep again

Appendix B - Surface-time

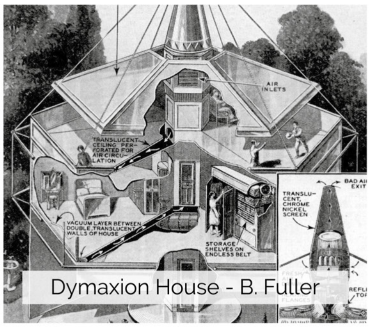
Function	Area (m2)	Used (h)	S-T (m2h)	Unused (h)	S-T (m2h)
Bedroom I	19,5	8,5	165,75	15,5	302,25
Bedroom II	10,5	9	94,5	15	157,5
Bedroom III	11	9	99	15	165
Kitchen	5	3	15	21	105
Living	24	4,5	108	19,5	468
Bathroom	5	1,5	7,5	22,5	112,5
Toilet	1	0,5	0,5	23,5	23,5
Study	6	13	78	11	66
Entree	3	0,5	1,5	23,5	70,5
Corridor I	3	0,75	2,25	23,25	69,75
Corridor II	3,5	0,5	1,75	23,5	82,25
Corridor III	6,5	0,25	1,625	23,75	154,375
Storage I	5	24	120	0	0
Storage II	5	24	120	0	0
Total	**108**	**99**	**815,375**	**237**	**1776,625**

Appendix C - Case study database

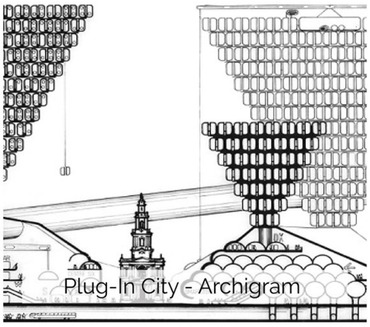
Adaptable environments
Predecessors

New Babylon - Nieuwenhuys

Fun Palace - Cedric Price

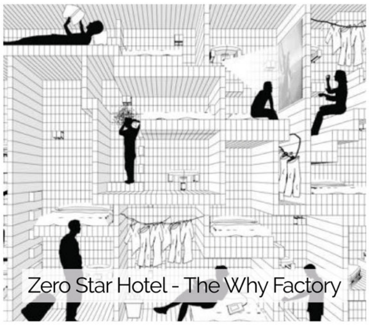


Dymaxion House - B. Fuller

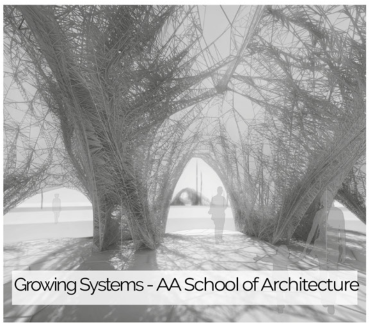


Plug-In City - Archigram

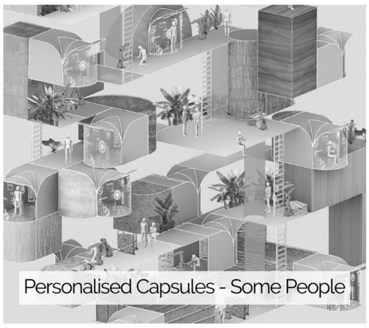
Adaptable environments
Contemporary



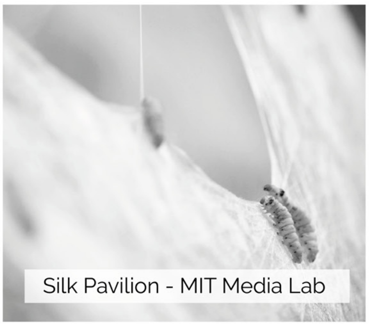
Zero Star Hotel - The Why Factory



Growing Systems - AA School of Architecture



Personalised Capsules - Some People

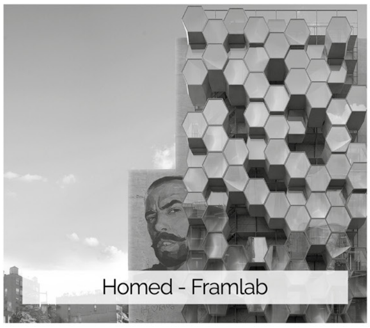


Silk Pavilion - MIT Media Lab

Micro environments

Domestic Transformer - Gary Chang

Rotating House - George Clarke

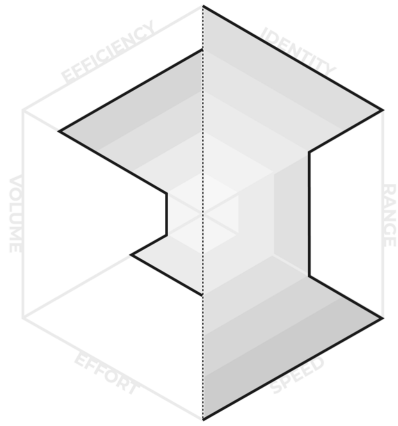


Homed - Framlab

Diogene - Renzo Piano

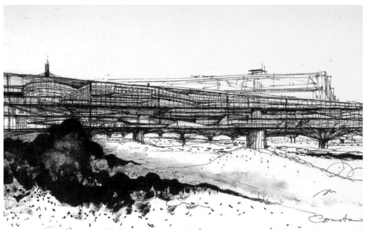
New Babylon
Constant Nieuwenhuys (1958)

New Babylon is a model for a new society in which production is fully automated, resulting in a surplus of free time. The human being should focus on the exploration of the inner soul and becomes the 'homo ludens'. It is based on an immense **volume**, consisting of a large number of 'sectors'. Within these sectors, everything can be adapted to the needs of the **individual**. These changes follow the **speed** of the homo ludens. To make the changes **efficient**, it is based on neutral structures, normalization of dimensions and standardization of production. The **range** is relatively large due to the size of the structure and the location on top of the existing cities. The level of **effort** is average because the homo ludens has the task of changing the environment and traveling to explore and find inner peace.



https://www.archined.nl/2016/07/de-wereld-is-mijn-speelveld/

Elements



Sectors

New Babylon is a network consisting of chains of units 15 to 20 meters above the ground These units, the 'sectors', are constructively independent and are positioned on top of the existing city.

Shared facilities

The project revolves around independence from materials. The collective facilities are therefore located within the sectors.

