TRANSFORMATION AS A TYPE

SEEKING A FLEXIBLE HOUSING TYPE FOR THE 21st CENTURY

by

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ABSTRACT

Transformation as a Type:
Seeking a Flexible Housing Typology for the 21st Century
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Rapid social and technological change have largely influenced the way in which individuals and families inhabit their dwellings, leading to new functional and formal lifestyle demands within the domestic realm.

> "The current information society is more closely linked to time than space. Its networks produce systems that are discontinuous in space but continuous in time…the most consistent systems are those capable of distributing their activities homogeneously in time, thus avoiding the generation of another parallel space…specifically for one concrete use." (Guallart, 2004, p.25)

In a time where change and transformation are omnipresent and highly influential, how can we design habitats that respond directly to the changing social order, by transforming into the appropriate space which supports the changing occupants, activities, and functions of a home?

This thesis proposes a flexible housing typology, which has the ability to transform and adapt to socio-cultural and technological changes over time.

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“In the name of Allah, Most Gracious, Most Merciful”

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To them I dedicate this thesis.

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“it is important above all to create an environment that does not prescribe people’s way of life, but in which they can develop creatively and design their individual ways of living together.”

Jan Krebs (source: Basics: Design & Living, 2007)

TOPIC: Housing typology: the single family house as a ‘type’

OPINION: The single-family house is morphologically stagnant in time and irresponsive to the changing socio-cultural and lifestyle advances of contemporary society. The typology should be reconsidered, and formally and functionally redefined in a manner which responds to the changing family, social and cultural lifestyle requirements of contemporary society. As a type, the single-family house type should have the inherent capacity to be ‘flexible’ as a strategy to respond to changing conditions.

DESIGN RESPONSE: A flexible housing typology for the 21st century, which adapts to the changing socio-cultural and lifestyle requirements of the occupants over time.

THESIS STATEMENT: This thesis proposes a new housing typology for the 21st century, through an investigation of past models and their response to the changing cultural dynamics of society. By exploring contemporary lifestyle requirements, it will examine housing as a durable commodity redefined and capable of transformation, which has the capacity to adapt to the changing family, social and cultural conditions of contemporary society.

RESEARCH QUESTIONS:

1. What are the conditions of 21st century housing that demand a reconsideration of the single-family house type to be more flexible and transformable?

2. Can transformation become a new typology on its own?

3. Can architects design habitats that respond directly and immediately to the changing culture of contemporary society, by transforming spaces contained within dwellings so that these spaces may support the changing needs of occupants, and concomitant activities within the dwelling and the required functions of a home in the 21st century?

1.0

1.1 Defining Transformation, Type and Typology

Transformation: Transform + ation

Transform: to change in form, nature, appearance or character.
"ation": suffix added to form nouns of action.
Transformation: refers to the act or process of change in form, nature, appearance or character.

Typology: Type + ology

Type: a number of things or persons sharing a particular characteristic, or set of characteristics, that causes them to be regarded as a group, more or less precisely defined or designated; class; category.
"ology": a suffix derived from the Greek logos, meaning the "study of"; a science or other branch of knowledge.
Typology: refers to the study of type, or a systematic classification of types.

1.2 Typology in Architecture

Types have been discussed in architectural discourse by numerous architectural practitioners and theoreticians who have sought to identify and define typology in relation to architecture. The first architectural typology developed out of the discussion on the rationalist enlightenment philosophy. According to Anthony Vidler, the architects of that time found in the origins of shelter the first dwelling type. In his Essai sur l'architecture (1753, as cited in Güney, 2007), abbé-Marc-Antoine Laugier indicates that such an understanding of typology proposed a natural basis for architecture, which can be found in the model of the primitive hut. According to

Figure 1.0
Laugier's Primitive Hut
Source: Laugier, M. A. (1977)

Laugier, the primitive hut embodied rationalized elements and standards. Four trees depict the first types of columns, the branches connecting column capitals represent beams, and boughs bend over to form the roof within a triangular form, which reflects the pediment (Figure 1.0). In this manner the primitive hut became the exemplar of all possible forms of architecture, and hence the principle and measure of all architecture as well.

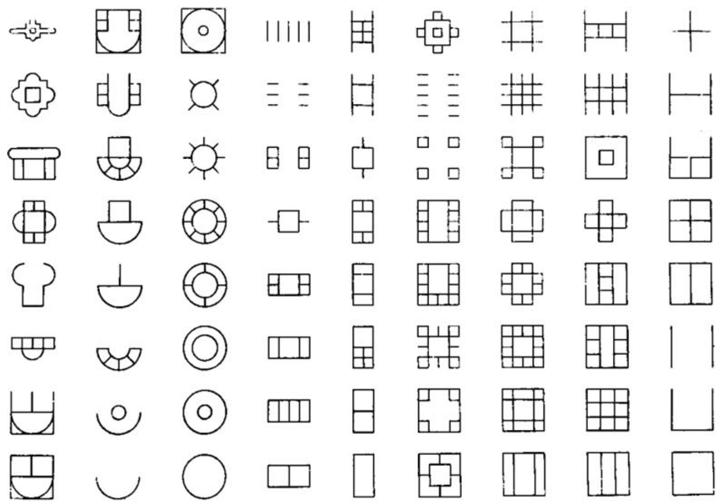
Similar to Laugier's rationalist stance, French archaeologist and theoretician Quatremére de Quincy symbolized architecture as an imitation of nature. His theory of type is metaphorical and is recognized by his description of "Type" in Encyclopedie Methodique of 1825. According to de Quincy, type originates from the Greek word "typos", which expresses what one means by model, matrix, mold, and figure in relief or in bas relief. He suggests that the word type "presents less the image of a thing to copy or imitate completely than the idea of an element which ought itself to serve as a rule for the model." (de Quincy, 1825, as cited in Vidler, 1998, p.618). De Quincy distinguishes between the notion of type and model, and defines the model as an object that should be repeated as it is, and type as an object after which each artist can conceive works of art with no resemblance between one and the other. He further elaborates that all is precise and given in the model, while the type is more or less a vague idea, like a nucleus about which variations of forms, to which the object is susceptible, are collected in time (de Quincy, 1825, as cited in Vidler, 1998). In this manner, he defines type as a process modified by circumstance.

De Quincy's metaphorical theory of type was the first theory introduced into modern architectural discourse. It is primarily based on three concepts: origin, transformation and invention. Unlike the primitive hut, which posited as the origin of all architecture, de Quincy's origin refers to the understanding of type as "the general form, structure, or character distinguishing a particular type, group, or class of beings or objects" (Güney, 2007, p.6). Such a classification was aimed towards creating a practical understanding of type by applying it to the context of use, need and custom, which refers directly to the Enlightenment idea of charactère. The notion of type as a symbol of function by virtue of a building's charactère was first introduced into architectural theory by Germain Boffrand. Based on Boffrand's theory, charactère represents the expressive function of a building to communicate with people and "different buildings should, by their arrangement, their construction and by the way in which they are decorated, proclaim their destination to the observer" (Kruft, 1994, as cited in Güney, 2007, p.7). De Quincy defines character in that

> "each of the principal [kinds of] buildings should find its fundamental purpose in the uses to which it is attached, a type which is its own; to which the architect should try to conform as closely as possible if he wishes to give to each building an individual physiognomy" (De Quincy, 1825, as cited in Vidler, 1998, p.449).

De Quincy's analysis of architectural precedents was the first to have gone beyond the limited scope of classical architecture; type became universal through his work (Lampugnani, 1985, as cited in Güney, 2007). However, he was not alone in theorizing about the idea of type around the time of Enlightenment. J. N.

Figure 1.1
JNL Durand's Typology
Source: Moneo, R. (1978)



L. Durand also explored Laugier's principles, albeit through a slightly different lens than that of de Quincy. Influenced by contemporary advancements in natural sciences, particularly those of taxonomy and descriptive geometry, Durand employed scientific methods of taxonomy for the study of building forms. He enumerated a number of inventories of building elements including pilasters, walls, foundations, etc., which were compiled in his Recueil et parallèle des édifaces de tout genre (1801), a kind of "typological atlas of architecture" (Kruft, 1994, as cited in Güney, 2007, p.8). Within this work, Durand drew the plans, sections and facades of selected buildings to the same scale, with the same technique (Figure 1.1). He then classified them based on both functional and morphological characteristics, "according to their kinds, arranged in order of degree of likeness" (Vidler, 1998, p.451). His intention was to rigorously describe and analyze form and geometry in architecture, while the external attributes were disregarded. This notion was distinctly separate from the Enlightenment idea of charactère. According to Vidler (1977), by juxtaposing the different historical styles parallel to one another, Durand eliminated the significance of any one singular style, while unconsciously reducing the precedents to an eclecticism of styles. Within his corpus of work Durand stated that composition related specifically to economic needs should be the first aim of architecture. His work was one of the first attempts to disconnect the foundation of an architectural order from existing traditions towards an autonomous architecture free from traditions. The work, presented in table format, reflected the geometric combinations to be used as a basis for various types of building plans. Assumed as representing geometric reduction, the table made a legible connection between existing and historically concrete typologies and general architectural form, based on the laws of universal geometry. Considering the combination of economy and construction, coupled with the idea of geometric reduction, Vidler (1977) suggests that Durand's theory of type was perhaps the first move towards the modernist idea of type.

The modernist theory of type is primarily based on the changing social conditions and the desire for mass production following the First World War. The reconstruction of post-war Germany was controlled by a radical avant-garde that based its architectural projects on standardization and typification. Architecture was considered a social duty, which would provide clean and healthy living spaces for people of varying socio-economic classes. One particular type that emerged in response to the demand for clean and healthy living spaces was Le Corbusier's "Maison Minimum", which was thought to have been derived from the perceived 'scientific' needs of human life at that time. While this new concept of type was in line with Durand's theory, it differed in that it was directed by new concepts of clean, uncluttered and simple living spaces. Hence the form-making process was aligned with the mass-production process, and type became standardized (Vidler, 1976). Within the process of mass-production, type required repetition and hence became regarded as prototype. According to Gregotti (1985, as cited in Güney, 2007, p.9), “a production-oriented model becomes anti-specific and universally applicable and scientifically based.”

Raphael Moneo presents three major themes in order to summarize the characteristics of the notion of type at the beginning of the twentieth century. These include functional determinism, the rejection of precedents in favour of pure forms, and the notion of prototypes versus mass production. Functionalism rejected the past as a source for knowledge, stating that context was the most important influence within the form-making process. According to Reichlin (1985), Le Corbusier, one of the pioneers of Modernism, recognized that an architectural work is an accumulation of functions that could often be mutually contradictory and therefore in the design process these functions first should be recognized by an analytical separation. This analysis was required in order to reorganize the contradictory functions in a synergic manner which eliminates or reduces the obstacles in between them. Reichlin highlights Le Corbusier’s Plan Libre as a representation of a disruption which seems to negate the idea of type. However, he also argues that Le Corbusier posits himself within the boundaries of the typological problem, by using terminology such as ‘type Domino’ to describe the structural correlates imposed by Plan Libre (Reichlin, 1985). According to Reichlin (1985), Le Corbusier’s Plan Libre suggested a successful design solution that balances and satisfies the needs of different modes of architectural artefact.

The design broke new conceptual ground as it established the notion of a new architectural type.

In his article “The Production of Types”, Anthony Vidler (1977) denotes type as a proposed source of unity in architecture, as an alternative to architectural programme. According to Vidler, typology provides a basis for the generation of new species of building. Similarly Moneo (1978) states that “architecture is not only described by types, it is also produced through them. Stability in a society-stability reflected in activities, techniques, images-is mirrored also in architecture.” In other words changes in socio-cultural activities and interactions often influence associated changes to the architecture that supports these activities. As time moves forward, society adapts new typologies and models by which to operate and conduct their lives, in a manner that best accommodates the change. Often, external events, such as new techniques or changes in society, are responsible for creating these new typologies. While society experiences continual change, new models and typologies take birth to accommodate these changes.

> “The characteristic of our age is change, and because of that it is necessary to investigate the part which modifications of type solutions play in relation to problems and solutions, which are without precedent in any received tradition” (Colquhoun, 1967, p.276).

According to Moneo, the struggle with an identical problem tends to lead to almost identical forms. Architects rely on precedent studies to establish solutions for similar problems. However, these precedent studies, perceived in a time and age drastically different from the current culture of society, do not respond to the continual transformation of civilization. Although society advances and evolves, the precedents remain stuck in time, anchored by the socio-cultural attributes of their epoch. The design process is a way of unifying the elements of a typology into a specific state that characterizes the single work. This process facilitates new typologies to emerge from previously existent precedents. The very concept of type implies the idea of change or of transformation (Moneo, 1978).

Similar to Moneo, Quatremere de Quincy elaborates that “in architecture…the art of regular building is born out of a pre-exisitng source. Everything must have a precedent. Nothing, in any genre, comes from nothing, and this must apply to all the inventions of man.” (de Quincy, as cited in Vidler, 1998, p.618). De Quincy distinguishes between type and model by defining model as an object that should be repeated as it is, while type is the idea of an element which should serve as a rule for the model. “All is precise and given in the model; while all is more or less vague in the type” (de Quincy, as cited in Leupen, 1997, p.133). He stresses that the type is not the primitive hut, the tent or the cave; those were models. The type was, in the case of timber construction, that particular combination to which the use of wood is susceptible. Hence the type is the process that is modified by circumstance.

> “In 1825 Quatremère de Quincy offers a thoroughly modern (non-modernist) definition of Type, which continues to have critical repercussions in architecture today. His is a form-less Type without predefined function, in which ‘all is more or less vague’. The Type is a nucleus for a complexity of spatial arrangements that are adaptable to, but not (or not only) generated

by function" (Stoppani, 2005, p.12)

> "Not a static form but a multiplicity of variations, Type operates in time 'like a sort of nucleus about which are collected, and to which are coordinated in time, the developments and variations of forms to which the object is susceptible" (Quatremère de Quincy, 1825, as cited in Stoppani, 2005, p.12).

> "Extraordinarily modern in its non-definition of space, this description refuses to congeal Type in one form, offering to architecture the tool of a dynamic four-dimensional proto-form that is at the same time original-generative and derivate-cumulative. We would call it, today, a diagram" (Stoppani, 2005, p.12).

In order to examine transformation as a single type, this thesis illustrates a time-based design through the use of diagrams, as a dynamic tool to represent the proposed, transformable dwelling. These diagrams are presented in Chapter 5.0 along with a detailed description of the proposed type.

1.3 Transformation as a Type

Contemporary society is deeply embedded within a rapidly changing global atmosphere. The rate of change of society often supersedes the rate of change of its supporting architecture. While digital networks and communication within a dynamic society result in new socio-cultural advances and activities, somehow, without precedent, the supporting architecture remains stagnant in time. Is it not appropriate to assume that a new function or activity which is derived from changes in the socio-cultural dynamics of society should require a new architectural response as well? Rather than remaining static, should architecture not provide responses that better suit contemporary needs of users?

One particular type that has remained morphologically stagnant in time is the single-family dwelling. This may be due to the fact that twentieth century urbanism has focused on the high rise, multi-storey residence as opposed to the single family dwelling. However, it is commonly understood that the single family detached house persists as the most common form of housing in North America. This may be due to consumer preferences, historic traditions, land availability, as well as other perceived advantages such as privacy and freedom. Despite its popularity, its formal composition has remained unchanged over time. It is therefore important to establish a new housing typology that can offer the advantages of a single-family, detached dwelling, while also reflecting the changing socio-cultural dynamics of contemporary society.

In a time where change and transformation are omnipresent and highly influential on lifestyle choices, how can architects design a new housing typology, which can respond to change through its ability to formally transform, in order to meet the demands of the changing dynamics of society? Can transformation become a new typology on its own? Can architects design habitats that respond directly to the changing socio-cultural needs, by transforming into appropriate spaces which support the changing occupancy, activity, and function of a home? This thesis proposes a flexible housing typology appropriate for our time, which has the ability to transform and adapt to socio-cultural and technological changes that come about in time.

1.4 The Unchanging Variable: The Transforming Occupant

Housing should be focused on creating appropriate, human-scaled living spaces that are capable of adapting to the future needs of occupants. Currently, housing quality is generally associated with aspects of ecology and energy, while changing demographics impact the demand for appropriate housing. Even though housing typologies are largely affected by the changing dynamics of our society, human beings and their basic needs should be considered the most important factor in designing living spaces (Krebs, 2007). According to Krebs (2007), it is important above all to create an environment that does not prescribe people's way of life, but in which they can develop creatively and design their individual ways of living together.

Even though the human species has experienced variable change, the human being changes significantly over the course of his/her lifetime. As the human being grows over time the human body experiences drastic changes in autonomy and performance. These changes include changes in height, weight, ability, speed, mobility, health, etc. This change is also reflected in day-to-day activities and overall lifestyles requirements at the various phases in a lifetime. By continuing to question familiar and standardized housing typologies, architects can establish flexible living environments that are better suited for the changing lifestyle requirements of the transforming occupants.

2.0

2.1 The Case for a New Housing Typology

Housing is subject to a range of changes that come about in time. If it is unable to respond to these changes it becomes unsatisfactory and eventually obsolescent. "The developed world has come to accept the built-in obsolescence of consumer products, largely persuaded by the manufacturers that it is desirable to continually upgrade our lifestyles through endless consumption" (Schneider and Till, 2007, p.35). Such a concept when applied to housing can become highly problematic, due to vast economic, physical and social implications of built in obsolescence. Housing provisions work within a short-term mindset due to economic reasons. Market-led factors are large determinants in the shape of housing, particularly due to the large excess of demand over supply, mainly caused by the scarcity of land. Due to this imbalance, there is little incentive for developers to innovate or offer added value, in terms of both design and construction, as sales are almost guaranteed with high profit margins. Therefore, previously tested models are often situated irrespective of social or physical context, or of changing technologies. According to Schneider and Till (2007, p.35), the "lack of investment in research and development has resulted in a house building industry that is unable to keep abreast of innovation in processes and technology or to cater for long term social needs."

Typically the spaces in a house are designed down to the absolute limits of their function, and are often determined through furniture layouts. According to Rabeneck (1973), this creates spaces of 'tight-fit functionalism', which refers to the idea that a room can only be used for its preconceived purpose. For example, a separate dining room is seen as a desirable feature in upmarket developments, despite the fact that such rooms are used for less than five percent of the day on average. The dimensions of the room are established by the size of the furniture within it, with little circulation around the periphery. The result is a long narrow room which is difficult to use for any other function, with or without the specified furniture in it. This concept becomes highly problematic when applied to the whole house; coupled with inherently inflexible construction techniques, it makes future change of space either impossible or extremely expensive (Schneider et al., 2007).