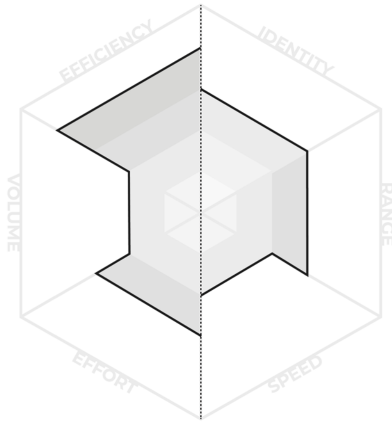
Movable components

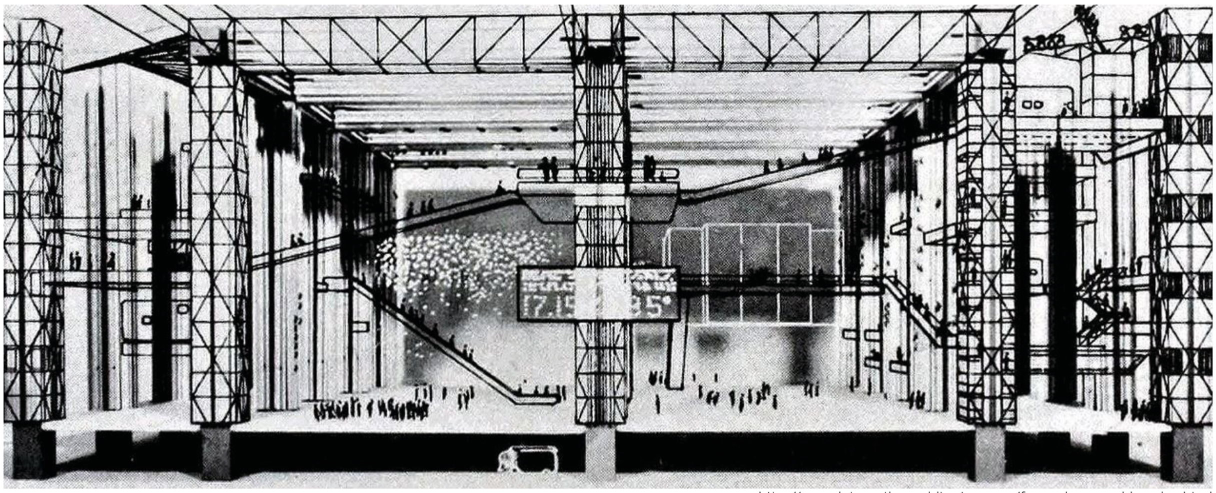
A constantly changing space is created within the sectors through movable walls, stairs and bridges.

Fun Palace

Cedric Price - 1961

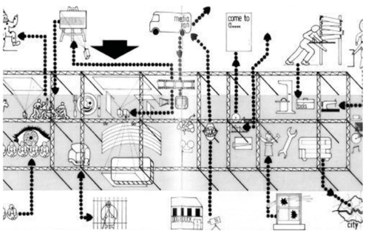
Fun Palace is not a conventional building, but a socially interactive machine where ordinary citizens can escape from the everyday life. Users can create their own environment by using cranes and prefabricated modules. Because the modules are standardized, the users cannot give the space their own **identity**. For the positioning of the modules, the users are not limited to a grid but are limited to the **range** of the structural frame. The **time** needed for the change of the building is quite long, and the level of **effort** is high, as the users have to use the cranes themselves to arrange it according to their desires. The space is used **efficiently** because it can be adapted to various functions, but the **volume** is large because is stores all possible modules.





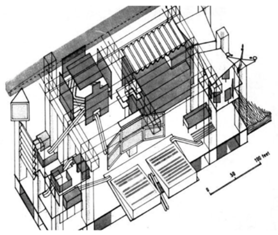
http://www.interactivearchitecture.org/fun-palace-cedric-price.html

Elements



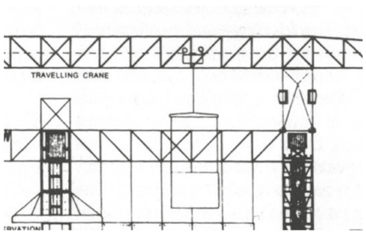
Structural frame

The various modules are integrated in a huge steel structural frame, almost 780 by 360 feet, on a tartan grid of interlocking squares of different sizes.



Modules

The building consists of a 'kit of parts'; prefabricated walls, platforms, floors, stairs and ceiling modules that can be moved and installed by the cranes. Practically every part of the building is variable.

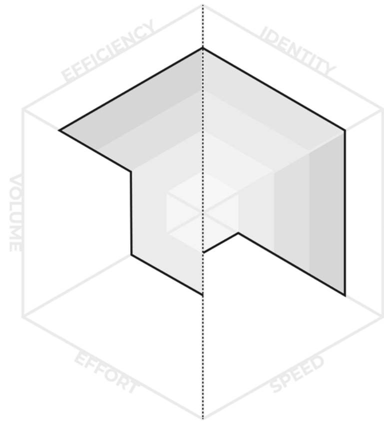


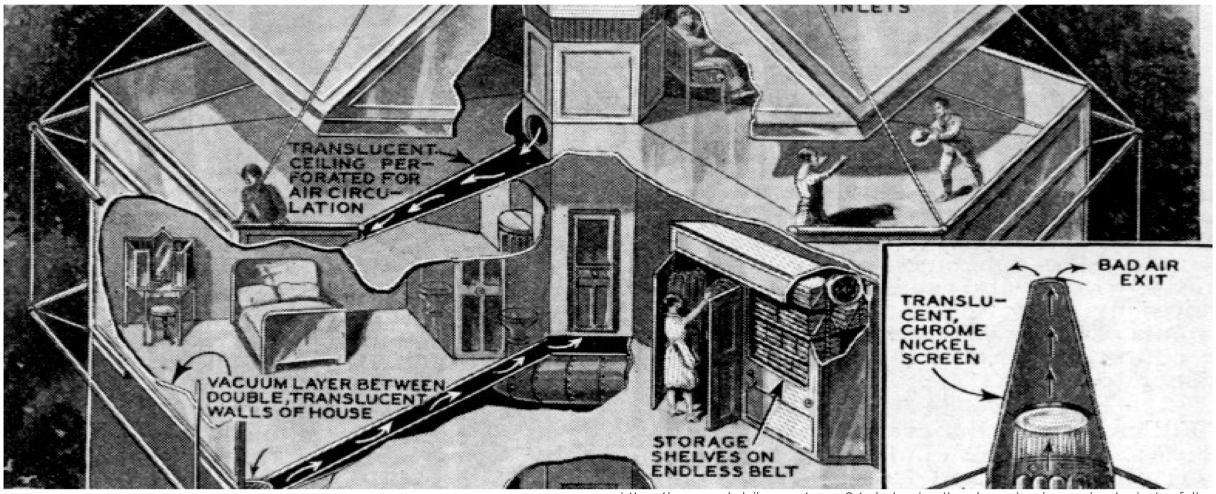
Cranes

The mobile gantry cranes and cranes installed near the roof covered the entire length of the building. Using the cranes, the users would be able to place the modules and other pneumatic structures where needed.

Dymaxion House
B. Fuller

The Dymaxion House was designed by Buckminster Fuller to address the deficiencies of the available housing techniques. It is a hexagonal, single-family house covering an **area** of 100 sqm. It could be mass produced and shipped in a metal tube all over the world, making the **speed** relatively slow. The assembly was with moderate **effort**, since each structure was assembled at ground level and then hung on the central pole. By clustering utilities in this pole, there is a flexible plan that would allow users to transform a wide **range** of spaces according to their **identity**. The plan is **efficient** because the spaces can be easily rearranged. (e.g. during an event, the living room can be enlarged and the bedroom downsized.)





https://www.archdaily.com/401528/ad-classics-the-dymaxion-house-buckminster-fuller

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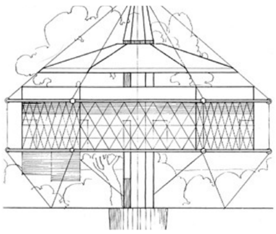
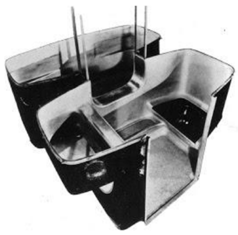


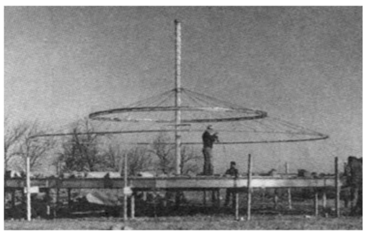
Central pole

The design is based on a central pole on which cables are hung in order to make the exterior walls non-load-bearing. By clustering all permanent utilities in this pole, the rest of the interior space becomes modular.



Prefabricated bathroom

The bathroom consists of four metal sheets that can be easily bolted together. The elements are light enough to be carried by two workers and all the plumbing and appliances are integrated.



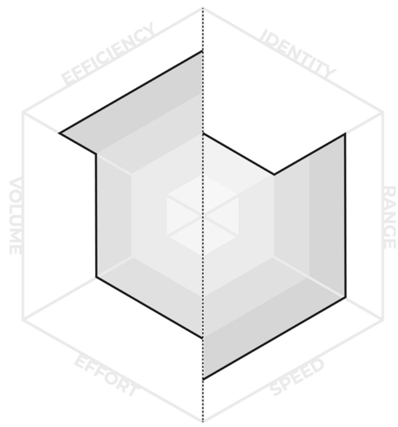
Easy assembly

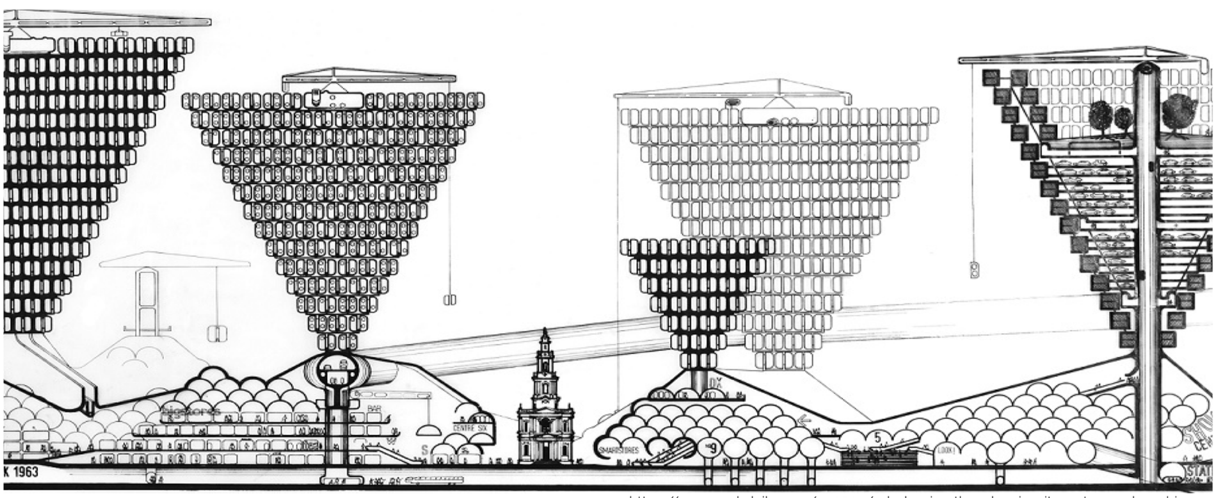
The house can be packed flat, shipped in a metal tube and simply assembled. Each part weighs less than 10 pounds and the total weight of the Dymaxion is 3 tons (compared to an average of 150 tonnes).

Plug-In City

Archigram - 1964

Plug-In City is a utopia consisting of various elements that can be plugged and unplugged in the city according to the users' needs. The dwelling capsules can be placed wherever the users wishes, but the **range** is limited to a grid. The (re)placement of the capsules is carried out by automatic cranes, making the **effort** low for the users and the **speed** of the adaptation relatively high. The dwellings have standardized measurements and a standardized interior. The users cannot give their own **identity** to the dwellings. Each capsule is **efficiently** designed with transformable components, such as a folding screen and a clip-on device wall. Therefore the dwellings fit into the relatively **small** capsules.





https://www.archdaily.com/399329/ad-classics-the-plug-in-city-peter-cook-archigram

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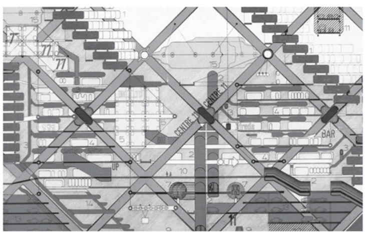
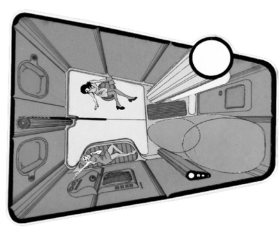


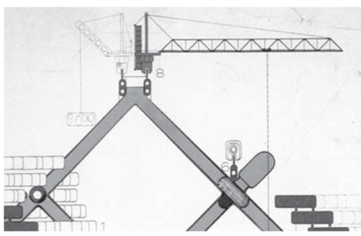
Megastructure grid

The plug-in City is based on a constantly evolving grid that accommodates dwellings, offices, infrastructure and other services.



Capsules

All facilities, such as the dwellings, are in standard size capsules. This allows them to be placed anywhere in the grid. The dwellings resemble hotel rooms.