“The housing sector is building in obsolescence through inflexibility” (Schneider et al., 2007, p.37). This idea is driven purposefully for economic reasons. Inflexibility requires occupants to move to a new home when the occupants’ needs change, thus keeping up demand in the housing market. However, flexibility can allow occupants to adapt to their houses as needs change and occupy them for a longer period of time. However, this can alter housing demands and potentially impact the new housing market, on which developers are so dependant. Therefore, housing provision demands a broader view of the subject than treating housing merely as a short-term investment. Simply providing additional houses is not sufficient enough if, in a few years’ time, these houses will become obsolete as well. Therefore, an appropriate solution is to consider flexible typologies to accommodate new demands on the built environment resulting from shifting demographic trends, ageing users and changing working patterns, etc. This approach can reap benefits in the long run, particularly in terms of life cycle costing, sustainability, as well as the incorporation of new technologies with time. In order to accept these principles architects must reconsider housing as a long

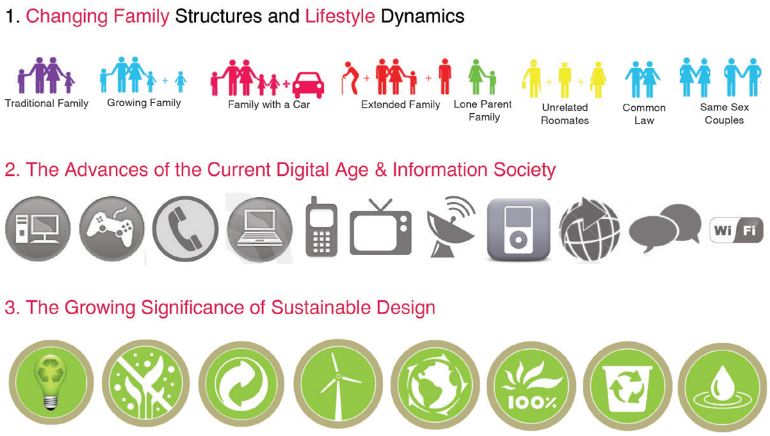


Figure 2.0
Considerations for a Contemporary, Flexible Housing Typology
Source: Self-derived

term asset rather than a short-term commodity (Schneider et al., 2007).

Why do we need a new, flexible housing typology for the 21st century, and what are the considerations for such a contemporary typology?

In order to respond to this question, understanding the background and statistics pertaining to the rapidly changing society is necessary. Among other things, contemporary lifestyles are largely affected by the following criteria: changing population and demographics, changing family structures and lifestyle dynamics, the advances of technology witnessed by the current digital age and information society, and the significance of sustainable design (Figure 2.0).

2.2 Changing Population & Demographics

In 2011 the world's population reached a total of 7 billion people, more than half of which reside in urban areas (The World Bank, 2011). The projected world population by 2023 is expected to be 8 billion and according to the World Bank

(2011), by 2050 75% will occupy urban areas. Across the world cities are growing rapidly in size and number as people are increasingly drawn to urban areas and the promise of a better standard of living. As the population within cities continues to grow, so does the demand for housing.

An increase in population in urban areas also means an increase in population density. According to the 2011 census, Toronto's population is reported to be 2,615,060. Considering that the urban land area accounts for approximately 630km2, Toronto has a population density of approximately 4,151 people/km2 (City of Toronto, 2006). How can architects design a new housing typology which responds to the growing population in urban areas in the developed world?

2.3 Changing Family Structures and Lifestyle Dynamics

The single family detached house in an ex-urban or suburban setting became a symbol of homeownership throughout the 1950s following the Second World War. The majority of post-war homes within North America were built as discrete houses for individual families. According to Malvina Reynolds' popular folk song of 1962, these houses were uniform "little boxes made of "ticky-tacky", conceived not necessarily due to a lack of imagination, but rather as a reflection of a remarkably homogeneous image of North American families and the impetus of the home building industry. The traditional family of the post-war era comprised four occupants within the household: husband, wife, and two children. Typically the husband was the sole bread-winner, while the wife assumed the role of the home-maker (Rybczynski, 1991).

The Central (now Canada) Mortgage Housing Corporation (CMHC) promoted various models of the typical single-family house (Figure 2.1). In a time when war veterans returned home in the hopes of starting families, this typology was idealized as the “norm” through various agents including popular media as well as the profession of architecture (Kapelos, 2009) (Figure 2.2). While most models were small and similar in configuration, there seemed to be slight variation in formal arrangement and material application. Consumers could choose from numerous models including one-storey bungalows, split-level and 1 ½ storey houses, as well as some double storey houses, based on their preferred mode of living. However, all models seemed to follow a similar functional hierarchy and spatial arrangement.

Figure 2.1
CMHC, 1947, 67 Homes for Canadians, February, Cover
Source: Kapelos, G.T. (2009)

In the early 1960s, the composition of the family began to change. In 1956 the median age at first marriage was at a historic low, with 22.5 years for men and 20.1 years for women. The introduction of readily available birth control (the pill), first marketed in 1960, affected fertility rates, with the result that young adults would wait longer before getting married and starting a family. In the ensuing decades women began to have fewer children and had them at a later age. This led to shrinking family sizes, and by 1989 the average number of occupants within a household reduced to 2.6 (Rybczynski, 1991).

Figure 2.2
“The Pool Side Life”, CH&G, May 1962, Cover
Source: Kapelos, G.T. (2009)

The 1960s didn’t only affect family sizes but also the dynamics within households, as members of the traditional family assumed new and changing roles. In the post-war decades, women entered the workforce, producing dual-income households and, by 1970s, they were entering the work force in significant numbers. As the responsibilities of the bread-winner and home-maker shifted to both parents, lifestyles were also affected. Parallel to this, divorce rates also increased, as more people started to live alone, with single-person households accounting for almost a quarter of the total. Married-couple households decreased from 71% to 55% and the typical family of four became known as the "traditional family", making up less than a third of all households (Rybczynski, 1991).

In contemporary society, family arrangments and living modes have evolved further as new norms of living and family structures have emerged (Figure 2.3). Increasing global migration, the emancipation of young adults and the delay

Figure 2.3
Varying Family Units
Source: Guallart, V. (2004)

in having children, higher life expectancies and the improved quality of life of senior citizens are a few of the many factors that influence the way in which people group together to occupy a house today. Single parent families, immigrant families, large, small, and extended families, young students, young couples, senior couples, adoptive families, common-law families, same-sex partners, same-sex parent families, etc. are all the various types of occupants that exist and are housed within our society today (Guallart, 2004). Furthermore, according to Guallart (2004), a new concept of the family has recently emerged. The “virtual family” indicates people of various generations who are not blood related, but behave to some extent as a family by sharing resources and activities (Guallart, 2004).

Although there has been an observed progression of family structures since the Second World War, the single-family house remains morphologically unchanged, as stated previously. With the exception of technological and material applications within the composition of the house, the general functional arrangement and relationship between occupy-able spaces remains fairly unaltered. This can be observed within the matrix analysis conducted between the CMHC housing models from the 1950s, and the Mattamy Home models of 2010 (Refer to Appendix 5.1 and 5.2).

Given this apparent inertia, how can the single-family home be adapted to meet the spatial requirements of the various types of occupants and new family units of contemporary society?

2.4 The Evolution of the Single Family House: The "Domestic Trap"

The post-war home suggested a lifestyle and standard of living that was nested in the epoch of an industrial and consumer society. This society of the fifties on-wards marketed the single family house not only as a shelter for nuclear families but also a container full of modern furniture, clothes, appliances and gadgets. Consumerism led to larger houses, as can be noted by the mere difference in wardrobe sizes within houses of the 1920s (3 feet wide cupboards) in comparison to the contemporary models of our time, where walk-in closets account for an area as large as a washroom (Rybczynski, 1991).

Houses became larger in the 50s and 60s as the number of bedrooms and bedroom sizes increased. It became customary for each child to have their own bedroom, and the concept of the master bedroom emerged based on the demand for a larger bedroom for the parents. About half of the new houses constructed in the 1970s contained two or more bathrooms, and new types of bathrooms including powder rooms were also introduced within models. Modern appliances required larger and more elaborate kitchens with more counter space. Greater informality in living arrangements was achieved through the introduction of the family room or rec room "a place for children to play, and a place to put the television" (Rybczynski, 1991). This new functional space indicated the growing privatization of family life, which resulted in the subtle dissolution of the public realm, as the home became the primary location for family leisure (Rybczynski, 1991).

According to Betty Friedan the single family house became a "domestic trap"; the bigger the house, the bigger the trap. Larger houses required a greater effort and more time for cleaning and maintenance, which were traditionally tasks performed by the "home-makers" or stay-at-home mothers of the family. As women began to enter the workforce, the role of the wife changed and dual-income family units evolved. This however left little time for the women to focus on the maintenance of the house (Rybczynski, 1991).

As noted earlier, households began to shrink in size due to the introduction of birth control and reduced fertility rates caused by a delay in the average age for marriage, as well as other factors. Households were shirking, and houses increased in size, perhaps to match the crude "bigger is better" mentality of the era (Rybczynski, 1991). However, with larger space and less time to maintain it, not only did the cost of maintenance increase, but the quality of life of households abated as well.

Another factor that affected the quality of life of households was the typically inwardly focused arrangement of the house within the community. The houses were oriented away from the public realm of the street and focused inwards toward backyard recreation areas, thereby giving significance to backyards at the expense of public space (Wallack, 2009). According to James Howard Kunstler, as reported by Wallack (2009), the architecture of the suburban house expresses a disengagement from an idea of community in itself. Another significant hallmark promoted by the post-war, suburban house is the promotion of technology. New materials and electronics became an inherent component within the North American cultural milieu. The utilitarian technology portrayed within these models promised efficient environments of that time. Apart from utilitarian and "timesaving" equipment, entertainment media was also inclusive within the homes. The houses offered self-contained, self-sufficient, and controllable environments, which effectively ignored the outside world and the public realm. "Social activity and entertainment became increasingly privatized and accessible within the confines of the domestic realm" (Wallack, 2009, p.335).

2.5 The Digital Age & the Information Society

In the current information society, virtual networks and contemporary technologies and systems have largely changed the social interaction of individuals within families and society. Internet alone has more or less diminished certain architectural functions within communities. For example, internet banking is a faster and easier way to bank. While this may have resulted in efficient lifestyles, it has also caused individuals to become increasingly isolated from the public realm. According to Guallart (2004, p.25):

> "the information society is more closely linked to time than space, as its networks produce systems that are discontinuous in space but continuous in time. The most consistent systems are those capable of distributing their activities homogeneously in time, thus avoiding the generation of another parallel space…specifically for one concrete use."

While the socio-cultural dynamics of society have changed parallel to technological innovations over time, the single family house remains formally and functionally stagnant within the post war epoch of the industrial and consumer society. Since that time rapid changes within contemporary society have led to new functional and formal lifestyle demands. A new approach is to design time-based architecture, which is able to cope with such changes over time (TBA, 2007).

How can architects design effective living arrangements for contemporary family systems, in order to maximize social interaction as well as build cohesive communities within the current period of the digital age?

2.6 Sustainable Design

The rapid proliferation of single family houses on large individual plots had been possible solely due to the high rate of car ownership since the 1920s. Other transportation types including the streetcar, the elevated train, and the commuter railroad, along with the automobile, had made inexpensive suburban land available to housing developers. However, the energy crisis of 1973 initiated talk of moving back to the city as the benefits of energy conservation and mass transit were considered. “Eventually cars became smaller and cheaper to operate, home-insulation retrofitting became a lucrative small industry, and energy efficiency became a selling feature of new houses, though residential development continued to depend on the automobile just as much as before” (Rybczynski, 1991, para. 15).

During the 1980s, global warming surfaced along with a series of scientific disclosures pertaining to the deteriorating state of the physical environment caused by excessive carbon-dioxide emissions. At the time the principal sources of CO2 emissions were automobiles and power plants, and so the dependence on automobiles was considered problematic. The large, suburban, single family house was criticized as a lavish consumer of energy, physical resources and land; resources which were once considered abundant and plentiful could no longer be taken for granted (Rybczynski, 1991).

Contemporary society has begun to engage with sustainable design in several professions including architecture. Designing for the present while keeping the needs of the future generations in mind, has increasingly become a priority for current industries and professions. Buildings with varying functions (commercial, institutional, residential, etc.) are considered in a sustainable light. Apart from energy efficient and resource saving initiatives, sustainable design also seeks to improve the quality of the occupants experience within buildings. While a large proportion of sustainable design tends to concentrate on environmental issues, as they are easily quantifiable and easier to address technically, it often fails to address the social and economic aspects. These aspects are omnipresent within the approach of flexible design.

Flexibility is an inherent part of sustainability, as buildings with a long-term future that are capable of responding to changing aspirations and needs, eliminate the need for a new building to fulfill the new requirements and needs that come about in time. Flexibility integrates social, environmental and economic fields. It is more economic in the long term since it limits obsolescence in the housing stock. Socially it has the capacity to accept demographic change and thus stabilise communities, and its environmental benefits result from the elimination of the need for a new building to replace another that has become obsolete due to the changing requirements of the occupants (Schneider et al., 2007).

> "Flexible housing potentially exceeds the accepted definition of sustainability – providing for the needs of the present without compromising the ability of future generations to meet their own needs – inasmuch as it is not about the avoidance of future compromise but the encouragement of coming change…By acknowledging change as an underlying parameter but accepting the level and extent of change as unknown, flexible housing is inherently sustainable" (Schneider et al., 2007, p.50).

In a world seeking sustainable development, how can architects increase the flexible use and longevity of habitable environments?

3.0

Based on the social considerations and conditions mentioned in chapter 2.0, a house for the current age should be designed with the following criteria in mind: flexibility to address the changing family structures and lifestyle dynamics of contemporary society, and a compact design to afford efficient living spaces for the fast paced lifestyles of the 21st century. Taken together these concepts support a larger objective of sustainability, coupled with contemporary construction techniques and technologies suited to the current digital age and information society.

3.1 Flexible Housing

Flexible housing can be broadly defined as housing that can adjust to changing social and technological needs and patterns (Schneider et al., 2007). These changing needs can range from personal changes such as expanding families, to practical needs caused by the onset of old age, or even technological advances requiring updating of old services etc. Furthermore, the changing patterns may be demographic (i.e. the rise of the single person household), economic (i.e. the rise of the rental market), or environmental (i.e. the need to update housing in order to respond to climate change). Hence the breadth of this definition of flexible housing affords the possibility to make changes prior to occupation as well as the ability to adjust ones housing over time after occupation as well. In other words, prior to occupation, a flexible approach can allow future users a degree of freedom to choose the layout that is most appropriate to their current needs, and after occupation people can occupy their homes in a variety of ways without being tied to the specifics of room designations, allowing them to make adaptations to their home. In the longer term, a flexible approach can allow the occupants to change internal layouts, and upgrade their properties in an economic manner as well. It must be noted that this approach to flexible housing varies from traditional terminology applied to homes that can be adapted for hanging needs. For example, the definition of “Lifetime Homes” describes dwellings which can be adapted to accommodate the occupants’ changing physical needs and abilities as they age with time (Schneider et al., 2007). The flexible housing approach within this thesis investigation goes beyond the tenets of Lifetime homes, in terms of both design and construction, in order to accommodate social and technological changes that come about in time. This thesis proposes a new housing typology that can respond to the volatility of dwelling, by being both adaptable and flexible.

Flexibility and adaptability are terms that are often used interchangeably as they are confused or used to describe the same thing. According to Steven Groak, as stated by Schneider et al. (2007), adaptability allows for to the capability of different social uses, whereas flexibility refers to the capability of different physical arrangements. Adaptability is achieved through the design of rooms or unites that can be used in a variety of ways, primarily through the way that the rooms are organised, the circulation patterns as well as the arrangement of rooms. This concept can be related to the idea of polyvalent spaces. ‘Polyvalence’ is the term employed by Dutch architects and theorists to describe spaces that can be used in a variety of ways, generally without making physical changes. On the other hand, flexibility is achieved by altering the physical fabric of the buildings, by combining, extending, or subtracting rooms or units through the employment of sliding or folding walls and furniture. Therefore, adaptability is based on issues of use, whereas flexibility involves issues of form and technique (Schneider et al., 2007).

The word "flexible" implies very specific connotations, which often suggest a potential for movement or change. Flexibility is frequently associated with progress, and so in its literal reading "flexibility provides a convenient and immediate fix to that common architectural need to be allied to the 'progressive' forces of modernity." (Schneider et al., 2007). Therefore, it is not surprising that flexibility in architecture is historically dominated by a list of seminal, one-off experiments that include buildings with parts that actually move, or buildings that signify potential for change. The first category includes projects such as Rietveld's Schroder Huis, Le Corbusier's Maisons Loucheur and Chareau's Maison de Verre set in the 1920s, whereas the latter category includes the Eames House, Cedric Price's Interaction Centre and Piano and Rogers' Beaubourg (Schneider et al., 2007).

3.1.1 History of Flexible Housing

Flexible housing is not a new concept; however, it is next to impossible to document it in history as it was not a result of a developmental sequence of cause and effect. A linear route through flexible housing cannot be traced with one exemplar apparently informing the next in a deterministic way, and so Schneider and Till (2007) state that flexible housing can be seen in two ways: firstly as a result of the evolving conditions of the vernacular, and secondly as a result of external pressures that have led designers to develop alternative design solutions, including flexible housing. In this way the first category can be seen as "the response of the non-architect deriving solutions through long-term adjustments to patterns of use and cultural formations", whereas the latter can be expressed as "the response of the designer, deriving solutions through the authority of expertise" (Schneider et al., 2007, p.13).

The first category is often missing from official architectural histories and is expressed within the work of a few scholars including Paul Oliver, through his written records in two publications: Encyclopaedia of Vernacular Architecture and Dwellings. According to Oliver (2003, as cited in Schneider et al., 2007, p.13), "with the growth of families, whether nuclear or extended, the care of young children and the infirm, and the death of the aged, the demands on the dwelling to meet a changing family size and structure are considerable." Therefore, the range of responses to these issues was often determined by culture and climate within vernacular housing, ranging from a single space used for the whole family to a collection of individual cells arranged around a courtyard. The latter is an extremely flexible approach to dwelling as the function of each hut can be varied based on circumstance. "Each unit (hut) is in effect a room, and the whole compound constitutes the dwelling" (Oliver, 2003, as cited in Schneider et al., 2007, p.13). Embedded within the vernacular approach to flexibility is a series of profound insights into the way that buildings may open to adaptable and flexible usage, as opposed to the fixated structures of many architect-designed housing in which the response to changing family sizes in contemporary western cultures is often to sell and move to another house, which is the least responsive and most expensive option (Schneider et al., 2007).

The second category, according to Schneider and Till (2007, p.13), "the response of the designer, deriving solutions through the authority of expertise", is often listed within the history of modern architecture. In modern times three key drivers influenced the development of flexible housing. The first influence came about in the 1920s as a result of the need for European social housing programmes to provide mass housing. Due to the shift in space standards, coupled with new methods of construction, architects were prompted to develop designs that allowed flexible usage so that users were not constrained by the new minimum standards of the dwelling.

The second influence, which came about in the 1930s and 1940s and is still present today, results from the belief that prefabrication and emerging technologies, should provide solutions for mass housing. Flexibility was often inherent within industrially prefabricated buildings and their associated components. The third influence came about in the 1960s and 1970s from the move towards participation and user involvement, which led to a renewed interest in flexible housing. It should be noted that all three of the afore-mentioned episodes determined that flexible housing is most successful as a response to real and pressing needs. "It is much less successful, or even counterproductive, when it is treated as a self-contained credo, employed by architects as an end in itself as opposed to a means to an end" (Schneider et al., 2007, p.15).

The history of flexible housing illustrates three episodes during which flexible housing was considered as a solution to the socio-economic and technological advances of society at that time.