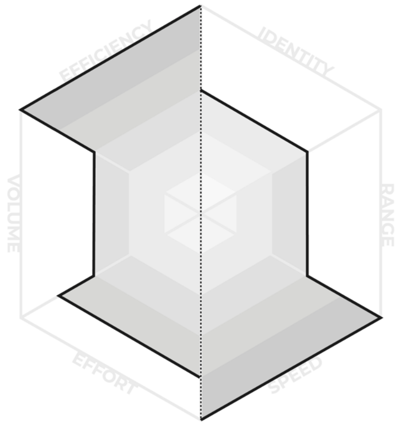
Cranes

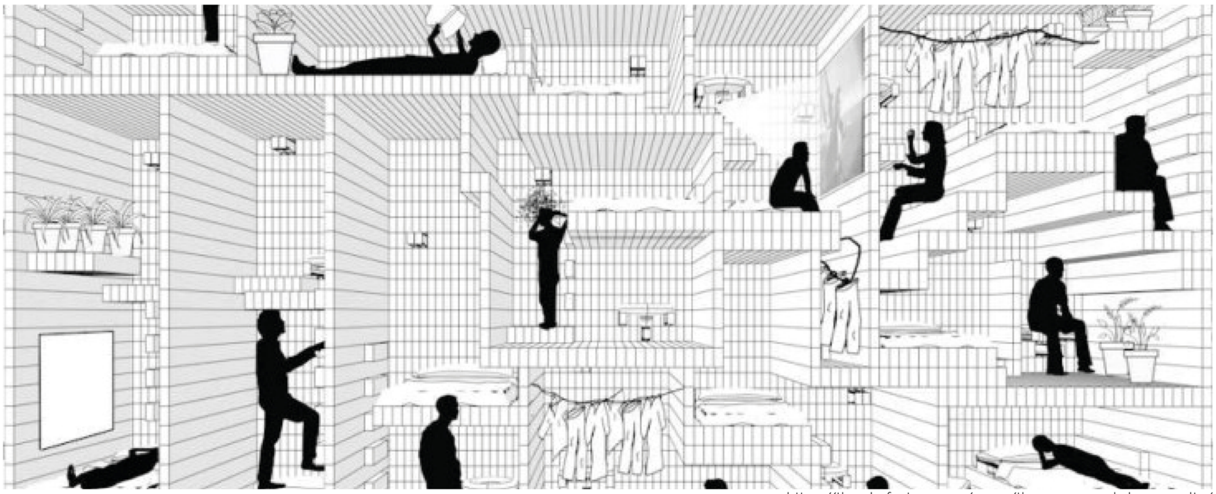
The cranes place the capsules at various places in the grid. They are controlled by a network of sensors that monitor people to ensure that the environment is always tailored to the needs of the user.

Zero Star Hotel

The Why Factory

The Zero Star Hotel is a fully adaptable building that explores temporary lifestyles. It consists of a structural frame in which sticks can be moved, allowing various configurations. The **range** is limited to the boundaries of the frame. The residents have full control over the function of their room. However, the **individuality** is moderate because they have to trade space with their neighbours. Using artificial intelligence, the rooms will adapt **immediately** when there is a change in activity. This does not require any **effort** on the part of the residents. The space taken by each resident is small because it only covers the surface area needed for the activity carried out at that time. This **efficient** spatial arrangement ensures that as many people as possible can reside in a small area. However, the **volume** itself is relatively large, as the structural frame is static.





https://thewhyfactory.com/news/the-wego-workshop-results/

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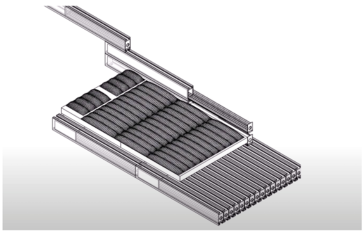
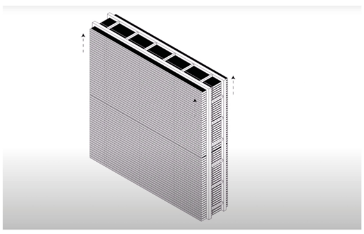


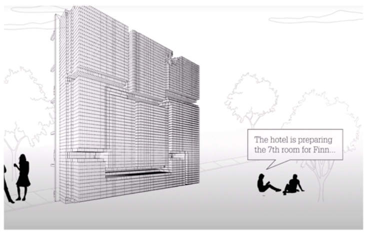
Cartridges

The sticks contain cartridges with various functions such as; inflatable bed, toilet, kitchen etc. These can be pulled out if needed.



Structural frame

The structural frame determines the boundary of the building. In this frame, sticks with various functions can be moved, creating an infinite number of configurations of the space.

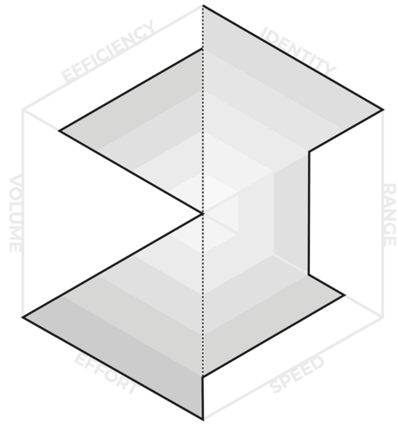


Artificial intelligence

Artificial intelligence ensures that the rooms are always perfectly suited to the needs of the residents. It determines the configuration of the space and when it is necessary to trade space with the neighbours.

Growing Systems
AA School of Architecture

Growing Systems is a project that explores customizable building systems using robotic fabrication. A robotic arm is used on-site, allowing for **faster** construction. Because the structure depends on the robotic arm, the **range** is limited. The applied artificial intelligence minimizes the **effort** as it scans the environment and adjusts the design real-time, thus completely erasing the line between design and fabrication. The meltable bio-based plastic can respond to the dynamics of the city and facilitate programmatic housing changes, making the structure suitable for **individual** needs (e.g. expansion of a home when a family grows). The structure is a system of elasticity that **efficiently** accommodates the site parameters, as well as future adjustments. As this case concerns a construction technique, it is not possible to make a statement on the **volume** of a dwelling.



https://www.archdaily.com/793054/aa-school-of-architecture-designs-adaptable-structural-plastic-3d-printing-method

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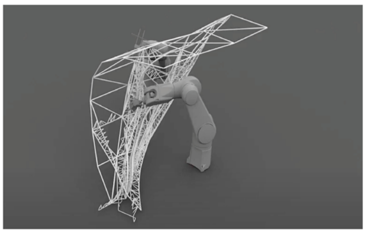
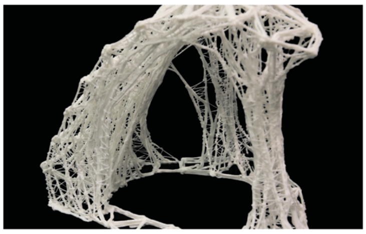


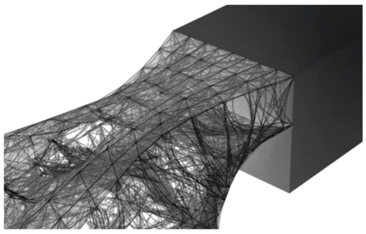
Robotic arm

A robotic arm is used on the site so that the construction can be carried out quickly and with minimal interruption, making scaffolding redundant and reducing waste.