I) Modernity and the Minimal Dwelling

II) The Industrialization of Housing
III) Participation and User Choice

i) Modernity and the Minimal Dwelling

There was a significant increase in the demand for urban housing following the First World War, particularly for the working classes. Previous models of urban housing did not meet the needs for this unprecedented demand in terms of economics, density as well as the required scale of provision. Space standards were dramatically reduced in order to provide a large number of dwellings at minimal cost. Therefore the notion of flexibility was considered as a response to the need for efficient and compact spaces. "Internal variability of dwellings was a key element in this work – driven by the desire to make minimum sized apartments as tolerable and cheap as possible" (Schneider et al. 2007, p.16).

Eventually flexibility became aligned with the forces of modernity, signalling a progressive challenge to established values. According to Alan Colquhoun (as stated in Schneider et al. 2007, p.17):

> "The philosophy behind the notion of flexibility is that the requirements of modern life are so complex and changeable that any attempt on the part of the designer to anticipate them results in a building which is unsuited to its function and represents, as it were, a 'false consciousness' of the society in which he operates." Alan Colquhoun

Flexible plans signified the true beginning of modernism,

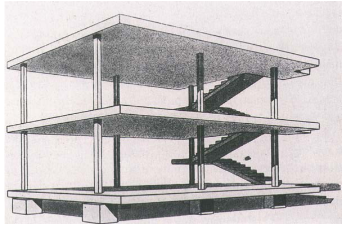


Figure 3.0
Le Corbusier's Maison Dom-ino (1914)
Source: Schneider & Till (n.d.).

driven not only by necessity but also by a strong belief in the liberation that these plans would bring to their occupants. Buildings and individual residential units were approached in a way that allowed for change over time (Schneider et al. 2007).

ii) The Industrialization of Housing

While the first episode in the history of flexible housing was motivated by social and economic forces, the second can be largely attributed to technological influences, particularly the adoption of industrialised solutions to housing provision. Even though industrialization had an immense impact on the nineteenth century lifestyle, its use within the delivery of housing was largely delayed until the beginning of the twentieth century. None-the-less, a rising demand for housing coupled with expanding technical capacity eventually led to an increased interest in standardised housing production. Due to the high housing demand following the First World War, architects began developing designs for residential dwellings that could be mass-produced by means of industrial prefabrication. This concept was largely adopted within the work of Le Corbusier, who from 1914 began developing projects that could be potentially produced on an assembly line. Maison Dom-ino (1914) (Figure 3.0), Maison Citrohan (1922) (Figure 3.1) and later Maisons Loucheur (1928) (Figure 3.2) are all examples of Le Corbusier's work dealing with the notion of prefabrication (Schneider et al. 2007). In his text Towards a New Architecture, Le Corbusier states that mass production leads to lower costs, as well as 'the lightly constructed walls and partitions can be rearranged at any time and the plan altered at will' (Jeanneret, 1986, as cited in

Figure 3.1
Le Corbusier's Maison Citrohan (1922)
Source: archweb (n.d.).

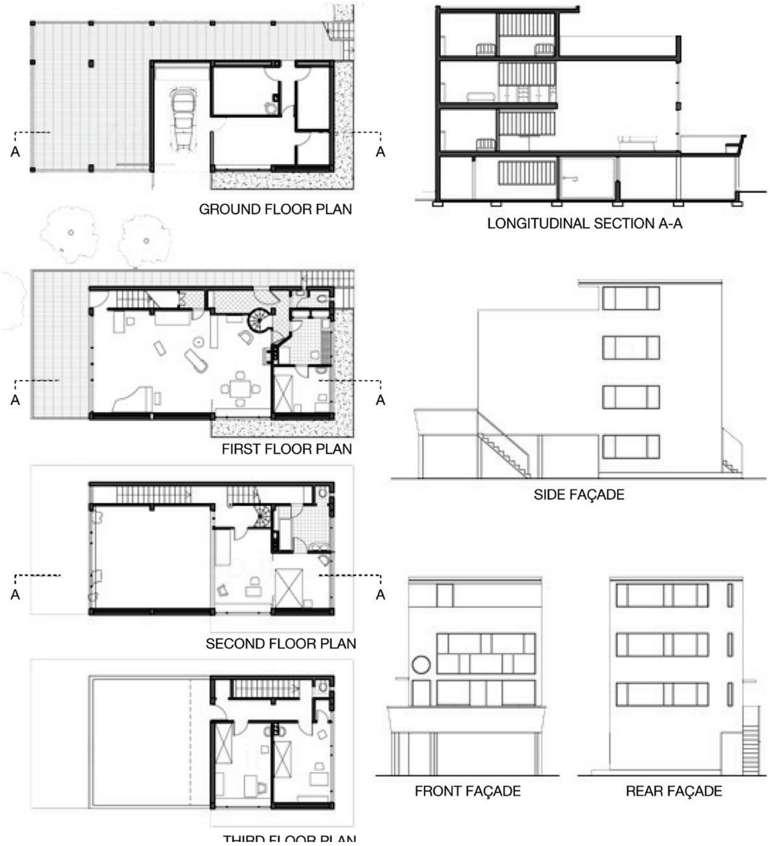


Figure 3.2
Le Corbusier's Maisons Loucheur (1928)
Source: Schneider & Till (n.d.).

Schneider et al., 2007, p.21). Evidently, the mass-production of these houses is linked to the argument that they are also inherently flexible. However, according to Gilbert Herbert (1984, as cited in Schneider et al., 2007, p.21), the motivation behind the concept of standardized housing was not simply limited to finding a technical means to solve the housing crises, but rather "the creative and intellectual challenge inherent in the design itself." Stemming from this idea, the concept of modularity was adopted by many modernists who believed that prefabrication and the industrialized process would lead to the provision of a range of choices for the future user. Walter Gropius saw the standardisation of individual building components as an opportunity to provide variability and flexibility in the floor plan. He became interested in the

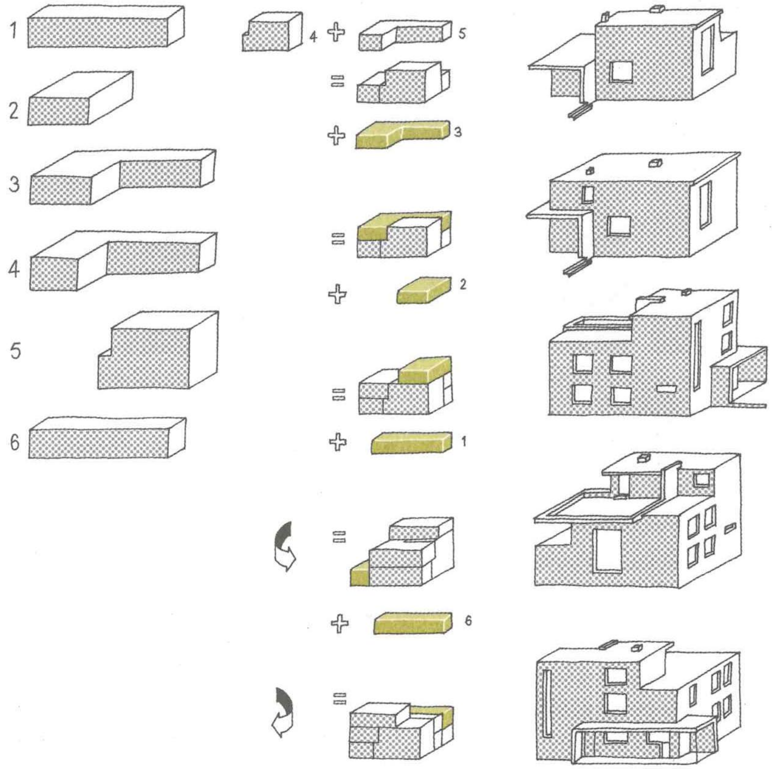


Figure 3.3
Haus Auerbach, Walter Gropius & Adolph Meyer (1924) Diagram of components
Source: Schneider, T., & Till, J. (2007)

automobile as an example of the construction industry's potential, as he saw the house as a set of components rather than a complete product (Figure 3.3). According to Herbert (1984, as cited in Schneider et al., 2007, p.23), Gropius made a convincing argument for the 'growing and shrinking house' by also highlighting 'other facets of dwelling flexibility, such as mobility in the face of changing site and programmatic demands.'

The standardisation of housing was largely initiated within a technological context based on the 'Henry Ford syndrome,' which asks 'Why can't we mass-produce houses…in the same way Ford mass-produced cars?' (Herbert, 1984, as cited in Schneider et al., 2007, p.23). Many of the industrialised methods of production are associated to some extent with the idea of prefabrication, and the argument for greater efficiency is often extended to an argument of a more flexible and adaptable design. This relationship between flexibility and prefabrication is generally based on the idea that prefabricated components can potentially be organized in an infinite number of arrangements. Therefore, the ability to customise the dwelling is an inherent aspect of prefabrication. However, "the short-term demands of the market in terms of providing immediate client satisfaction override any consideration of how the customer might use their 'product' over the longer term" (Schneider et al. 2007, p.27). Therefore, technique on its own cannot lead to inherent flexibility as it must be linked to the actual use of the house as well.

iii) Participation and User Choice

Beginning in the 1960s ideas pertaining to the involvement on part of the users within housing design surfaced in several publications. It was argued that user involvement in the design and adaptation of housing was often overlooked in mass-produced homes; hence treating occupants as standard consumers. In the late 1960s, flexibility was considered an important aspect by both architects and sociologists, who believed that occupants must be given a choice within the design and personalisation of their dwellings. Hence, most housing schemes coming out of the 1960s developed the principle of flexible housing in the context of user empowerment and participation. French architects Luc and Xavier Arsene-Henry were among the leaders in this field, and stated that 'not to reckon with the originality and unique character of each person is to negate one dimension of Man and, personally, we find that unacceptable' (Schneider et al.

2007).

Overall, throughout the history of flexible housing, it is evident that flexibility is not the primary impetus in the design of housing, but has generally come about as a response to other demands. However, it is important to note that these demands are in some form or another still omnipresent within our world today. The three main drivers presented in the history above (housing demand and minimal space standards, new methods of construction, and user participation) have all come forward within the contemporary housing agenda. Hence a flexible approach to housing design can be considered an appropriate solution for the house of the 21st century.

3.1.2 CMHC FlexHousing

CMHC has previously engaged in the concept of a flexible housing typology, which potentially allows the occupant to reconfigure their house to fit their changing lifestyle needs. Based on the CMHC model, commonly referred to as FlexHousing, rooms can change in size and/or a complete floor may change in function. Pre-wiring and plumbing ready for adaptation, allows the house to be equipped for such changes. CMHC's FlexHousing was designed to permit surplus space to be rented out to either a non-related tenant or a family member, in order to reduce the costs of ownership. The dwelling was envisioned to be reconfigurable as the family size increased or as family needs changed over time. For instance, the house can accommodate an addition or removal of a secondary suite, while a change in room configurations can also create a new bedroom for a child or elderly parent, which can also function as an office or den if there isn't a need for another bedroom.

While this concept allows for a transformable typology over time, it must be noted that the FlexHousing model presumes the exoskeleton of a conventional single-detached dwelling, and only the interior spaces are reconfigurable (CMHC, 1999).

FlexHousing was conceived to appeal to different segments of the population including: young couples who can benefit from reconfiguring the rooms in order to meet their changing spatial requirements as their families grow, single adults who may want to share communal spaces and keep sleeping quarters separate and independent (typically students or young working professionals), senior couples who can rent a portion of the space to a family member or unrelated party in order to help pay for the house, etc. (CMHC, 1999).

According to the CMHC model, the advantages of flexible housing include the provision of stable neighbourhoods as a family can remain in the same house over the span of many lifestyle changes, an increase in the amount of affordable rental stock within the municipality, and the ability to cater to all demographics within a household through its versatile design features. One disadvantage however could be that some neighbourhoods would not allow for two-unit dwellings based on zoning constraints (CMHC, 1999).

CMHC FlexHousing investigations have been undertaken in various parts of Canada. However, no examples have yet been explored within Toronto.

3.1.2.1 Case Study 1: The Convertible House

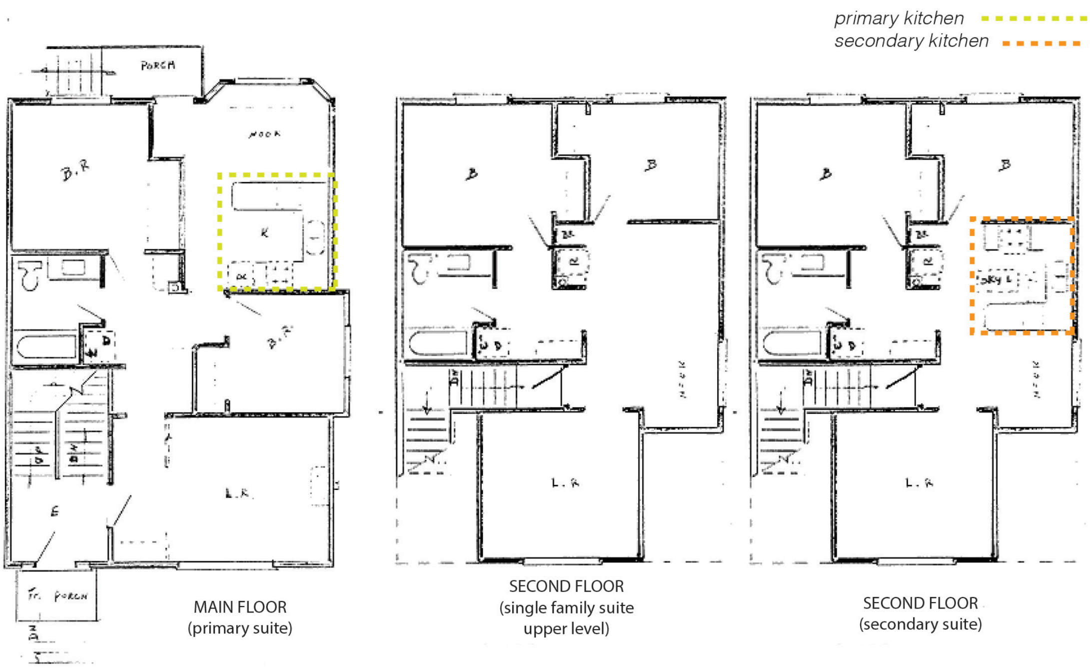
Designer: CMHC

Year: 1988

Location: Vancouver, Canada

The primary goal of the convertible house in BC was to construct an affordable house, which can transform from a one-dwelling unit to two-dwelling units and vice versa (Figure 3.4). The target group for this type are first time homeowners and secondary suite tenants. This concept dates back to 1988 when the City of Vancouver initiated the Secondary Suite Program. This program was designed to respond to the shortage of affordable rental accommodation, and hence ensured that new and existing secondary suites met building code requirements with the City. At the same time there was an increased demand for affordable ownership housing as well. Houses that contained secondary suites were particularly

Figure 3.4
The Convertible House Floor Plans
Source: Energy Pathways Inc. (1995)



attractive to first time homeowners as the rent from the secondary suite could be applied towards mortgage payments (Energy Pathways Inc., 1995).

In its physical sense the convertible house was built with the secondary suite in place on the second floor. The exoskeleton of the house maintains the appearance of a typical single-family house. The main dwelling on the ground floor comprises of a one-bedroom plus den unit, with a bathroom, kitchen, dining area, living room and laundry. The secondary suite on the upper level consists of a kitchen/eating area, one bathroom, laundry facilities and can contain up to two bedrooms depending on the occupant's needs. The house can convert the second floor into additional bedrooms as the family expands, and then back to a second dwelling unit for rent, as all the children leave home, in order to generate income yet again as the homeowners age within the original dwelling (Energy Pathways Inc., 1995).

Project Objectives: to construct an affordable house, which can transform from a one-dwelling unit to two-dwelling units and vice versa.

Description: The convertible house was built with the secondary suite in place on the second floor. This secondary suite consists of a kitchen/eating area, one bathroom, laundry facilities and can contain up to two bedrooms depending on the occupant's needs. The house can convert the second floor into additional bedrooms as the family expands, and then back to a second dwelling unit for rent, based on the occupants needs.

Resultant Design: a detached house with the ability to hold one to two families at a time.

Commentary: while the concept of a secondary suite is flexible in the long term, the house retains its exoskeleton and static volume/size, hence keeping the level of maintenance the same. Also the switch between one to two dwelling units converts it from a single family dwelling to a multi-family dwelling. This does not address the changing dynamics of a single family over time, but rather invites a second occupant within the built form in order to reduce the costs of living and maintenance through sharing. Hence the option to reduce living/maintenance costs is restricted to the addition of a second family, and cannot be achieved by retaining the dwelling as a single family unit. Furthermore, due to its conception in the 80s, the house is comprised of materials and construction techniques that have become out-dated within the current age.

3.1.3 Contemporary Flexible Concepts

Within the current, dynamic society that is in a constant state of evolution, housing should be conceived as a flexible commodity; one that can evolve with the constantly changing lifestyles of the occupants, and the social aspects surrounding them. Factors such as the value of urban space, a changing model of the family unit and the new urban dweller, must be considered in combination with considerations for the maximum utilization of available space, as well as contemporary technologies, in order to design a flexible housing typology suited to the current time.

Although flexible housing is not a new idea, the concept has adopted contemporary ideals, materials and constructions in the context of the current information/digital age. This is primarily due to the shrinking size of habitation units and a freer concept of domestic environments which respond directly to the contemporary and fast paced lifestyles of the current time. In order to allow for flexibility, a single space for a lifestyle without barriers demands a certain level of versatility. This requires the single space to convert from private to public and vice versa several times a day based on the occupants needs (Mostaedi, 2006). Unlike the CMHC model of flexible housing discussed earlier, this notion challenges flexibility at a faster pace, requiring the space to change multiple times during the day, as opposed to slowly over a lifetime. This fast pace is appropriate to the current zeitgeist of the digital/ information society surrounding us today.

How can architects design a flexible dwelling that has the ability to change with the fast paced, contemporary lifestyles of the current society, while also retaining the possibility to transform (expand or contract) over the longer lifetime of the occupants as well?

Within the context of a computerized society, some contemporary examples of flexible housing tend to resolve definite problems in innovative ways while other examples tend towards a more experimental route, taking the possibilities of a viable living space to the limit of abstracting the notion of flexible space (Mostaedi, 2006). The following examples serve as important case studies for the development of a contemporary flexible housing typology as they are embedded within the current context of the digital/information age and computerized society.

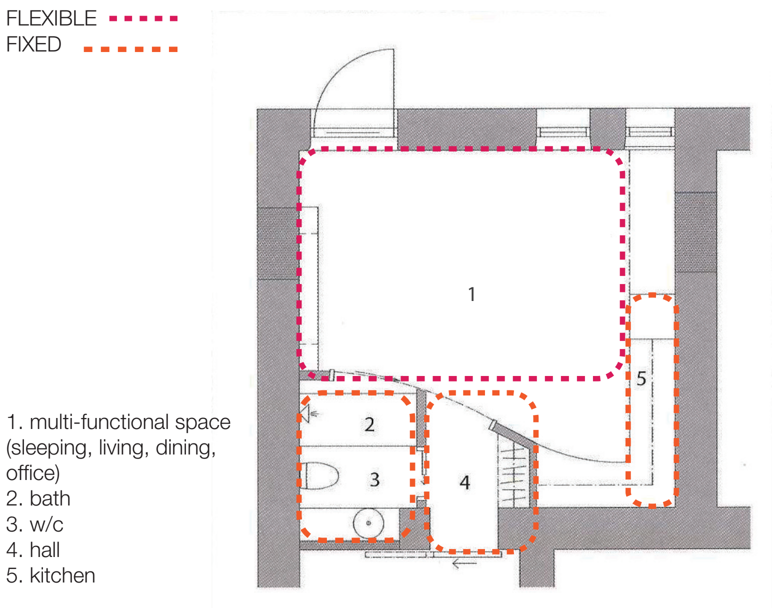


Figure 3.5
Flexible Floor Plan of the Optibo Flat
Source: Gardiner, V. (2004) Dwell Magazine

3.1.3.1 Case Study 2: Optibo Prototype Flat

Designer: White Design

Year: 2003

Location: Goteborg, Sweden

The design of this flat was conceived in response to the changing living patterns and households in the current age. With 80% of Goteborg's population living in one or two person households, the Optibo prototype explores the technical, environmental and human possibilities for future living and housing, by incorporating the functions of a 75m^2 apartment into a 25m^2 space without compromising quality. The premise of the project is to offer plenty of room in a limited space by offering a large room with multiple usage options, instead of smaller specialized subdivisions (Figure 3.5). A control panel in the lobby can be used to select a number of pre-programmed furniture configurations within the space to create distinct functions within the same space at varying times. Most of the furniture has been multi-functionally designed and

Figure 3.6
Optibo - Flexible Options
Source: Gardiner, V. (2004) Dwell Magazine

incorporated into the floor, under which there is a 60 cm space from which chairs, sofas, beds or tables emerge hydraulically to meet different user demands. The height of the table can be varied into three suitable configurations from dining to coffee to work station respectively. The functions of the space are regulated by computer technology. For instance, heating and cooling are delivered automatically through newly developed gypsum panels in the ceiling and the venetian blinds close when the "bedroom" function is activated. The space is also automatically cleaned through a robotic vacuum cleaner which comes out once all the furniture disappears. The only partition within the space is that separating the washroom behind a sliding frosted glass door. The apartment is easy and cheap to maintain, and successfully contributes to environmental concerns and the notion of future housing (Mostaedi, 2006).

Project Objectives: reducing the functions of a 75m^2 apartment into a 25m^2 spaces without compromising quality.

Description: Multi-functional space: all furniture is able to be stowed away in the walls or floors, hence clearing up the central space for flexible use (Figure 3.6). The space can be programmed as a bedroom, dining area, or living area (Figure 3.7) with the touch of a button through regulated computer

Figure 3.7
Optibo - Multiple Furniture Configurations
Source: Gardiner, V. (2004) Dwell Magazine

technology.

Resultant Design: a compact, flexible, multi-functional space. Commentary: while the space is flexible within its prescribed volume to be able to accommodate multiple functions, it is not expandable in order to meet the demands of a growing family. There is only one bedroom and so a family requiring more than one bedroom cannot be comfortably accommodated within the design. Furthermore, the space does not allow for segregation of public and private spaces, and so both types of spaces can only be accessed interchangeably and not simultaneously at the same time.

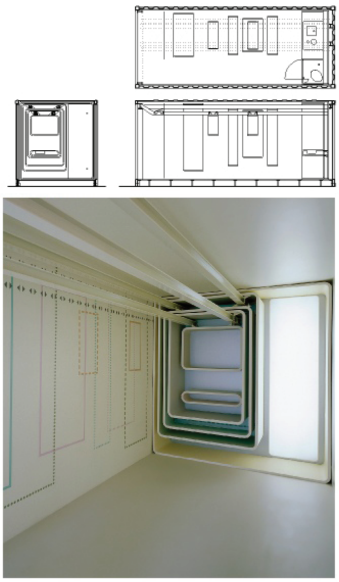


Figure 3.8
CircuitBox - Plan & Section
Source: Designboom (n.d).

3.1.3.2 Case Study 3: CircuitBox

Designer: Studio X Design Group – Lara Rettondini + Oscar Brito
Year: 2004
Location: Tokyo, Japan

As a response to the concept of freer domestic space and the shrinking size of dwelling units, Studio X Design Group conceived "CircuitBox" as the appropriate solution. This project won first prize for the "Open Living in Container" competition inaugurated by the Italian Trade Commission, in order to seek Italian presence at the Tokyo Design Week 2004. The CircuitBox consists of a series of rings of gradually decreasing size, fitted inside one another, with the largest ring anchored to a wall as it contains fixed services like the kitchen and the bathroom, and all of the other rings as well (Figure 3.8). The consecutively smaller rings are hung from a rail which allows them to slide/move along, while passing one through the other. Each ring is conceived as multifunctional furnishings (Figure 3.9) and may be equipped with a set of

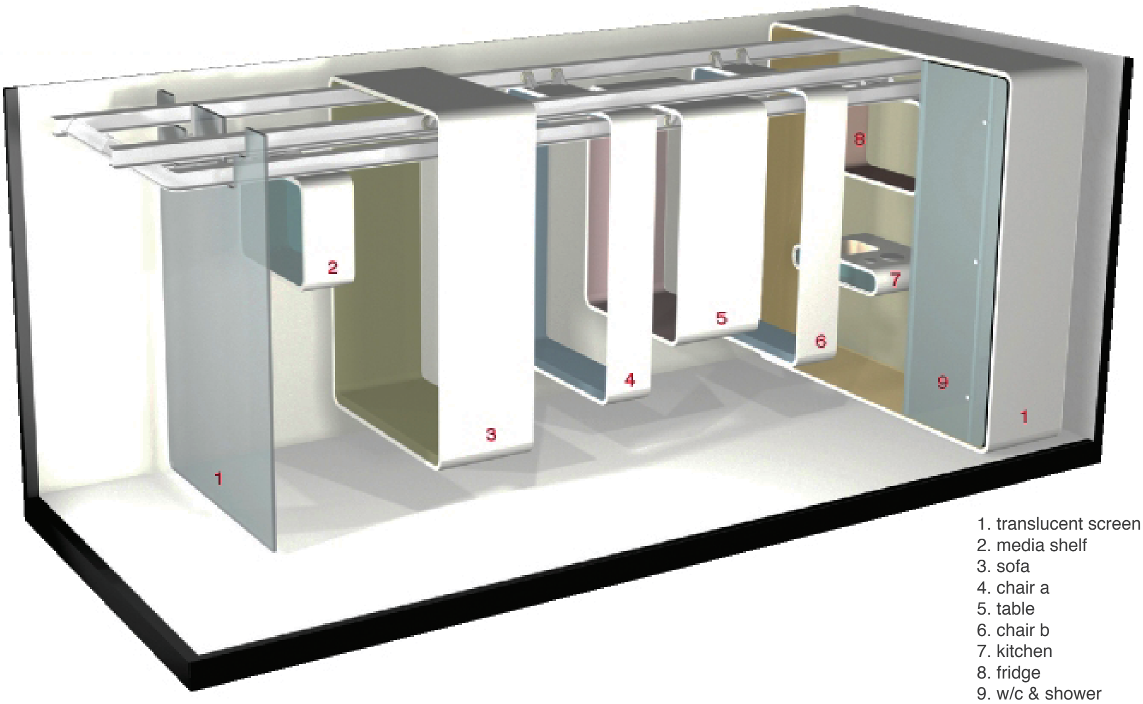


Figure 3.9
CircuitBox - Multifunctional Rings
Source: Designboom (n.d).

accessories to meet the user's needs. The rings can be pulled out in several arrangements defining the function of the room when a particular set of rings are presiding over the space. The function of the space can be transformed by extracting and arranging the rings in multiple layouts suited to various functions of a dwelling: dining room, office, bedroom, etc. (Mostaedi, 2006) (Figure 3.10).

Project Objectives: creating a flexible dwelling space within a compact area of a shipping container.

Description: Multi-functional space: the furniture is conceived as movable rings that can be contained within one another. Similar to the Optibo Prototype all furniture is able to be stowed away within a prescribed ring, hence clearing up the central space for flexible use. The space can be programmed

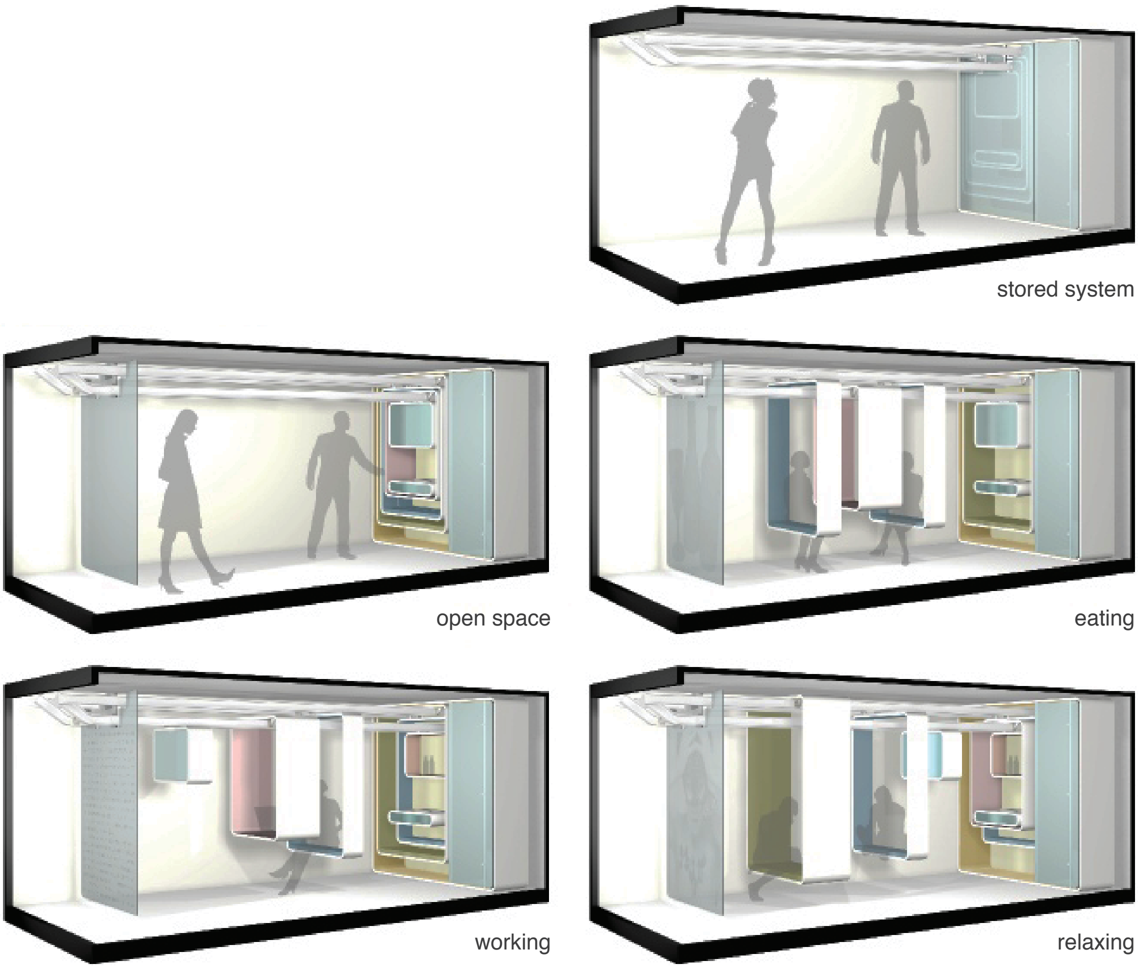


Figure 3.10
CircuitBox - Varying Spatial Configurations
Source: Designboom (n.d).

as a bedroom, dining area, or living area based on varying ring configurations that respond to different furniture layouts.

Resultant Design: a compact, flexible, multi-functional space.

Commentary: while the space is flexible within its prescribed volume to be able to accommodate multiple functions, it is not expandable in order to meet the demands of a growing family. There is only one bed and so a family requiring more than one bedroom cannot be comfortably accommodated within the design. Furthermore, the space does not allow for segregation of public and private spaces, and so both types of spaces can only be accessed interchangeably and not simultaneously at the same time. The design has potential for expansion if additional modules can be added to create expanded dwelling units in order to accommodate larger families.

3.1.3.3 Case Study 4: Modular 4

Designer: Studio 804

Year: 2007

Location: Kansas City, USA

With a total floor area of 1496 sq. ft., this single-story family dwelling with basement comprises of one to three bedrooms and two bathrooms. It contains modular furniture which gives it versatility in its organization in order to meet the different and changing needs of the occupants. The house features a flexible floor plan with the only fixated walls being those defining the bathrooms, kitchen and services core (Figure 3.11). Seven modules are offset in the middle in order to separate the public and private areas, while creating a bold four foot cantilever on either side of the house (Duran, 2009).

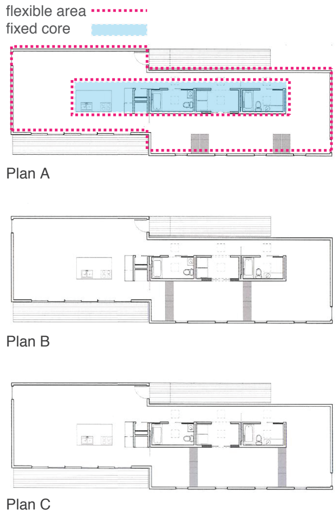


Figure 3.11
Modular 4 - Flexible Floor Plan Arrangments
Source: Duran, S. (2009)

Figure 3.12
Modular 4 - Exterior VIew
Source: Duran, S. (2009)

The house is constructed with recycled and eco-friendly materials, including reused aluminum in the foundation walls, waste from recycled timber in the concrete of the stairwells leading down to the basement, recycled steel in the outdoor decking and ash from incinerated processes with all concrete components. The exterior façade is clad in Brazilian teak wood slats, sealed with an organic polymer (Figure 3.12). Recycled aluminum panels are used for the exterior shutters. By employing EPDM roofing membrane the house is able to minimize solar gain by 50 percent. Also, the plaster used for the drywall contains 95 percent recycled paper, and the wall and ceiling insulation within the garage is comprised of cellulose fibre from old newspapers. Furthermore, part of the formwork used within the foundations was later used to construct the garage. The house also features a StabiliGid rainwater drainage system that enables water to permeate into the ground using 100 percent polythene drainage conduits. Another sustainable consideration is the layout of the openings which enhances cross ventilation. In addition the south-facing glass façade comprised of three sliding doors, optimizes passive solar gain in the winter (Duran, 2009).

Project Objectives: to create a prefabricated modular home with a flexible plan to accommodate changes in occupancy.

Description: By using prefab modular technology the house was constructed within three months. Flexibility is achieved around a fixed service, bathroom and kitchen core, with open space surrounding it. This space can be reconfigured into different rooms as per the occupant's needs and desires.
Resultant Design: modular and flexible house.

Commentary: while the house affords a flexible plan that allows for modification of the functional spaces within the interior, it does not allow for the expansion of the total area through the further addition of modules. Hence the total area is fixed within the prescribed arrangement of modules, and cannot be expanded or contracted based on the occupant's needs.

3.1.3.4 Case Study 5: System 3

Designer: Oskar Leo Kaufmann, Albert Ruff

Year: 2008

Location: MoMA, The Museum of Modern Art, New York, USA

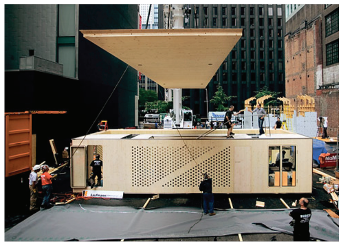
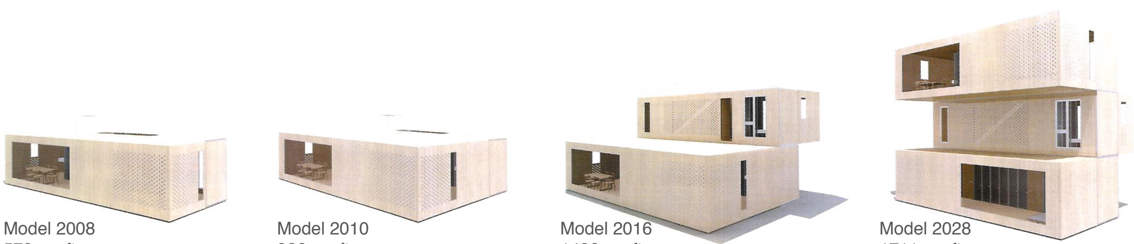


Figure 3.13
System 3 - Assembly
Source: Duran, S. (2009)

At the 2008 MoMa exhibition, “Home Delivery: fabricating the modern dwelling”, System3 was unveiled by an Austrian architecture studio as an ideal prototype for a transportable, expandable and long-lasting dwelling. The concept of the house is based on two types of spaces within a dwelling: “serving space” and “naked space”. The “serving space” is a complete prefabricated module that includes the central stairwell, kitchen, bathroom and electrical and climate control systems; while the “naked space” comprises of the floors, walls, windows and roof enclosing the living areas of the dwelling. Both spaces are the same size and are placed adjacent to one another in one lateral. Even with equal proportions both volumes comprise of different structural functions. The basic module that contains a one bedroom unit has a total floor area of 570 square feet and the parts fit perfectly into a shipping container (Figure 3.13). The dwelling is expandable through the addition of similar modules that can be organized in a flexible manner to meet the occupant’s needs (Duran, 2009).

Figure 3.14
System 3 - Arrangment Diagrams
Source: Duran, S. (2009)



Model 2008
570 sq. ft.
living area, bedroom, kitchen, bath + roof deck

Model 2010
926 sq. ft.
expanded living area, bedroom, kitchen, bath + roof deck

Model 2016
1496 sq. ft.
expanded living area, kitchen, bath for guests, master bedroom with bath, roofed front yard and car port + two roof decks

Model 2028
1711 sq. ft.
living area, kitchen, bath for guests, master bedroom with bath, studio with bath and kitchen on third floor, roofed front yard and car port + three roof decks

Project Objectives: a prefabricated dwelling comprised of a set of modules used to create an almost infinite variety of spatial configurations (Figure 3.14).

Description:
A system similar to that of Lego blocks is employed within the concept of this project, which allows for the creation of multiple modular configurations of a dwelling based on the occupant's needs and desires. Modules can be added or removed above and beside the original module in order to expand or contract the total area of the dwelling.
Resultant Design: prefabricated, modular, and flexible dwelling.

Commentary: all the modules comprise of the exact same dimensional configurations, hence creating a very uniform appearance among the varying modular arrangements. This creates a very consistent appearance lacking individuality across varying dwelling configurations as the same module is repeated multiple times to create the expanded dwellings.

3.2 Compact Housing: Rethinking the Small House in Light of Sustainability

The typical single family, suburban home was conceived as a response to a particular need, unique to the post-war housing boom, and the parallel consumer society. As the urban population increased, the demand for housing also grew exponentially, while undeveloped land within urban centres remained unavailable. This continuous demand for housing, along with the popularization of the automobile, led to the eventual development of the suburbs, where land was available in vast quantities. Although the suburban, single family dwelling was well suited for households and families at that time, there is no reason to believe that it has the versatility to adapt to different circumstances. For example, this typology is ill suited to smaller and more heterogeneous households including lone-parent families, or seniors living without their children, etc. (Rybczynski, 1991).