Biodegradable plastic

The plastic is a phase-changing building material, which can easily be connected to other structures because it becomes sticky when heated. Similarly, the plastic can be melted to demolish parts of the structure



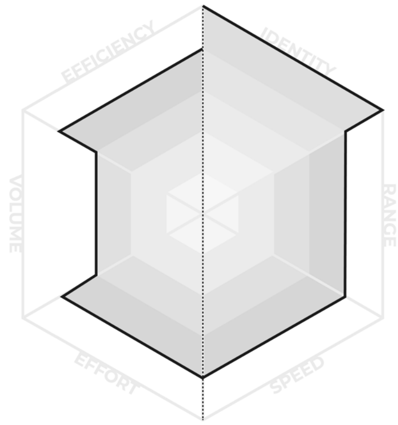
Artificial intelligence

The robotic arm is equipped with artificial intelligence, allowing a quick adaptation to the changing environment and providing feedback.

Personalised Capsules

Some People Studio

This project envisages an urban future that uses technology to enhance human creativity. It is based on the idea that the future home should provide a dignified space for each person, expressing his or her **individual** identity and needs. Capsules are providing the facilities to help people design and build their own homes. A projected interface helps the user to design his own home **effortlessly** using machine learning. A mini robotic fabrication space creates a prototype of the design chosen. The **speed** of the adaptation is high because it is built by small robots. These robots are mobile, making the **range** relatively large. The **efficiency** is high because each person ends up with a unique and personalized home, without unnecessary spaces. As a result, the **volume** of the homes can also be kept to a minimum.



https://somepeople.studio/Personalised-Capsules

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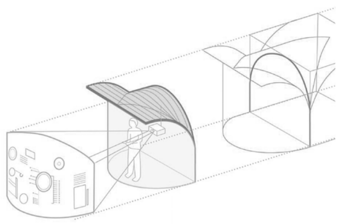
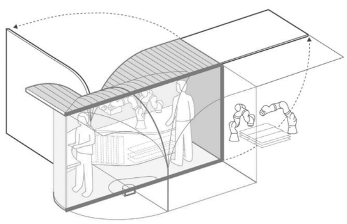
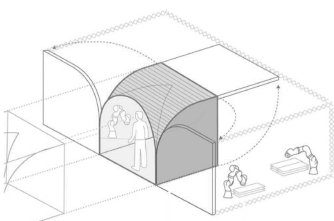






Design space

In the design space the user interacts with a projected interface that uses machine learning to understand people's tastes and preferences and proposes design solutions for their needs.

Fabrication space

The interface generates and proposes a fabrication process. In the fabrication space, the user collaborates with robots for prototyping parts of the new house.

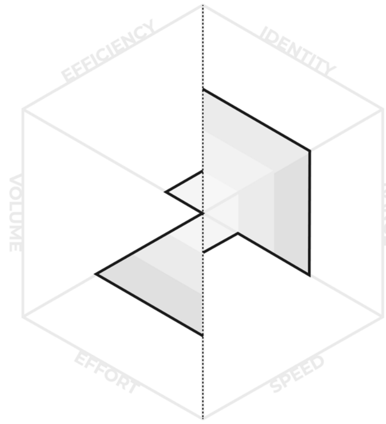
Robots

The fabrication space is equipped with robots that prototype the chosen design and fabricate the new home on site as an extension of the capsule.

Silk Pavilion

MIT Media Lab

This project integrates Algorithmic design, digital manufacturing, and biologically-inspired fabrication. The pavilion was constructed using a base of robot-woven threads that wrapped a steel frame. The need for this frame limits the **range** of this method. The frame was filled-in by silkworms, making the **effort** low. The pavilion's character lies between a scaled-up version of the insect's own cocoons, and a functional space for humans. The structure is in constant, but very **slow** growth, making the possibilities to adapt to **individual** preferences mediocre. As this concerns a construction technique, a statement about the **volume** of a dwelling cannot be made. With this technique, a dwelling could be designed **efficiently** if we only look at its adaptable character, but it is not feasible because it takes a considerable amount of time.



https://www.archdaily.com/384271/silk-pavilion-mit-media-lab

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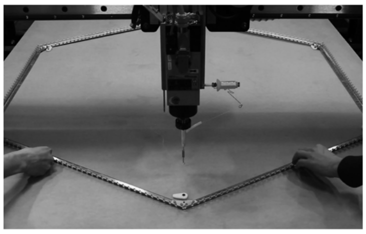


Metal frames

Flat polygonal metal frames, which are arranged like a dome, function as scaffolding.

CNC machine

A single silk thread is placed by a Computer Numerically Controlled (CNC) system following a subdivision algorithm until a temporary scaffolding has been covered.

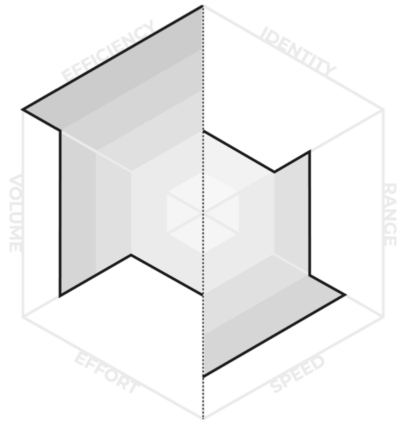
Silkworms

6500 living silkworms were placed around the bottom of the dome and left alone to finish the pavilion, filling in the remaining holes and binding together the CNC-placed thread.

Domestic Transformer

Gary Chang

Chang designed this dwelling in which walls and furniture can be pulled around to create more than 24 rooms according to the user's **preferences**. It is located in a 17-story apartment building in the Sai Wan Ho district of Hong Kong. It covers an **area** of 344 sqft, but due to the wide **range** of configurations it feels infinite to Chang. The dwelling is highly **efficient**, because the space is optimized based on the idea that a resident performs only one activity at a certain time. Instead of the conventional routine of moving from one room to another, the space transforms from one scene to the other while the resident occupies the entire space at all times. Shifting the walls is done **quickly**, but takes quite a lot of **effort** from the residents.

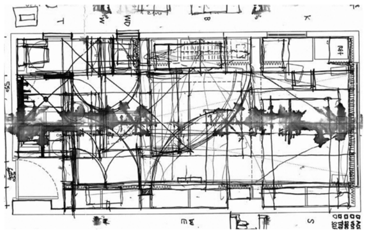


http://www.edgedesign.com.hk/2007domestictransformer

Elements

Materialization

Chang used materials that make the apartment appear larger, such as the granite floor and the reflective ceiling. The yellow tinted windows provide a sunny atmosphere all year round.



Sliding walls

The sliding walls double as storage and, as they are moved around, the apartment can become a variety of spaces. They are suspended from steel tracks bolted to the ceiling and seem to float an inch above the floor.

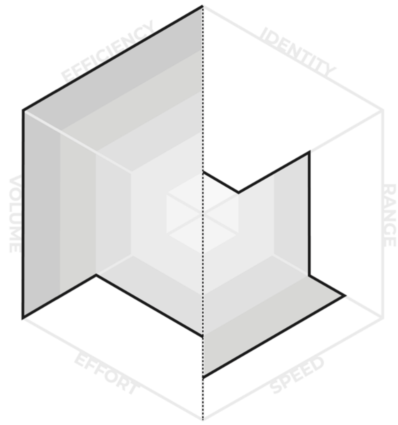
Unused space

Altough most space is taken up by the sliding walls, there is about 180 sqft of unused space. Chang points out that this is essential to make the apartment feel spacious.

Rotating House

George Clarke

The Rotating House is designed to take up as little space as possible, providing four rooms in one, by literally turning the space around. The rotation is carried out by an engine of a second-hand electric wheelchair. It spins **quickly** and turns 90 degrees turn in just 10 seconds. The only fixed section is a small area that houses the bathroom and the controlpanel. The user only has to click the button for the desired function, which makes the **effort** low. The dwelling has a diameter of 4,3 meters and a total floor area of 40 square meters, but only a footprint of 10 square meters. Therefore, the **volume** is low and the space is used **efficiently**. There is no room for **individual** adjustments, as the interior and accessories are custom made to withstand rotation. Due to its small dimensions, the dwelling can be easily transported, making the **range** large.



https://www.housebeautiful.com/uk/renovate/homes-makeovers/news/a989/amazing-spaces-george-clarke-william-hardie-futuristic-rotating-house/

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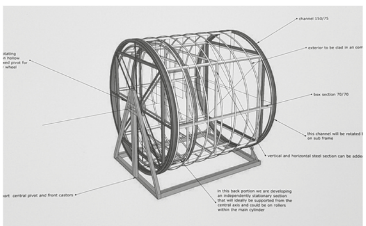


Rotation motor

The dwelling is rotated on its axis, depending on what room is needed. The engine allows it to rotate 90 degrees in just 10 seconds, leaving the door in place as it rotates to give each room an entrance and an exit.

Living wall

There is a 'living wall' made of moss balls that require little water or sunlight. According to Clarke, having a little piece of green inside the white space makes it feel like it's connected to nature.

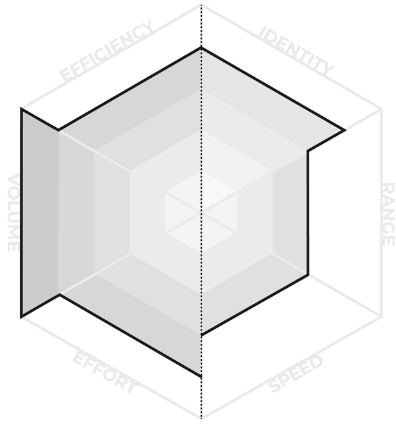
Vacuum wardrobe

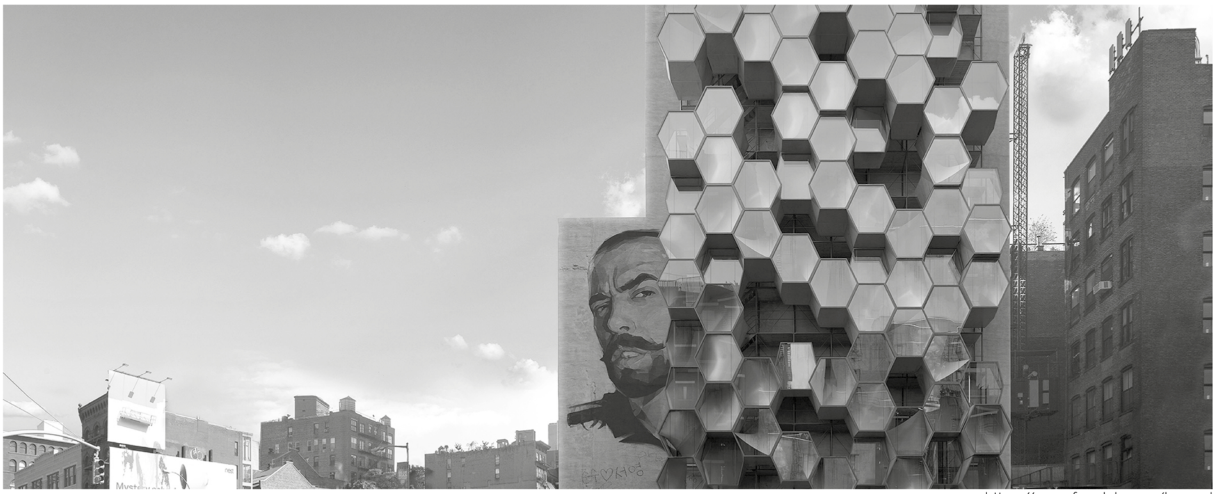
A special wardrobe has been designed to vacuums clothes so that they don't take up a lot of space and don't get crumpled when the house is rotating.

Homed

Framlab

This proposal seeks to solve New York's homeless dilemma by covering the vacant walls with **small** housing pods. The hexagonal 3D printed modules connect to a scaffolding frame up against the side of a building. The honeycomb structures will make it possible to form a densely packed, active community in the most unlikely places. The pods will have furniture, appliances and cabinets that are **efficiently** integrated into the wood-clad interior. By combining different modules from an extensive catalogue, a wide range of different spaces can be created. The 3D printing technology even allows **individual** customization. Using the installation cranes at the top of the scaffolding, the pods can be **quickly** assembled, moved or removed. Therefore, the **effort** for the residents is minimal. The **range** is average, as the application depends on the availability of a façade.





https://www.framlab.com/homed

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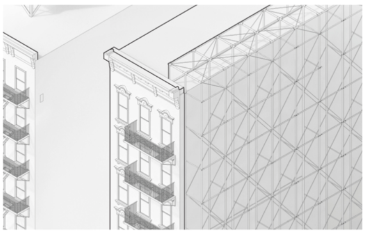
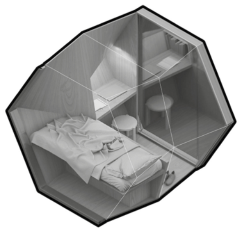


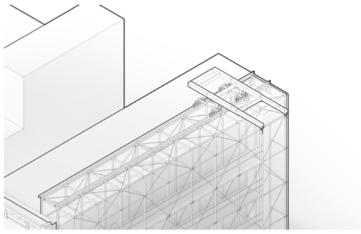
Scaffolding

The pods will be supported by scaffolding attached to the solid facades of buildings. The scaffolding makes it possible to quickly set up, expand, move and remove the system.