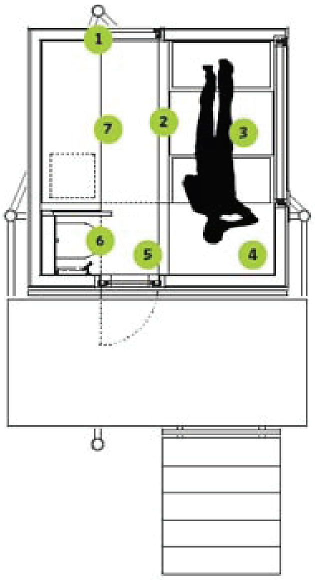
Apart from the concept of excessive space, the post-war, suburban houses also required a lot of maintenance. In the post-war consumer society of that time, it was understood that the female parent was the "home-maker", and hence involved with domestic chores and home maintenance. However, as women began to enter the workforce, there was little time and energy available for home maintenance. (Rybczynski, 1991).

The single-family, suburban house is also criticized for its size as after the energy crises, it was identified as one of the largest consumers of energy. Since that time a growing understanding of sustainable development has evolved, although sustainable neighbourhoods have not evolved at the same pace as the theoretical concept of sustainability. Needless to say that a community of sprawling houses on large lots resulted in increased dependence on the automobile. Community amenities such as schools, libraries, etc. were more spaced out, and to reach them required not only automobiles but also time. As family structures evolved and women entered the work force, there was little time to do daily activities after work (Rybczynski, 1991). Today, our lives have become intertwined in time and space, as rapid communications and networks have resulted in efficient lifestyles.

In order to maintain these efficient lifestyles, we must consider developing much more compact dwellings that are capable of distributing domestic activities homogeneously in time, thus avoiding the generation of another parallel space specifically for another use. Other advantages of a compact dwelling include the provision of pedestrian scaled neighbourhoods, which may reduce, though not eliminate, dependence on the automobile. This is not only sustainably responsible in the sense that it reduces CO_2 emissions through reduced dependence on the automobile, but it may also increase social cohesion within communities, as neighbours will be in closer proximity to one another. A compact home will also consume less energy than the post-war suburban giant. Smaller houses are cheaper to heat and cool and easier and less time consuming to maintain (Rybczynski, 1991). Overall, a compact home will not only make a significant sustainable impact, but also have a significant impact on the lifestyles of contemporary households.

While there are plenty of small dwellings world-wide, they are often characterised as high-density typologies such as apartment buildings, and condo towers. Although these dwellings are effective in producing dense and compact living arrangements, they do not provide land ownership, which is an important asset of the single-family dwelling; it represents monetary wealth in the form of land ownership.

The following case studies provide insights on how architects can design a compact single family dwelling that provides easy access to a variety of activities that are homogeneous in time, without compromising land ownership and equity?



1. Fire alarm and smoke detectors
2.Sliding table that seats up to five people
3. Two 7.5-foot-long Double Beds (a bunk above the dining table and a slide-out at floor level)
4. Shelves and drawers for storing clothes, bedding, cleaning supplies and, equipment, etc.
5. Control panel operates all electrical systems: heating, air-conditioning, TV, CD player, and LED lighting
6. Bathroom with a sliding screen that separates the toilet and the shower, plus a drying area for clothes and shoes
7. Kitchen equipped with a microwave, fridge, sink, waste unit, and double-level work surface.

Figure 3.15
Micro Compact Home Plan
Source: Micro compact home. (n.d.).

3.2.1 Case Study 6: Micro Compact Home – O2 Village

Designer: Horden, Cherry, Lee Architects – Lydia Haack + John Hopfner Architekten

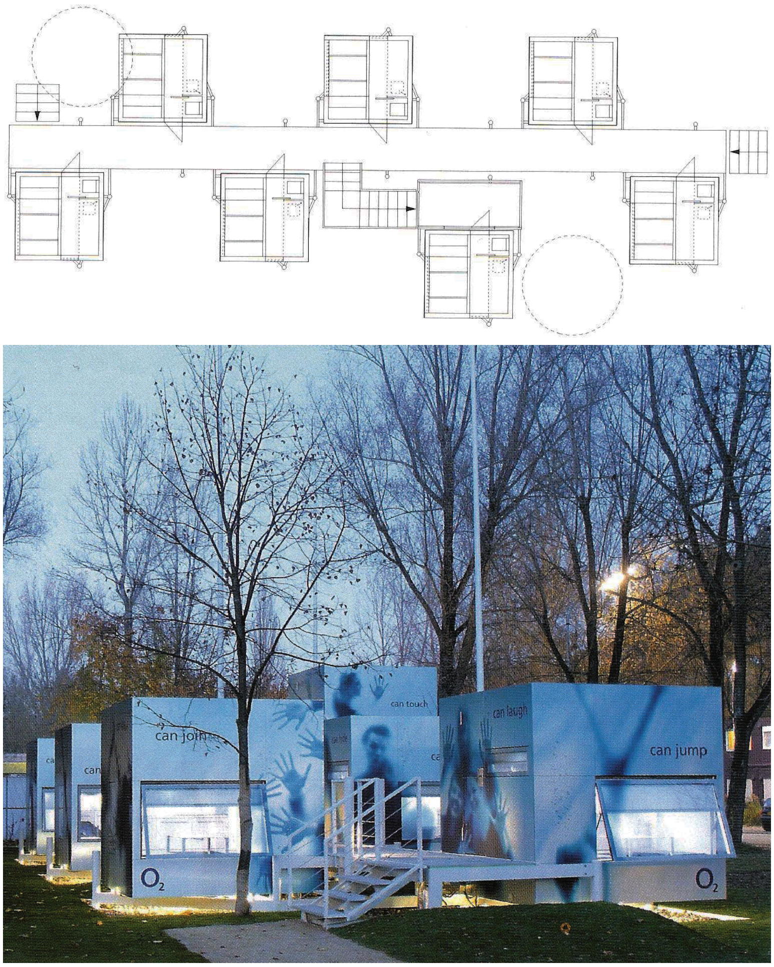
Year: 2005

Location: Munich, Germany

Taking inspiration from compact first-class airplane cabins, and the scale and order of a Japanese tea house, this compact and lightweight structure is transportable and expandable beyond its unit size of 2.6m x 2.6m. It is also a cheap solution to housing as it costs about 50 Euros. Within its cubic dimensions it offers areas for working, dining for four, cooking, washing and sleeping in a double bed above (Mostaedi, 2006) (Figure 3.15). In section the cube is divided into 1.5 levels, with the lower level comprising of living/dining spaces and the upper half level occupied by the sleeping space (Figure 3.16). In plan the cube is subdivided into three zones, kitchen, living/dining, and a circulation corridor that provides access to all the spaces on both levels.

Figure 3.16
Micro Compact Home Interior Functions
Source: Micro compact home. (n.d.).

Figure 3.17
Micro Compact Home Estate
Source: Micro compact home. (n.d.).



The kitchen bar serves both levels and the corridor in the centre serves as a triple lobby space functioning as bathroom and drying area for clothing as well. Storage and basic modern facilities including energy outlets, water, etc. are all provided for within the thermally insulated modules. The modular concept of minimized living units and urban alternatives enables the temporary use of land and spaces of different characteristics. The modules can also be combined to create a small estate, which can gradually be completed with social spaces and other functions at a later time (Figure 3.17). The

modules are prefabricated and delivered to site by private car or a transport vehicle. The living space of the specified size is easily assembled on site within a short period of time. This prototype is available through Micro compact home Ltd. in Austria, and can be delivered throughout Europe with project individual graphics and interior finishes (Mostaedi, 2006).
Project Objectives: to create a compact living environment that is lightweight, easily transportable and expandable for future use.

Figure 3.18
Micro Compact Home - Interior Space
Source: Micro compact home. (n.d.).

Description: Multi-functional space: The five primary areas of a home (sleeping, living, dining, cooking, and washing) are instilled into a compact cubic form (Figure 3.18).

Resultant Design: a compact, multi-functional space.

Commentary: although this project is successful in combining the various functions of a home within a small footprint, similar to the Optibo Prototype flat by White Design the module cannot expand to meet the demands of a growing family within itself. Although the option of combining modules to provide for expansion is possible, there is no real connection designed between modules, in order to give them the character of a complete dwelling unit. Furthermore, the interior design of each module is so fixated that it tends to create a colony of dwellings when combined with other modules as opposed to creating an expanded dwelling unit for growing families.

3.3 Sustainable Considerations

In a society that is increasingly becoming aware of the need for sustainable design, compact and flexible homes are an efficient means to lower the impact on our environment. Designers and builders can make an enormous positive impact on the planet through the choices made in their work by evaluating the environmental costs, not just monetary costs, which would be incurred through their decisions (Kaufmann and Remick, 2009). As more and more companies are introducing “green” and “sustainable” products, architects should propose a sustainable living environment within the physical form and components of a house.

According to Kauffman and Remik the following smart design elements are excellent ways to ensure that a space is created using minimal resources (Kaufmann and Remick, 2009, p.37):

1. Design to Use Less: “The most sustainable material is the one we don’t use.” Designing small, compact spaces relies on fewer building materials, and hence reduces the amount of natural resources that go into the construction and maintenance of a house.

2. Design Big, Don’t Build Big: designing efficient and flexible spaces that maximize the utility of the room can reduce the impact that a structure has on the environment. Between 1950 and 2004, the average American living space tripled from an average of 290 square feet per person to about 900 square feet per person. A house that was considered sufficiently spaced in the 1950s is now only a third of the size of our current homes. By replacing the notion of “bigger is better” with “better is better” we can reduce the impact that larger footprints can have on the environment by promoting smaller and more compact dwellings. Smaller dwellings provide for a more comfortable living environment proportionate to the human scale. Aside from properly scaled living spaces, compact homes are also more energy efficient as they cost less to heat and cool (Kaufmann and Remick, 2009).

Smart design strategies can make a smaller space feel bigger in several ways. By bringing the outdoors inside the home with elements such as glass doors and connecting gardens, courtyards and decks, the sense of space outside a house can extend into the surrounding environment. Another technique is by employing high ceilings and creating taller spaces which are helpful during the warmer months as hot air can rise up and out of the living space below (Kaufmann and Remick, 2009).

3. Design for Dual Function: “Make one thing serve the purpose of two and you eliminate the need for the second.” (Kaufmann and Remick, 2009, p.38). By creating a flexible plan and multi-purpose rooms, the functions of a house can be compacted into a smaller space.

4. Design for Longevity: “here today, gone tomorrow” is a common phenomenon with many consumer goods. This wasteful concept should not be considered for housing, as homes should be designed for longevity. One way in which this can be accomplished is by using low-maintenance, long-lasting materials such as metal and stone as opposed to exteriors such as painted sidings or wood that require a certain degree of upkeep over their lifetime, which is not only expensive and time consuming but also consumes natural resources (Kaufmann and Remick, 2009). Another way to design for longevity is by creating a flexible plan that can change overtime to accommodate the user’s needs.

5. Design for Flexibility: Flexibility is a critical component of a home if it is to adapt to the changing needs of a family overtime. An adaptable home that meets the future needs of the occupants can be programmed with multi-use spaces that possess a certain amount of fluidity to flow from one intended use to another. As the family requirements and lifestyles evolve, an adaptable home with multiuse open spaces and sliding walls can also increase the longevity of the house (Kaufmann and Remick, 2009).

4.0

FLEXIBLE DESIGN STRATEGIES

The three categories mentioned in the previous section (flexible housing, compact housing, and sustainable housing), are all interrelated in multiple ways. For instance many flexible homes are also compact, which in turn makes them sustainable as well. Therefore, strategies for flexible design often suggest compact arrangements as an efficient and sustainable solution for a new housing typology for the 21st century.

Flexibility in design can be achieved prior to occupation as well as post-occupation. The most effective design is one that allows for flexibility during both phases. Flexible housing design considered prior to occupation allows future residents to provide input towards the layout and/or appearance of their house. Therefore, the use of non-loadbearing internal partitions might provide a variety of possible layouts that can be adjusted by future tenants based on individual needs and desires. Post-occupation flexibility reflects the ability of the design and construction of the housing to allow for future adaptations over time. In general pre-occupation flexibility strategies also enable post-occupation flexibility, and vice-versa. However, certain strategies are more effective during one phase rather than the other in terms of both cost and benefit. This section will explore several flexible design strategies that have been previously utilized in past precedents, and evaluate them through a cost-benefit analysis (Schneider et al., 2007).
Within their research on Flexible Housing, Schneider and Till (2007) indicate several design strategies and precedents of flexible housing. For the purpose of this thesis, only the strategies that can inform flexible design within detached dwellings will be scrutinized. Similarly, the precedents that have explored flexible design in single-family, detached or small dwelling units, or those with strategies that can be applied

to such units will be presented within the following section. These precedents have also been arranged in chronological order in the timeline presented within Appendix 1.2.

The following flexible design strategies have been formerly applied within built, and in some cases theoretical, projects in the past. For the investigation of this thesis, their formal, functional and technological applications and strategies within the selected precedents will be scrutinized through the lens of contemporary times and society in order to propose a new transformable housing typology for the 21st century. The twenty four categories have been appropriately catalogued into three broader classifications: Flexible Arrangement and Layout, Flexible Construction Methods and Flexible Services.

i) Flexible Arrangement and Layout Strategies: This category refers to the core issue of use, while also dealing with specific principles in terms of designing the plan of a flexible dwelling. The strategies listed within this category reflect the ability of the house to adapt to other uses, while having the capacity to transform between uses on a day-to-day activity basis, as well as over the course of a lifetime.

ii) Flexible Construction Strategies: The flexible design strategies listed within this category are inherent within the methods by which the dwelling is constructed. In order to achieve the highest degree of flexibility both a flexible arrangement/layout as well as a flexible construction system must be intrinsic to the design of the house. Typically the standard construction within the building industry is inherently inflexible with cavity walls, loadbearing internal partitions, roofs full of trussed rafters, buried services, etc.

These reduce the potential for future changes. However, the development of modern methods of construction has allotted an opportunity to reconsider the way in which housing can be built in a flexible manner without a significant increase in cost.

iii) Flexible Services: Services are often the most permanent and hidden elements of a house. Typically they are designed without a view to future upgrading, alteration or addition. This is largely due to the fact that they are placed out of sight, which makes it difficult to suggest how they might be changed in the future as access to them is often extremely limited. Several flexible housing precedents deal with this issue by grouping services within service cores or areas that are designed to be easily accessible without interrupting the surrounding flexible space. The strategies listed within this category are often found within such precedents.

4.1 Flexible Arrangement and Layout

1. Horizontal Additions

Refer to precedents 14, 16, 34, and 62 in Appendix 1.2

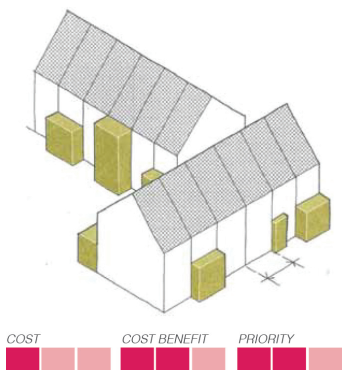


Figure 4.0
Horizontal Additions
Source: Schneider et al. (2007)

The ability to expand is a key characteristic of flexible housing design, particularly for houses as opposed to apartment buildings, etc. The potential for additions should be tested at the design stage in order to allow for the anticipation of future extensions while minimizing limitations within the initial plan (Figure 4.0). Due to the infinite variety of site layouts, it is difficult to prescribe the manner in which to design buildings, in order to allow additions to be made easily. However the following criteria should be considered (Schneider et al., 2007):

i) Access: future additions should be accessible through existing circulation space. If this is not the case, and access is through an existing room, the use of that room becomes limited.

ii) Light: potential additions should not cause loss of light to existing windows. This is typically a problem within complex plans, for example filling in the space in an L-shaped plan is probably going to block some light. Furthermore, wide frontage housing is often more accepting of additions as opposed to narrow frontage.

iii) Structure/Construction: Lintels and frame openings should be considered where future additions are anticipated.

iv) Services: servicing for future additions must be considered without huge disruptions within the existing composition.

2. Vertical Additions

Refer to precedents 05, 24, and 63 in Appendix 1.2

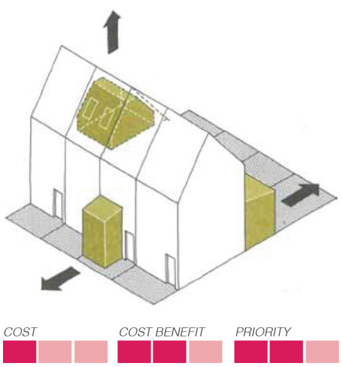


Figure 4.1
Vertical Additions
Source: Schneider et al. (2007)

Similar to horizontal expansion, vertical expansion can also accommodate future extensions (Figure 4.1). This concept effectively exploits the future potential of space that one has to build anyway. The following criteria should be considered (Schneider et al., 2007):

i) The location and form of the staircase in plan should be carefully considered for easy extension into the new accommodation.

ii) Flat roofs within existing structures allow for easy vertical expansion by typically adding another storey to the existing condition. However, this has structural and planning implications that should be carefully thought out.

3. Slack Space

Refer to precedents 21, 31 and 60 in Appendix 1.2

Slack space refers to excess space surrounding the house that can be appropriated by the occupants' overtime, providing more flexibility in use (Figure 4.2). This space is typically situated outside the housing units in areas which are suggestive of potential occupation such as flat roofs that can be built upon, courtyards that can be occupied and even filled in, a communal stairwell that is large enough to accommodate occupation by its users, an alcove for enclosing storage, etc. Although initially slack space is left unfinished, its success depends largely upon the proper consideration of its design based on how it may be appropriated in the future (Schneider et al., 2007).

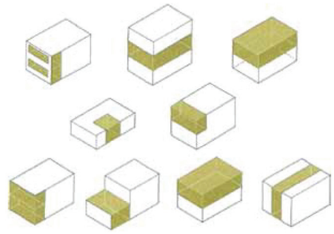


Figure 4.2
Slack Space
Source: Schneider et al. (2007)

4. Functionally Neutral Rooms

Refer to precedents 02 and 52 in Appendix 1.2

Due to the demands of the various design standards as well as perceived client demands, it is typical in housing for rooms to be labelled and then designed appropriate to the functions that they withhold. Such planning is referred to as tight fit functionalism (Figure 4.3), and it often leads to plan forms that prescribe the location and potential for activities within the dwelling. Flexibility within the functional uses of a dwelling can be achieved by omitting such room labels. This approach has a long and successful history. The strategy involves the

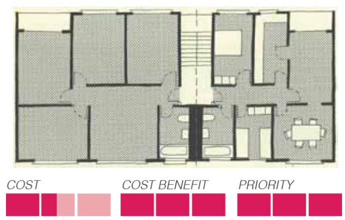


Figure 4.3
Functionally Neutral Rooms
Indeterminate uses (left) versus tight-fit functionalism (right)
Source: Schneider et al. (2007)

provision of a number of equally sized rooms off a central hall or circulation spine (Figure 4.3). By doing so, different social interpretations that are open to diverse cultural scenarios are made possible within the dwelling (Schneider et al., 2007).

By removing the hierarchical order contained in the labelling of rooms – i.e. dining room, living room, master bed-room, bedroom - each space becomes an independent entity which can be used according to the needs of the users, which inevitably change over time (Schneider et al., 2007). According to Schneider and Till (2007, p.186):

> "Another advantage to this approach is that the unit can be occupied by a variety of different user groups. For example, a small family may occupy it as a two bedroom and a living room unit, or it can also be utilized as a shared apartment for 3 adults. Functionally neutral rooms can be sized based on various furniture layouts. Ideally they should measure 3.6m wide by 4.0m deep, in order to accommodate a variety of furniture and functions".

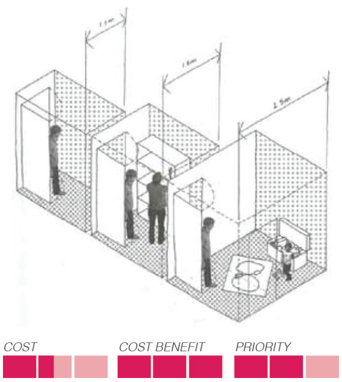


Figure 4.4
Circulation Space Usage
Source: Schneider et al. (2007)

5. Circulation

Refer to precedents 45 and 64 in Appendix 1.2

Typically circulation space within dwellings is reduced to an absolute minimum in order to maximize occupy-able space for other functions of the home. However, in poorly designed housing this can add up to a large amount, and becomes largely redundant in terms of social occupation. Flexibility within the design of a dwelling can be easily achieved simply by allotting a dual purpose to circulation spaces. For example, if a circulation area is marginally increased it can accommodate other functions as well (Figure 4.4), hence increasing the ways that the overall unit might be used (Schneider et al., 2007). According to Schneider and Till (2007), a corridor with a width of up to 1.60m can provide space for a cupboard, the storage of a bike or a pram. Slightly wider still and the corridor effectively becomes an extra room with space for a desk for home working or for use as a children's play area. Although at first glance this excess space may appear wasteful in plan, in actuality it provides a much greater variety of use in the unit as a whole with a slight increase in the overall area.

6. Joining

Refer to precedents 25, 47 and 68 in Appendix 1.2

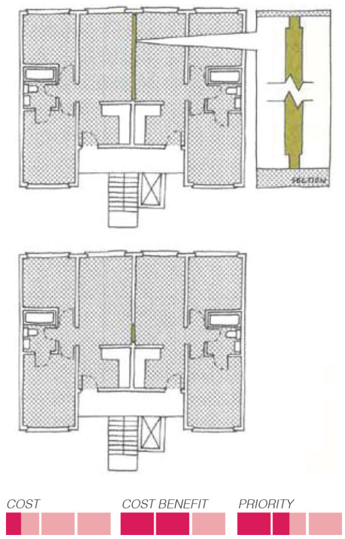


Figure 4.5
Joining Units - Removable Walls
Source: Schneider et al. (2007)

Individual housing units are typically designed and considered in isolation from the one another, hence precluding the potential for a combination of units in a convenient or efficient manner. Several schemes in the past have played with the notion of joining units together either horizontally or vertically in order to allow for flexible usage overtime, based on occupant needs. For example, two one-bedroom apartments can be joined together to form a three-bedroom apartment, allowing a family to stay in place as it grows over time. The potential for the expansion of units also addresses the demands of extended families that arise in several ethnic and social contexts. Furthermore, within the social sector this long term opportunity also provides a variety of rental opportunities (Schneider et al., 2007).

The following should be considered when designing for flexibility with regards to the joining of units (Schneider et al., 2007):

i) When considering a horizontal connection between two units, any future openings should be carefully designed and lintels and framing should also be provided for ease of opening up in the future (Figure 4.5).

ii) One problem with the combination of two units into a larger unit is the duplication of bathrooms and kitchens. While adding more bathrooms may not be considered as large of an issue, duplication of kitchens is less sensible. Therefore, the use of the room with the kitchen removed should be considered at the onset of design, in order to avoid awkward or under-utilized excess space.

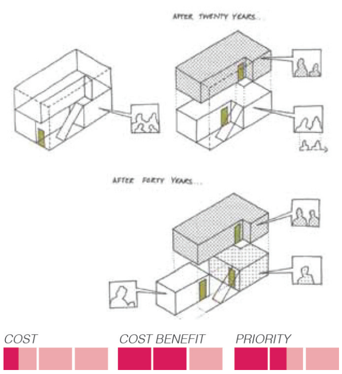


Figure 4.6
Joining and Dividing Units
Source: Schneider et al. (2007)

7. Dividing Up

Refer to precedents 04, 23, 43, 46, 47, 51, 54 and 68 in Appendix 1.2

In contrast to the preceding strategy, dividing up refers to the design of a single large unit that has the potential to be divided up at a later time (Figure 4.6). This allows the occupants to stay in the same house even once they have outgrown it (Schneider et al., 2007). This strategy can be achieved in two ways (Schneider et al., 2007):

i) A large unit can be designed in a manner that allows for its division into two self-contained units. This usually demands consideration for a second entrance at the onset of the initial design.

ii) A large unit can provide for a variety of small separate areas to be used by the same family or extended family (i.e. a granny flat, home-office, etc.). In such cases a separate entrance may not be required.

8. Shared Room

Refer to precedent 50 in Appendix 1.2

A shared room is one that is situated between two units and can be allocated to either one or the other (Figure 4.7). This idea was originally initiated by the German concept of Schaltzimmer which translates to 'switch rooms'. Within a typical arrangement of two basic one-bedroom apartments, the shared room allows for the possibility for one of the apartments to gain an extra bedroom or workroom, and then give it over to the other when it is no longer required by the occupants. Although this strategy curtails obvious management implications, the shared room option allows for a certain level of flexibility over time, whilst also potentially allowing tenants to stay in an apartment of the size and rent that suits them (Schneider et al., 2007).

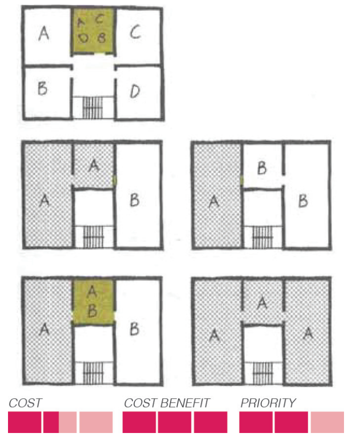


Figure 4.7
Shared Room Diagrams
Source: Schneider et al. (2007)

9. Service Core

Refer to precedents 59 and 61 in Appendix 1.2

One way to organize flexibility within plan is to allot all the permanent elements of a dwelling (typically the kitchen and bathroom) to a specified location, while freeing the rest of the space from any fixed services or plumbing (Figure 4.8). This is often achieved through the provision of a service core, the design of which is critical in determining the flexibility of a unit. Flexibility can be achieved by drawing the plan empty of anything but the service core. However, based on the

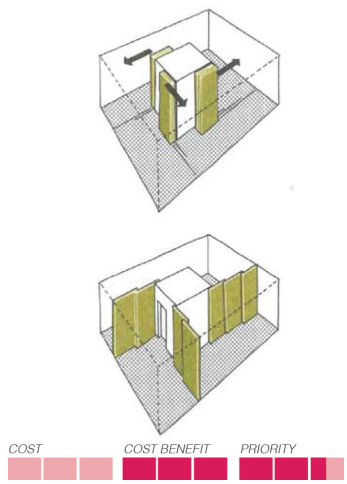


Figure 4.8
Service Core
Source: Schneider et al. (2007)

location of the core, it is important to consider the different ways of achieving the division of the surrounding space in order to effectively support the activities of a dwelling. Hence careful consideration must be assumed during the design and situation of the core in plan (Schneider et al., 2007).

10. Raw Space

Refer to precedent 58 in Appendix 1.2

Raw space refers to the provision of excess unfinished space which can be appropriated based on the user's needs. This principle has been used in past examples of flexible housing in the form of the loft space or the speculative office, which allows the tenants to appropriate an empty space with basic services based on their specific needs. Flexibility through this approach is achieved in a manner such that anything that is placed within the basic shell should be adaptable or movable. In order to provide a wide range of potential layouts, the planning of services and the entrance should be carefully considered. One drawback to this approach is that within the directly rented sector, tenants would not get a return on any investment they made in fitting out or adapting their unit (Schneider et al., 2007).

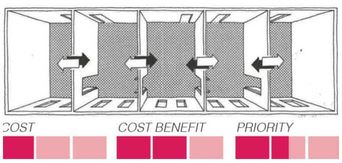


Figure 4.9
Enfilade System
Source: Schneider et al. (2007)

11. Connections between Rooms

Refer to precedents 01 and 56 in Appendix 1.2

Typically in housing rooms for distinct functions are often separated. The idea of creating connections between rooms falls within the traditional 'Enfilade' system, in which a series of adjacent rooms can be connected through sliding wall panels or doors (Figure 4.9). This connection can be temporary, lasting over the course of a daily cycle, or permanent, allowing users to connect rooms with one another to expand the potential of their function. This strategy can also allow for an increase in the perceptual size of a dwelling with tight spatial conditions by opening the rooms up to one another. This can be particularly useful in one-bedroom apartments where privacy between the living room and the bedroom is not necessary at all times; hence a sliding door between the two can open up the space (Schneider et al., 2007).

12. Foldable Furniture

Refer to precedents 09, 55 and 57 in Appendix 1.2

Foldable furniture is an effective strategy for compact units with little space to accommodate distinct rooms for varying functions. Built-in and foldable furniture can allow the user to change the use of a room, where space is limited, on a daily basis. For example, a foldaway bed can be stored away during the day in order to allow for the space to be used for another function rather than a bedroom (Figure 4.10). It is important however to consider the design of foldable furniture in a manner that allows for its effective integration within the fabric of the unit, so that it does not appear as an afterthought (Schneider et al., 2007).

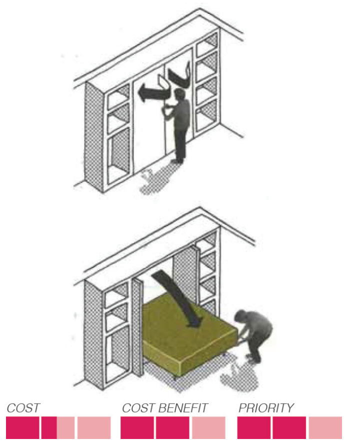


Figure 4.10
Foldable Bed Strategy
Source: Schneider et al. (2007)

13. Moveable and Sliding Walls

Refer to precedents 06, 09, 17, 22, 36, 61 and 66 in Appendix 1.2

Moveable and sliding walls are a common feature within architect-designed flexible housing in the twentieth century. This strategy can be applied in a variety of ways from solutions in which all walls can be slid or folded away to

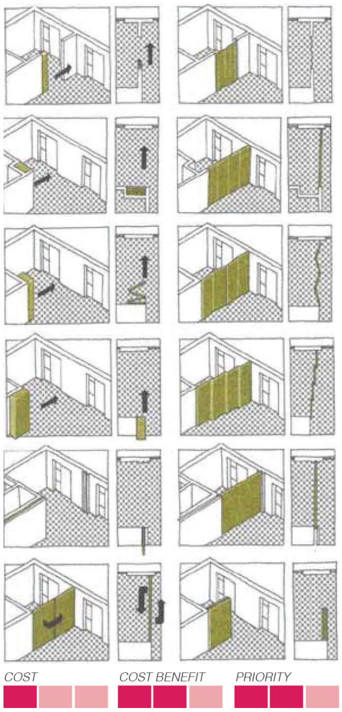


Figure 4.11
Sliding Wall Arrangements
Source: Schneider et al. (2007)

provide a completely open plan to solutions in which folding walls are used to divide two distinct rooms in order to suggest connections between rooms (as discussed in strategy 11 above) (Figure 4.11). According to Schneider and Till (2007), a good approach to the design of sliding walls is to ensure that the basic layout of the housing first works without the inclusion of sliding walls, and then to add them in. This ensures that the sliding walls add something to the spatial quality and usage of the dwelling.

14. The Divisible Room

Refer to precedents 10 and 11 in Appendix 1.2

Divisible rooms refer to the ability of a large room to be split into two or more areas, allowing for the capacity to withhold more than one distinct activity simultaneously within a space. For example a large bedroom may be temporarily divided in order to provide a space for working and sleeping respectively. The following criteria must be considered when designing divisible rooms (Schneider et al., 2007):

i) As a general rule divisible rooms should have a proportion closer to 2:1 than 1:1.

ii) If the division is predicted to be permanent, then the original room must have two points of access.

iii) The number and location of windows should be carefully considered in divisible rooms to allow for ample light in both divided areas.

4.2 Flexible Construction Strategies

15. The Frame

Refer to precedent 13 in Appendix 1.2

The concept of the frame allows for flexibility by allowing a variety of infill and layouts within. By providing a background frame architects can set a suggestive grid for the housing infill units to lay within based on occupant needs. One example is the bottle-rack system developed by Le Corbusier (Figure 4.12). The frame should be separate from the infill of partitions, services and fittings in both construction and concept, in order to allow for it to be changed itself at a later date as well (Schneider et al., 2007). According to Schneider and Till (2007, p.192):

> "The frame does not over-determine what goes into it, but provides a support structure, and a skeleton for services to be attached to. The frame is conceived as permanent, whilst the infill elements have different and shorter life spans, and can be adapted over time or parts replaced wholesale."

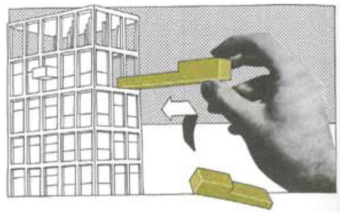


Figure 4.12
Bottle-Rack Infill System Developed by Le Corbusier
Source: Schneider et al. (2007)

16. Layers

Refer to precedents 03, 41 and 42 in Appendix 1.2

By considering the elements of construction as separate elements, architects can acknowledge different life spans and degrees of adaptability for each element respectively. This is highly effective since different building elements inevitably have different lifespans due to their construction or use. Hence, by separating these elements in a manner that

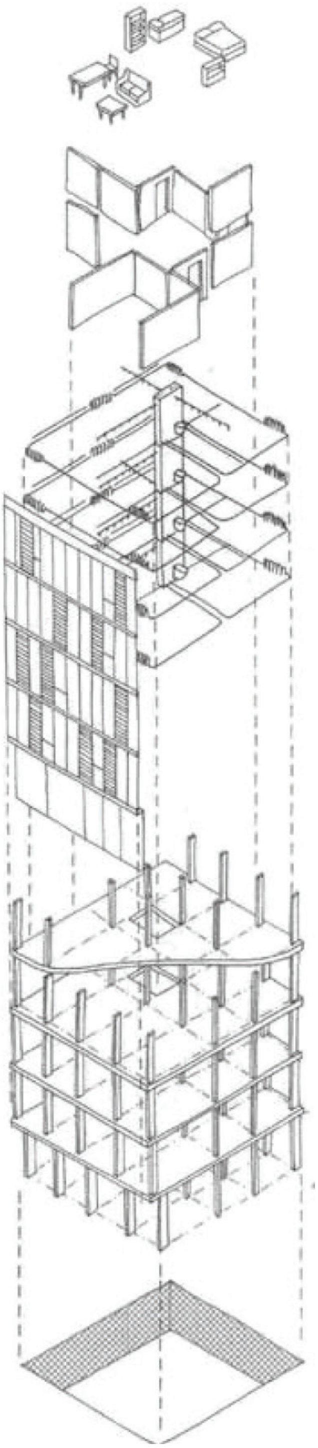


Figure 4.13
Layers
Source: Schneider et al. (2007)

allows for one layer of the system to be adapted or exchanged without affecting the others offers a high degree of flexibility in construction. This strategy also proposes that the user can and should be more involved in decisions as one moves down through the layers of a dwelling; hence leading to a wider, social vision of flexibility. However, it is often easy to become obsessed by the idea of layers and to create a complex system for such a simple principle (Schneider et al., 2007).

One approach to layers was developed by Stuart Brand, who classified six layers and called them the six S's (Figure 4.13) (Schneider et al., 2007, p.193):

Layer 1: The site which is always there

Layer 2: The structure which is the most durable part of the building (life span > 100 years)

Layer 3: The skin which is a less permanent envelope (lifespan = 30 – 60 years)

Layer 4: The services which refer to the wiring and piping (essential parts will need to be maintained and changed as new technologies emerge)

Layer 5: The space-plan, which refers to the internal partitions (lifespan = 5 – 30 years)

Layer 6: The stuff, which refers to the interior fit-out and the finishes

17. Simplicity and Legibility

Refer to precedents 12, 18, 30, 48 and 65 in Appendix 1.2

By adopting a simple and legible construction system, potential for future adaptation can be increased. The load-bearing elements should be easily identifiable in contrast to non-load bearing elements. This is often not the case as even within built examples of flexible housing technical over complication has led to difficulties amongst new generations of users to distinguish between the fixed and flexible elements, hence leading to failure in flexible design (Schneider et al., 2007).

18. Clear Spans

Refer to precedents 15, 19, 33 and 44 in Appendix 1.2

Internal flexibility within a plan can be easily achieved through the provision of clear spans across the width of the unit. This concept allows for non-loadbearing internal partitions, facilitating future internal re-modelling (Figure 4.14). Even though clear spans are easily achievable through modern technical advances they are rarely implemented within the construction and design of housing, particularly in low-rise terraced housing (Schneider et al., 2007).

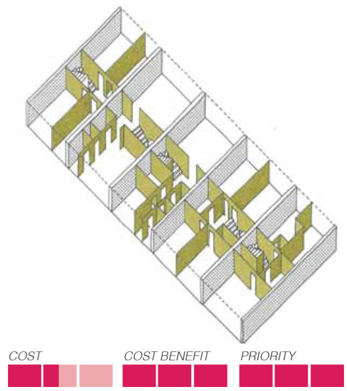


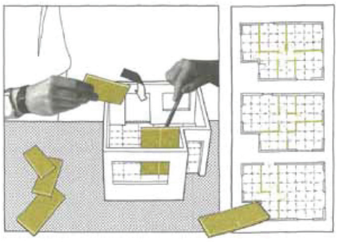
Figure 4.14
Clear Spans
Source: Schneider et al. (2007)

19. Partitions

Refer to precedents 40 and 54 in Appendix 1.2

Using non-loadbearing partition walls that can be moved to vary room sizes, affords a high degree of flexibility within the interior space plan of a dwelling (Figure 4.15) (Schneider et al., 2007).

According to Schneider and Till (2007) in order to design partitions as a means for flexibility the following criteria



COST COST BENEFIT PRIORITY

Figure 4.15
Interior Partitions
Source: Schneider et al. (2007)

should be considered:

i) Partition walls should not contain any electrical or plumbing services.

ii) Modular wall elements can be highly flexible as they provide a kit of parts for the various elements of a wall (i.e. doors, wall panels, framed openings, etc.) that can be easily and flexibly deployed.

iii) The wall and floor finishes past or under any removable partitions should be continuous.

20. Roof Construction

Refer to precedent 24 in Appendix 1.2

COST COST BENEFIT PRIORITY

Dwellings with flat roofs are more flexible than dwellings with pitched roofs, as the flat roof allows for the potential vertical expansion of the dwelling (refer to strategy no. 2 above). However, both the roof and foundations must be sized appropriately in order to allow for additional loads (Schneider et al., 2007).