Prefabricated pods

The pods are prefabricated and 3D printed, allowing furniture, storage, lighting, and appliances to be integrated into the structure. This results in a minimal space, tailored to the specific needs of its resident.

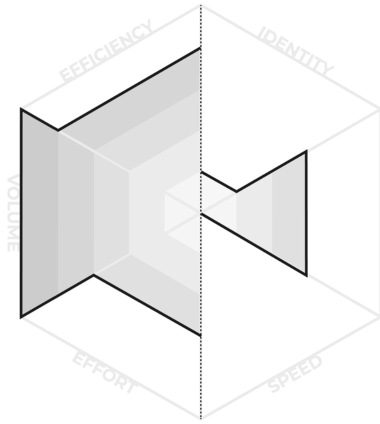


Installation crane

The temporary parasitic structures can be rapidly constructed and dismanteld by the use of installation cranes located at the top of the scaffolding.

Diogene
Renzo Piano

Diogene is a dwelling with a floor area of just 2,5 x 3 meters. The concept stems from a fascination of Piano; the exploration of the minimum space in which a person can possibly live. The small **volume** was achieved by integrating the interior and making it foldable. This ensures that the space is organized as **efficiently** as possible, but also requires a relatively large amount of **effort** from the resident and limits the **range**. The Dionege is equipped with various installations and technical systems to guarantee its self-sufficiency. Furthermore, the small dimensions make it easy to transport. The cabin is presented as an experimental concept rather than a finished product. The Diogene will be mass produced and is not suitable for adaptation to the needs of the users, making the **individuality** low and the **speed** not applicable.

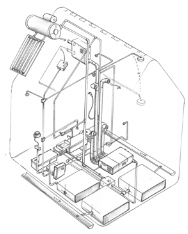


https://www.dezeen.com/2013/06/12/diogene-by-renzo-piano-at-vitra-campus/

Elements

Integrated furniture

The furniture is integrated. The front part serves as a living room: on one side there is a pull-out sofa, and on the other side a folding table. There is a shower, toilet and kitchen behind the separation.



Self-sufficient

The dwelling is designed to be completely off-grid with solar water heaters, solar panels, rainwater collectors, a composting toilet, natural ventilation and triple glazed windows for insulation.

Relocatable

With a surface area of 2,5 x 3 meters when fully assembled and furnished, the dwelling can be loaded onto a lorry and transported anywhere. The off-grid setup makes it possible to live without regulation.

Appendix D - Starting points

1 BUILDING DENSITY

1.1 Increase the building footprint as this provides more usable surface area and thus offers the possibility to accommodate more residents.

1.2 Maximize the dwelling density, also known as the dwellings/hectare, as this results in as many residents as possible within the same urban environment.

1.3 Increase the percentage of dwellings in the functional mix, as this allows for more residents/hectare within the same floor area.

1.4 Reduce the floor area of dwellings because this ensures that more dwellings can be situated within an identical footprint.

1.4 a Limit the volume occupied by a dwelling through integrated interior.

1.4 b Provide a more efficient layout and use of available space by giving the interior multiple functions. Switching functions should be automated, otherwise it will take a lot of effort from the users.

1.4 c Apply prefabricated elements because this ensures that the layout is as efficient as possible since everything fit together seamlessly without taking up unnecessary space.

1.4 d Promote the use of spaces for various functions instead of one, as this reduces the volume of the dwelling. In doing so, avoid the need for a lot of storage space for the various functions.

1.4 e Stimulate sharing facilites between residents as this reduces the total floor area required per person.

1.4 f Make spaces adaptable so they always fit in seamlessly with the usage and do not take up unnecessary floor area (e.g. guest room is only present when there are guests)

1.4 g Do not approach the design of a dwelling as a collection of spaces, but as a sequence of activities.

1.4 h Do not only consider the floor as a usable surface, but also make use of the walls and the ceiling.

1.4 i Apply innovative ways to storage solutions, as storage is one of the main consumers of surface-time.

1.4 j Exchanging space with neighbouring dwellings reduces the amount of floor area required per building block.

2 POPULATION DENSITY

2.1 Increase the external density, also known as the residents/hectare, through a high dwelling density and a large household size.

2.2 Enlarge the internal density, also called the sqm/resident, by reducing the surface area per resident more people can be accommodated in the same area, regardless of household or dwelling size.

3 OPEN SPACE

3.1 Increase the open space ratio, also known as the open space area/ total floor area, by reducing the area of open spaces and increasing the total floor area.

1 HOUSE WELL-BEING

1.1 Provide all residents with access to well-located, affordable and comfortable housing and upgrade this housing stock on a regular basis.

1.2 Offer a diverse range of housing typologies and promote social cohesion by mixing households of different income groups and ethnic backgrounds.

1.3 Incorporate outdoor spaces such as balconies and patios into the design. Vegetation gives a close contact with nature but also provides a degree of separation and privacy.

1.4 Give the opportunity for people to have a place of their own by giving the ability to personalize their space.

1.4 a Avoid prefabricated solutions in which the residents cannot make their own adjustments.

1.4 b Use free floor plans that allow residents to tailor the space to their activities and preferences, e.g. by clustering facilities.

1.4 c Make the frequency of adaptability high, so it not only adapts to changing life situations, but also to changing preferences or activities.

1.4 d Automate the customization so it takes little effort for the residents and it increases the speed.

1.4 e Make the range of adjustments large because each individual has different preferences. Make sure it is not limited to a framework or grid, but do give the residents some guidance.

2 NEIGHBOURHOOD WELL-BEING

2.1 Activate street life by offering a diverse range of affordable services (retail, utilities, culture, etc), accessible to the entire community regardless of ethnic background.

2.2 Create effective meeting points in dense public areas.

2.3 Enlarge the recreational program by improving existing and adding new public parks, small businesses, marinas, beaches and other cultural amenities.

2.4 Maximize accessibility for all people and improve walkability by adding facilities for pedestrians.

2.5 Protect and increase vegetation in public spaces and promote natural biodiversity.

3 SOCIAL WELL-BEING

3.1 Increase multiculturalism and provide good relationships and daily interaction between people by providing public gathering places.

3.2 Design streets and buildings that reinforce safe environments.

3.3 Remove all barriers that reduce the participation in daily life of certain social groups, such as those with disabilities, women, children and elderly.