21. Over-Capacity

Refer to precedents 31 and 35 in Appendix 1.2

COST COST BENEFIT PRIORITY

In order to accommodate for future construction, certain elements within the dwelling should be designed to withhold over-capacity at a later time. Hence, certain structural elements should be over-sized in order to accommodate future dead and live loads (i.e. over-sizing foundations and vertical supports in order to allow for a potential vertical expansion). This may involve upfront investment that should be balanced against the long-term potential benefits of such a concept (Schneider et al., 2007).

4.3 Flexible Services

22. Vertical Distribution

Refer to precedents 38, 41, 49 and 67 in Appendix 1.2

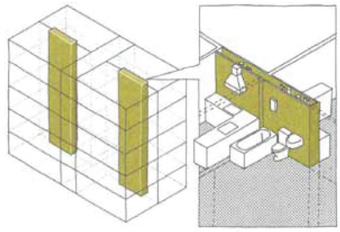


Figure 4.16
Vertical Service Distribution
Source: Schneider et al. (2007)

Services are often the most fixed elements of a house. By collecting them in vertical stacks or risers, access to them for future maintenance and upgrading can be simplified (Figure 4.16). Furthermore, through careful positioning of the service core, the distribution of the main serviced rooms around it can be allotted in a highly flexible manner. Access to the service core should be made apparent and easy in order to allow for maintenance as well as upgrading, for the potential accommodated of future technology. Since the future technology cannot be anticipated, excess space should be provided around the service core, which can be used as storage when not taken up by services (Schneider et al., 2007).

23. Horizontal Distribution

Refer to precedents 38 and 67 in Appendix 1.2

Similar to vertical service distribution, horizontal services should also be easily accessible, maintainable and exchangeable. Also, in order to avoid inflexibility, pipes and wiring should not be fixed to internal non-loadbearing partition walls. According to Schneider and Till (Schneider et al., 2007) there are several ways in which to avoid the burial of pipes and wires within horizontal service runs in housing

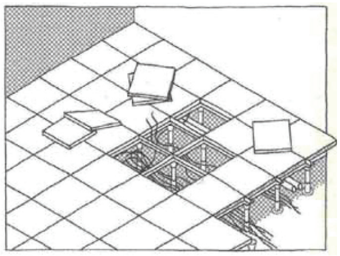


Figure 4.17
Horizontal Service Distribution
Source: Schneider et al. (2007)

construction:

i) Surface mounting, although sometimes not acceptable for aesthetic reasons, is the most obvious solution. The development of slim-line dado and skirting access systems has made surface wiring systems more reasonable in terms of cost and aesthetics.

ii) The employment of a raised floor or ceiling within which installations are led is another, although a more expensive, solution (Figure 4.17).

24. Lifetime Considerations
Refer to precedents 47 and 53 in Appendix 1.2

Services should be designed in an accessible manner for a wide range of people. In order to guarantee the usage of the unit by anyone, the height of switches, sockets, ventilation and service controls should be carefully designed. The typical height ranges from a minimum of 0.45m up to approximately 1.20m from the floor (Schneider et al., 2007).

4.4 Flexibility through Transformability

The design proposed within this thesis deals with flexibility through transformability. Transformation is directly associated with time, as it occurs over time. The flexible strategies mentioned within section 4.0 illustrate ways in which to create flexible spaces. This thesis relies on flexible strategies to create transformable spaces that can adapt to the users requirements over time. Hence, this thesis proposes a time-based design, which evaluates transformation through the lens of typologies.

FLEXIBLE:

Flexible: Flex + able

Flex: a combining form representing flexible in compound words: flextime.

"-able": a suffix meaning "capable of, susceptible of, fit for, tending to, given to,"

Flexible: susceptible of modification or adaptation; adaptable.

TRANSFORMABLE:

Transformable: Transform + able

Transform: to change in form, nature, appearance or character.

"-able": a suffix meaning "capable of, susceptible of, fit for, tending to, given to,"

Transformable: to change in condition, nature, or character; convert

Definitions derivied from Oxford English Dictionaries Online

5.0

DESIGN PROPOSAL

5.1 A New Typology for the 21st Century: Compact, Flexible & Sustainable

Subsequent to the research and analysis conducted earlier, this thesis seeks to create a transformable housing typology for the 21st century, which is compact, flexible and sustainable; one that is able to transform and adapt to the changes in family dynamics and the corresponding spatial requirements that come about in time (Figure 5.0). According to Guallart (2004, p.25):

> "The information society is more closely linked to time than space, as its networks produce systems that are discontinuous in space but continuous in time. The most consistent systems are those capable of distributing their activities homogeneously in time, thus avoiding the generation of another parallel space…specifically for one concrete use."

In a time where change and transformation are omnipresent and highly influential, how can architects design a new housing typology, which can respond to change through its ability to formally transform, in order to meet the demands of the changing dynamics of society? Can transformation become a new typology on its own? Can we design habitats that respond directly to the changing culture of society, by transforming into the appropriate space which support the changing occupants, activities, and functions of a home?

The following questions were addressed within the design of this project:

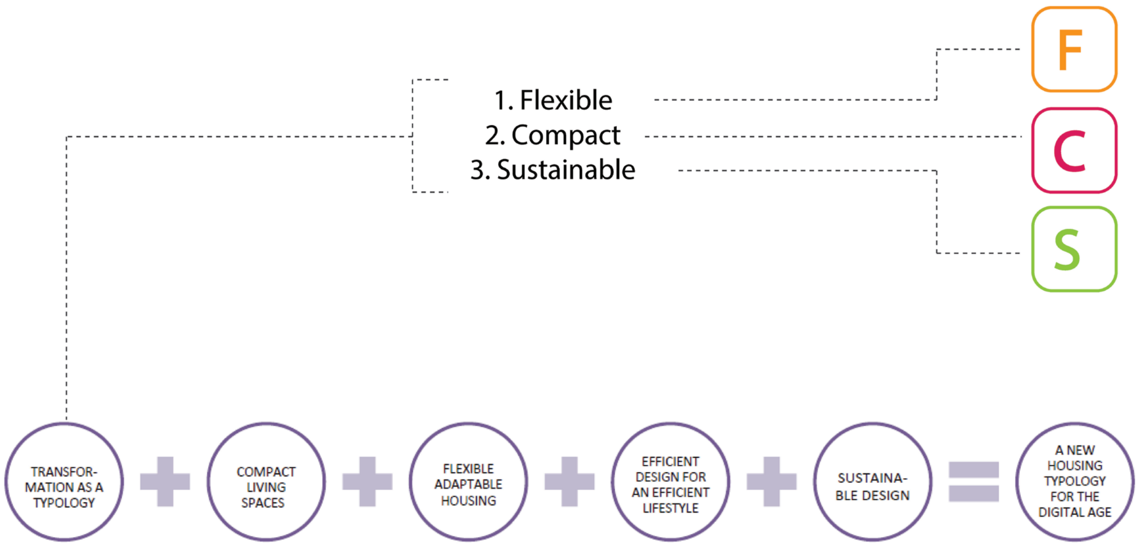


Figure 5.0
Strategy for a New Transformable Housing Typology
Source: self-derived

1. Amidst the rapidly changing culture of our society, how do we integrate new functions into the home, in order to create a flexible habitat?

2. Using modern technologies, how can we design an architecture that is able to formally transform itself to suit the spatial needs of its occupants?

The response to these questions is reflected within section 5.4.

5.2 Situating the Transformable Housing Typology

It is important to consider certain implications of the transformable housing typology that this thesis seeks to propose, in order to situate it within the built fabric of the contemporary city. The basic implication of a transformable house is that it eliminates the need to move from one house to the other, as family needs and circumstances evolve and produce new requirements that are not fulfilled architecturally within the original (un-transformable/fixed) dwelling.

This idea obligates the occupant within the same location, neighbourhood/community for a longer period of time than typically experienced. Hence it is not the most appropriate option for individuals, and in some cases families, who are constantly switching their place of residence due to personal choice (i.e. travelling, etc.), unstable job markets, or other socio-economic factors that demand an itinerant lifestyle. On the opposite end of the spectrum however, there is a significant population that places a lot of importance on neighbourhood bonds and community connections/relationships, as well as an attachment to their place and dwelling of residence for long periods of time. These people are often challenged with the problems related to the unchanging nature of typical housing, as they have to mostly rely on expensive renovations in order to transform their residence to suit their changing needs.

This thesis provides a cost effective solution to the afore-mentioned issues of fixed, unchangeable dwellings, by proposing a transformable housing typology that enables occupants to expand and contract based on their changing lifestyle requirements, economic means and personal preference. Since this new housing typology is specifically targeted towards occupants who wish to establish a longer attachment to their communities, it is important to situate this typology within an area accepting of this notion. Hence, it does not make too much sense to situate this type within a high-density downtown core. However, due to its contemporary aesthetic and compact and prefabricated concept, it should also not be placed within rural communities with vast areas of land available for construction. Therefore, in order to test this typology within an urban environment with suburban characteristics, this thesis will be situated in the community of Don Mills in Toronto.

5.3 Don Mills: The Experimental Suburb

Don Mills was considered to be the most influential development in Canada during the twentieth century. In some ways it became the epitome of post-war suburban development, and contemporary residential neighbourhoods. The plan comprises five basic principles: neighbourhoods, a discontinuous road system, a profusion of green space, new house forms and new lot configurations, and a separation of uses and activities (Sewell, 1993). The use of the neighbourhood unit as a key component of residential planning was fist established by Clarence Perry in his work for the Regional Plan of New York in 1929, and later expanded within his 1939 book, Housing for the Machine Age. The importance of neighbourhoods is best explained by the American developer, William Rouse as stated in The Shape of the City (Sewell, 1993, p.84):

> “The fact is that the city is out of scale with the human being. It is beyond his scope and capacity. It is unmanageable. It is only in an abstract way that the human individual can feel a part of his city. We must make the city consist of communities which are in human scale – communities which the individual can feel part of and for the life of which he can feel a sense of participation and responsibility. This means a city of neighbourhoods.”

Don Mills is an appropriate location to test a transformable housing typology for many reasons. Firstly, due to its historic significance as a testing ground for new house forms, as well as its renowned recognition as the experimental suburb. Secondly, the suburb comprises numerous single-family houses that have persisted since the post-war era, and are still present within the community. Demographically, it can be noted that much of the population residing within these dwellings has lived in Don Mills for a long period of time. This is also apparent due to the constant expansions and renovations of post-war houses that are so frequently found across the community (Figure 5.1). It is therefore accurate to conclude that a majority of the occupants residing in Don Mills have an attachment to the community and neighbourhoods within. Hence, a new, transformable housing typology should fit appropriately within the community of Don Mills.

Example of changes to homes in Don Mills over time, in order to accomodate changing user requirements/preferences

1. Original CMHC design

2. Same design flipped, with additional changes to original (car port area has been included within floor plan to accomodate an interior functional space)

Figure 5.1
Housing in Don Mills
Source: google images

5.4 The Transformable Dwelling

According to Won (2006, p.008) "static architectural spatial methods are becoming increasingly outmoded to meet the dynamically evolving activities" of our time. In order to respond to this dilemma, this thesis proposes a time-based design that reflects flexibility not be creating flexible spaces, but rather by exploring the flexible uses of a space over time. The proposed dwelling is able to transform to meet the daily spatial needs of the occupants, by allowing activities to occur homogeneously in time as well as having the capacity to accommodate long-term transformations that may come about across the occupant's lifetime (Figure 5.2). Therefore, in order to respond to the daily activity requirements, the design proposal includes moveable activity modules that can provide for a range of flexible layouts and arrangements of activity zones throughout the day, as well as a flexible envelope that

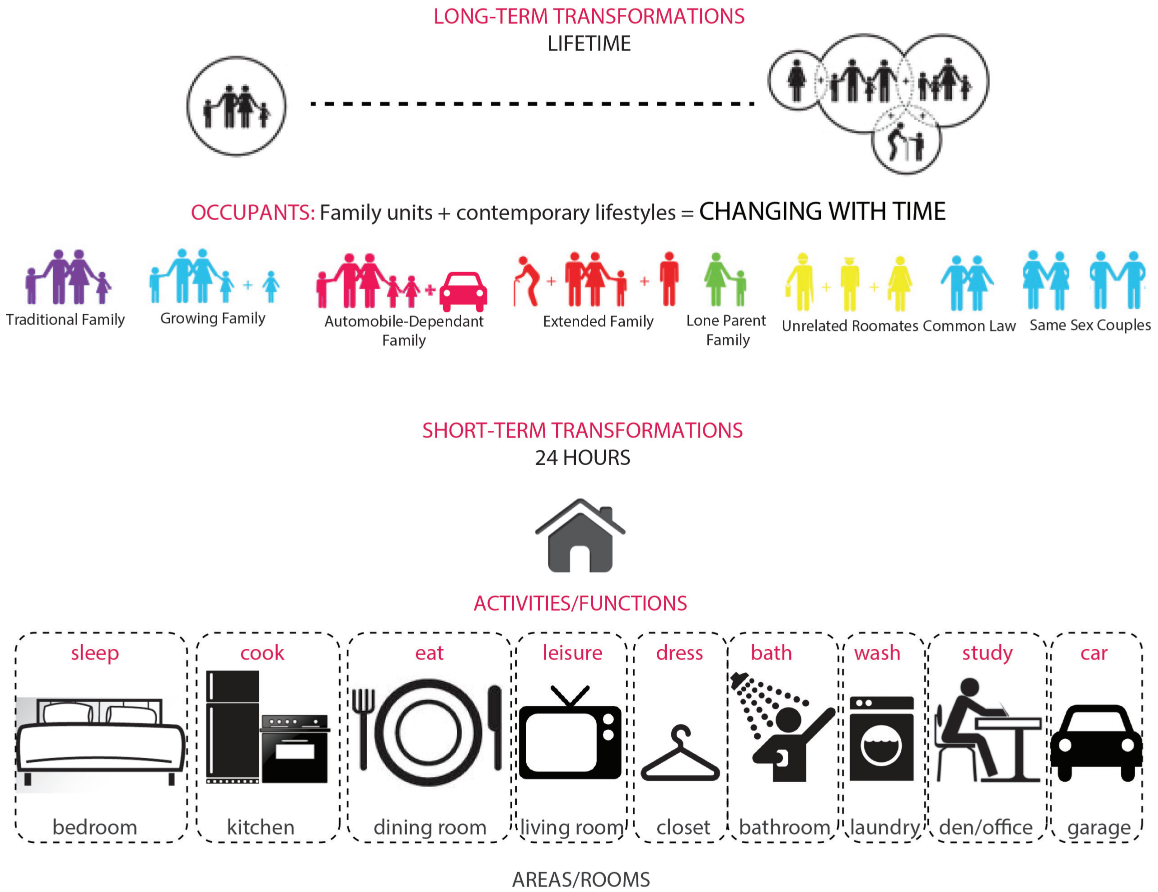


Figure 5.2
Time-based Design
Source: self-derived

has the capacity to expand and contract, in order to support the occupant's requirements across a lifetime.

5.4.1 Activity Modules

According to the research carried out by MIT, the activities in a house respond more to the furniture, objects, fixtures and equipment than to the predetermined space itself (Won, 2006).

> "The physically fixed architectural structures have become to experience many limitations in accommodating the activities' continuous fluidity

> more than the actual program. Generally, it is now very common for the structure to remain unaltered while the content changes." (Won, 2006, p.010).

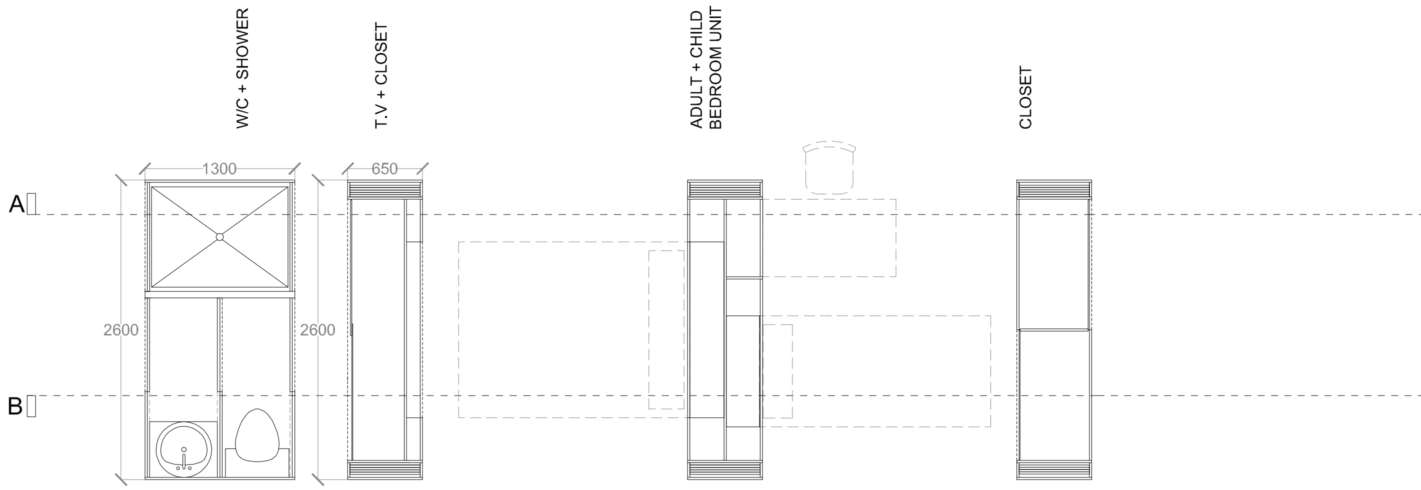
In order to design a flexible dwelling, the various activity spaces of a typical house are compacted into "activity modules", which are equipped with wheels that enable them to move along the X and Y axis of a gridded track.

> "The 'activity' meaning mainly physical movement, is differentiated from the more broad term of 'program'. The 'program' in the field of architectural planning consists of the function, necessary spaces, client's instructions and symbols." (Won, 2006, p.010).