3.4 Encourage citizens to participate in the creation and programming of public cultural venues and activities.

4 ECONOMIC WELL-BEING

4.1 Minimize inequity by providing equal access to economic activities, services and facilities

4.2 Promote economic equity by providing a broad range of housing types, tenure types and prices levels

4.3 Provide job opportunities and promote local business by attracting economic activity and mixed use development.

Appendix E

1 objective
to develop a new way of living that actively tackles the challenges presented by the ongoing **urbanization** of cities.
*How can we create a way of living that maximizes both **density** and **quality of life**?*

2 literature
to gain insight into the different **definitions** and to provide background information on the topics.
*How can we define **density**? How can we define **quality of life**?*

3 analyses
to explore whether improvements can be made in the **current built environment.**
*How is space in dwellings currently being **used**? What are the **parameters** that determine the density and quality of life?*

4 case studies
to clarify which **design elements** are effective and to provide a project database that can be used further in the design process.
*What **techniques** and **methods** are used in the selected case studies?*

5 starting points
to **maximize** the concepts of density and quality of life separately without mutually influencing each other.
*How can we translate these techniques and methods into **starting points** for the design?*

6 design principles
*How can we combine these starting points to define **design principles** for a way of living that maximizes both density and quality of life?*

1 objective

1.1 urbanization

Urbanization is one of the most urgent challenges currently being faced by cities across the world. More than half of the world's population (54%) resides in urban areas and the urbanization is expected to continue to grow to 68% by 2050. (UN, 2018)

The high demand for housing caused by urbanization needs to be accommodated, but available space is limited. More people will make use of the same amount of space, which will increase the pressure on the built environment.

1.2 visionary approach

Through visionary thinking, we can challenge long-standing traditions and pave the way for innovative approaches. Utopian visions are 'one of the most important catalysts for fundamental change' (Robert Klanten and Lukas Feireiss, 2011).

1.3 new way of living

The world is in need for way of living that does not fight against densification, but rather embraces it. This project explores how we can achieve maximum densification of a city while at the same time creating the highest quality of life for its citizens.

1.4 density vs quality of life

The relationship between density and quality of life is complex and has a multi-dimensional character (Searl, 2010). Answering the question how both the density and quality of life can be maximized requires some discussion about what both concepts entail, therefore they are first discussed separately and then recombined when formulating the design principles (see 6).

2 literature

2.1 density

definition — A certain **quantities per unit area.** In the urban environment it is a set of interrelated variables which are heavily reliant on each other for their assessment, significance and usefulness.

Net density: measured at the site
Gross density: integrating the larger context of public space

External density: at the level of the neighborhood
Internal density: at the level of the users per room or floor area

Three domains of density:
building density, population density, open space

Urban morphology study (informal settlement, high rise, urban, suburban) shows that a high building density does not directly cause a high population density and vice versa.

2.2 quality of life

definition — The **level of satisfaction** a person obtains from the surrounding environmental conditions. The quality of life is not linear, but complex and interwoven.

Four domains of quality of life:
house well-being, neighborhood well-being, social well-being, economic well-being

Objective dimension: the way in which the physical environment can influence behaviour positively or negatively
Subjective: people's perception of how their environment influences their experiences of life and how it shapes their cogenitive interpretation of the quality of life.

3 analyses

3.1 density

Analysis of what people do throughout the day showed that the standard timeline is valid. Most people sleep at night, around 08.00 people go to work and around 17.00 people return home.

Daily activities were projected onto a standard family home in the middle price range, allowing the surface-time to be calculated. The conclusion was that only 30% of the total surface-time of a standard dwelling is utilized.

Parameters density:
- **volume**
- **efficiency**
- **effort**

3.2 quality of life

Subjective dimension:
Mind - how we interact with our surroundings
Energy - how we see the world and process information
Nature - how we make decisions and cope with emotions
Tactics - our approach to work, planning and decision-making
Identity - how confident we are in our abilities and decisions

Parameters quality of life:
- **identity**
- **range**
- **speed**

4 case studies

identity — **New Babylon** - Nieuwenhuys
An immense volume consisting of a large number of 'sectors', within these sectors, everything can be adapted to the needs of the individual, following the speed of the user.

range — **Personalised Capsules** - Some People
A projected interface helps the user to design his own home effortlessly using machine learning. The speed and range of the adaptation is high because it is built by small robots.

speed — **Zero Star Hotel** - The Why Factory
A fully adaptable building that explores temporary lifestyles. Using artificial intelligence, the rooms adapt immediately when there is a change in activity.

effort — **Growing Systems** - AA School of Architecture
Artificial intelligence minimizes the effort for the user as it scans the environment and adjusts the design real-time, thus completely erasing the line between design and fabrication.

volume — **Diogene** - Renzo Piano
The exploration of the minimum space in which a person can possibly live. The small volume is achieved by integrating the interior and making it foldable.

efficiency — **Rotating House** - George Clarke
Takes up as little space as possible by turning the dwelling around. It has a total floor area of 40 square meters, but only a footprint of 10 square meters.

5 starting points

5.1 density

1.4 f — Make spaces adaptable so they always fit in seamlessly with the usage and do not take up unnecessary floor area (e.g. guest room is only present when there are guests)

1.4 e — Stimulate sharing facilites between residents as this reduces the total floor area required per person.

1.4 a — Limit the volume occupied by a dwelling through integrated interior.

1.3 — Increase the percentage of dwellings in the functional mix, as this allows for more residents/hectare within the same floor area.

3.1 — Increase the open space ratio, also known as the open space area/ total floor area, by reducing the area of open spaces and increasing the total floor area.

5.2 quality of life

1.4 — Give the opportunity for people to have a place of their own by giving the ability to personalize their space.

3.1 — Increase multiculturalism and provide good relationships and daily interaction between people by providing public gathering places.

1.4 a — Avoid prefabricated solutions in which the residents cannot make their own adjustments.

4.3 — Provide job opportunities and promote local business by attracting economic activity and mixed use development.

2.3 — Enlarge the recreational program by improving existing and adding new public parks, small businesses, marinas, beaches and other cultural amenities.

6 design principles

Optimize floor area
This results in an increase in the number of dwellings per hectare. It involves considering dwellings as a sequence of activities rather than a collection of spaces, giving spaces multiple functions and applying prefabricated and/or integrated furniture.

Offer adaptable dwellings
For density, this allows the space to be arranged efficiently and, in the case of quality of life, it means that people can adapt the home to their personal preferences. Ensure that the maximum possible frequency of adjustments is high and that the effort for the occupants is low.

Offer a range of typologies
This includes all price ranges and ethnic backgrounds. This ensures that each individual gets a well- located and comfortable home.

Promote facility sharing
The quality of life benefits from sharing facilities as it encourages good relationships and interaction between neighbours. In terms of density, this means that dwellings can be downsized, resulting in more dwellings in total.

Enhance outdoor spaces
To improve the quality of life it is important to maintain open public spaces, such as parks. And by making the urban environment more attractive, this can become the new 'living room' and dwellings can be made more compact, which increases the density.