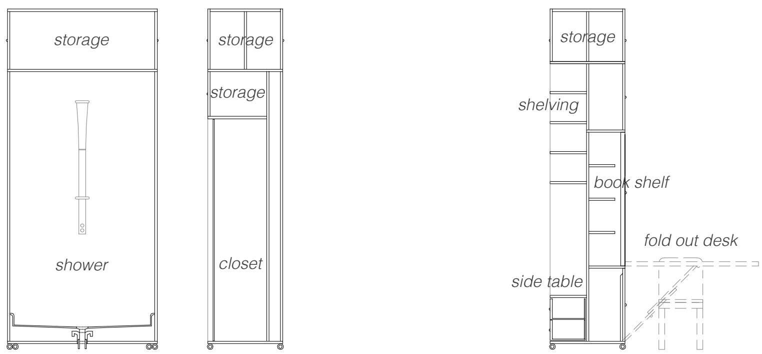
These modules contain fold out furniture elements pertaining to their respective activity, as well as storage capacity to withhold additional equipment and objects (Figures 5.3 and 5.4). In effect the modules also act as moveable partitions dividing up activity areas within the flexible space, hence allowing for two or more activities to occur simultaneously in time. The idea is that the modules can be arranged based on the activities occurring within the dwelling at a given time, in order to afford space to accommodate the occupied activity areas while storing away unused furniture and equipment. For example, during the night when all occupants are sleeping, the living room and dining room are unoccupied, hence they can be stored away and the space can be used primarily as bedrooms. The core of the activity spaces "is in the analysis of the actual activities and movements in a given program and not in the preconceived notion of a 'room', 'living room', 'dining room' which traditionally fixed the forms and methods" (Won, 2006, p.011). This notion supports the statements below:

Transformation as a Type

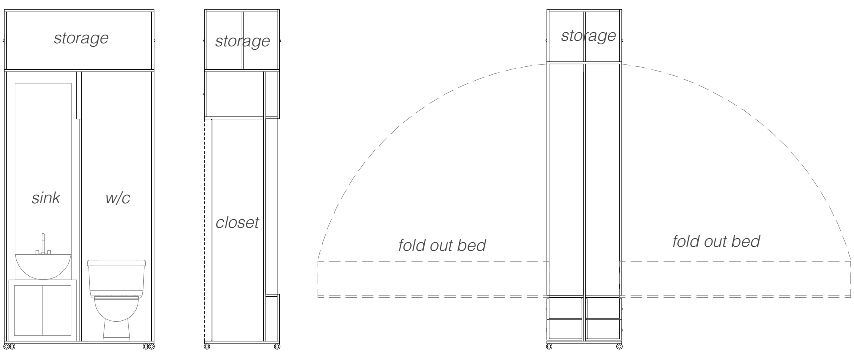
ACTIVITY MODULES PLANS



SECTION A-A



SECTION B-B



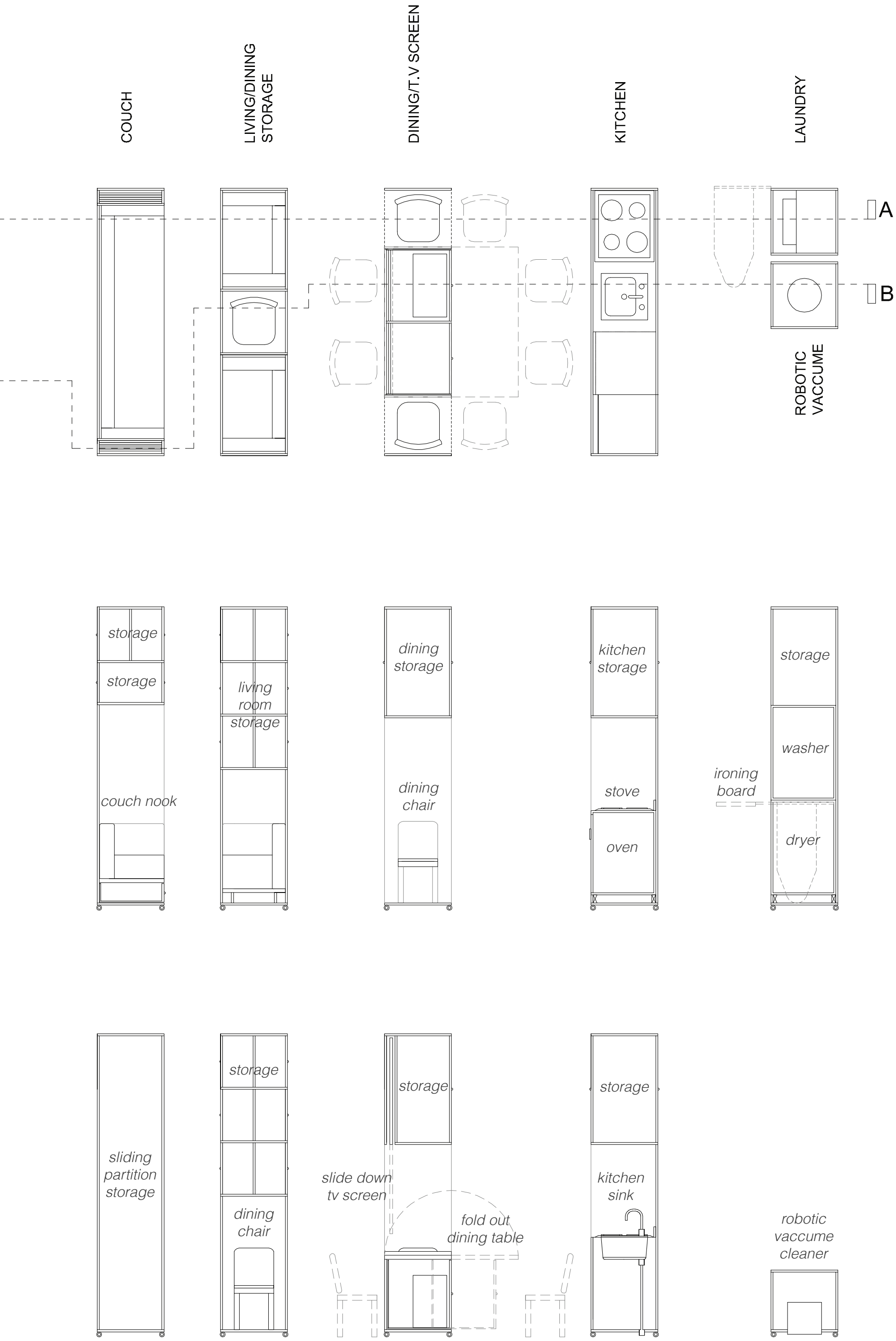
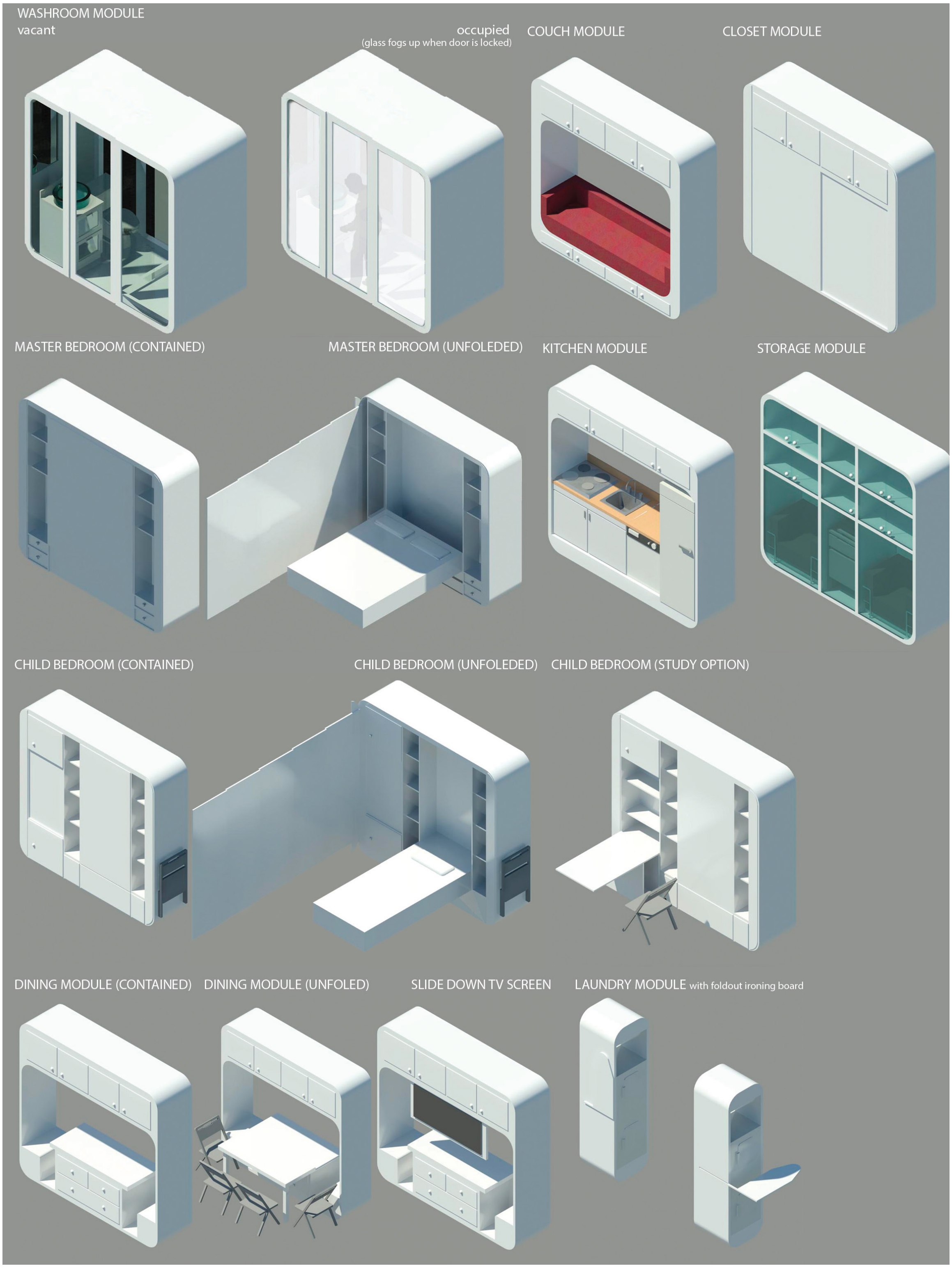


Figure 5.3
Moveable Activity Modules
Source: self-derived

Figure 5.4
Moveable Activity Module Renderings
Source: self-derived



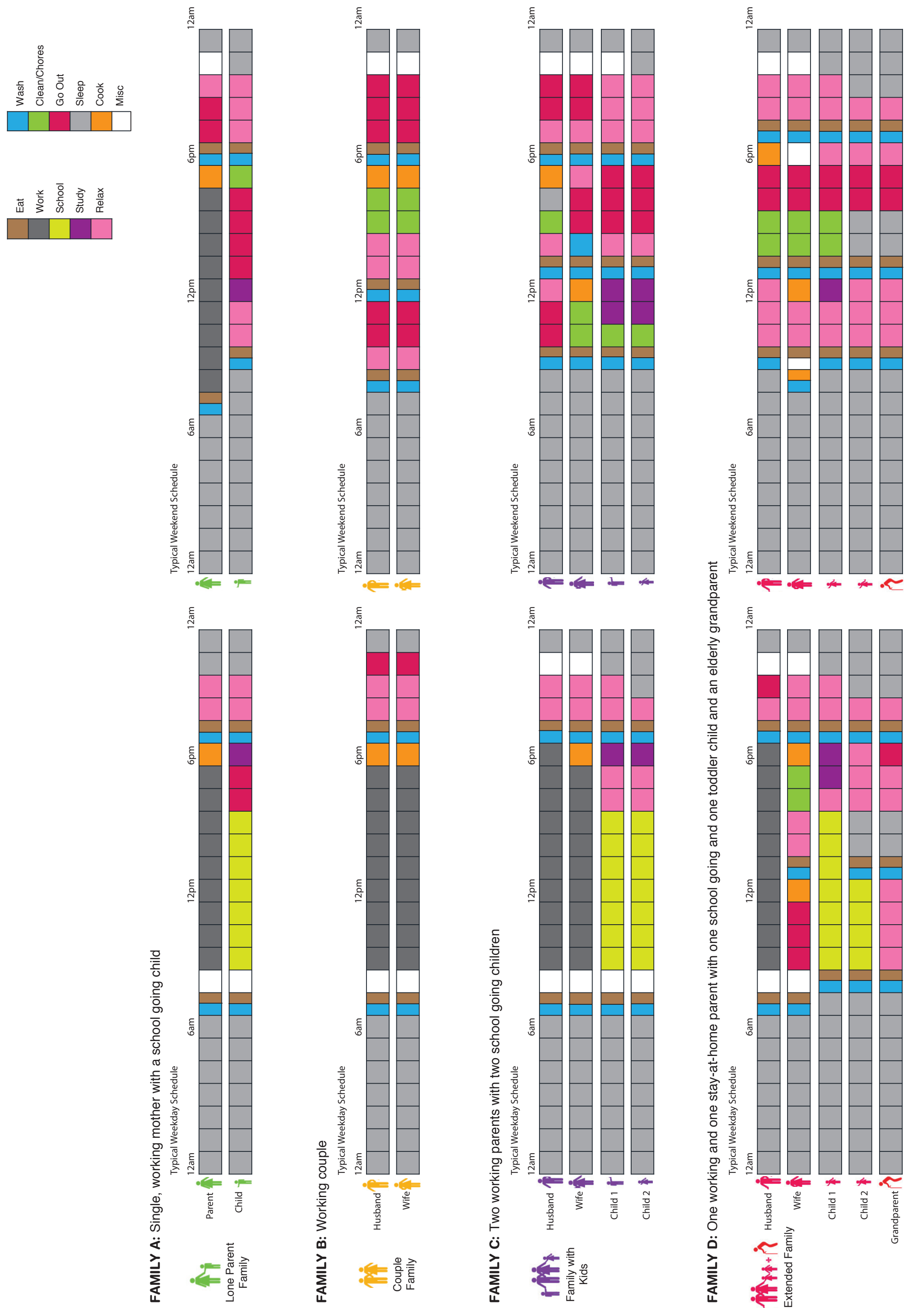
> "The most consistent systems are those capable of distributing their activities homogeneously in
> time, thus avoiding the generation of another parallel space…specifically for one concrete use." (Guallart, 2004, p.25).

> "Activities occur organically across different time zones and spaces. The one to one association between a specific space and a specific activity is now deconstructed, blurring the boundary of existing singular programs." (Won, 2006, p.009)

Hence, the given program no longer responds to a fixed predetermined singular function but rather to continuous changes that come about in time. The dwelling can be configured to a multitude of arrangements based on the major activity occurring at a specific time.

The "activity modules" can be moved with the simple touch of a button. Contemporary technology and sensor systems enable the safe movement of the modules in order to ensure that their movement does not interrupt an ongoing activity or any occupants present at that time. The main control panel can be programmed such that the modules can prearrange themselves into a given configuration at precise moments in time, based on the typical schedule of each occupant within the house (Figures 5.5). For example, when it is bedtime, the bedrooms can automatically open up, while other unused spaces (such as the dining room and living room) can be stored away.

Figure 5.5
Typical Activity Schedules
Source: self-derived

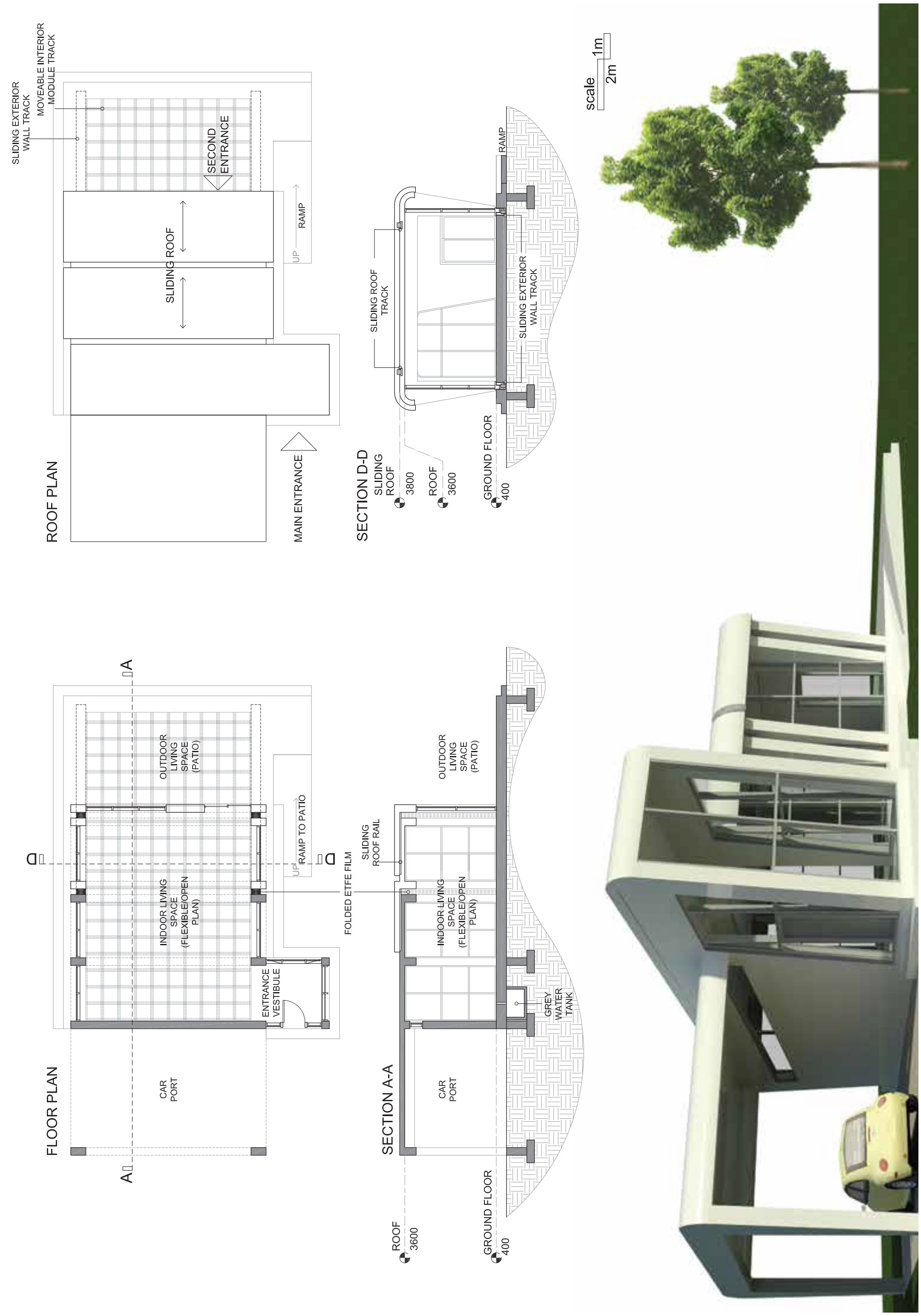


5.4.2 Lifecycle Transformations

While the "activity modules" manipulate the internal program and spaces of the dwelling based on the daily routine of the occupants, the envelope of the dwelling also affords a certain degree of flexibility in order to expand and contract the interior in response to changes in family dynamics across the lifecycle of the occupant family. For example, the house has the capacity to expand and afford a larger floor area in order to accommodate new family members (i.e. children, extended family, etc.) The dwelling can transform from a one-bedroom unit to a four-bedroom unit for larger families (Figures 5.6, 5.7 & 5.8).

The expansion of the envelope is achieved through the use of sliding wall panels that move on tracks along the floor. The envelope has glazed solid panels to allow for daylight, along with inflatable ETFE folding membrane panels that can be compressed when folded or expanded when unfolded in order to increase the area of the interior space. The membrane has the capacity to be inflated with air in order to achieve insulation. When the requirement for more space is present, the house will expand and compromise some of the outdoor patio space in exchange for additional interior space (Figure 5.9).

In combination, both the flexible envelope and the moveable "activity modules" allow for a flexible dwelling that can reconfigure its space to suit both the day-to-day as well as the lifetime requirements of their occupants over time. These transformations have been illustrated in Figures 5.10, 5.11, 5.12, 5.13, and 5.14.



One-Two Bedrooms
area: 60sq.m.

FIXED (static elements)
FLEXIBLE (moveable elements)

Figure 5.6
Three Stages of Lifecycle Transformations: Stage 1
Source: self-derived

Up to Three Bedrooms
area: 72sq.m.

FIXED (static elements)
FLEXIBLE (moveable elements)

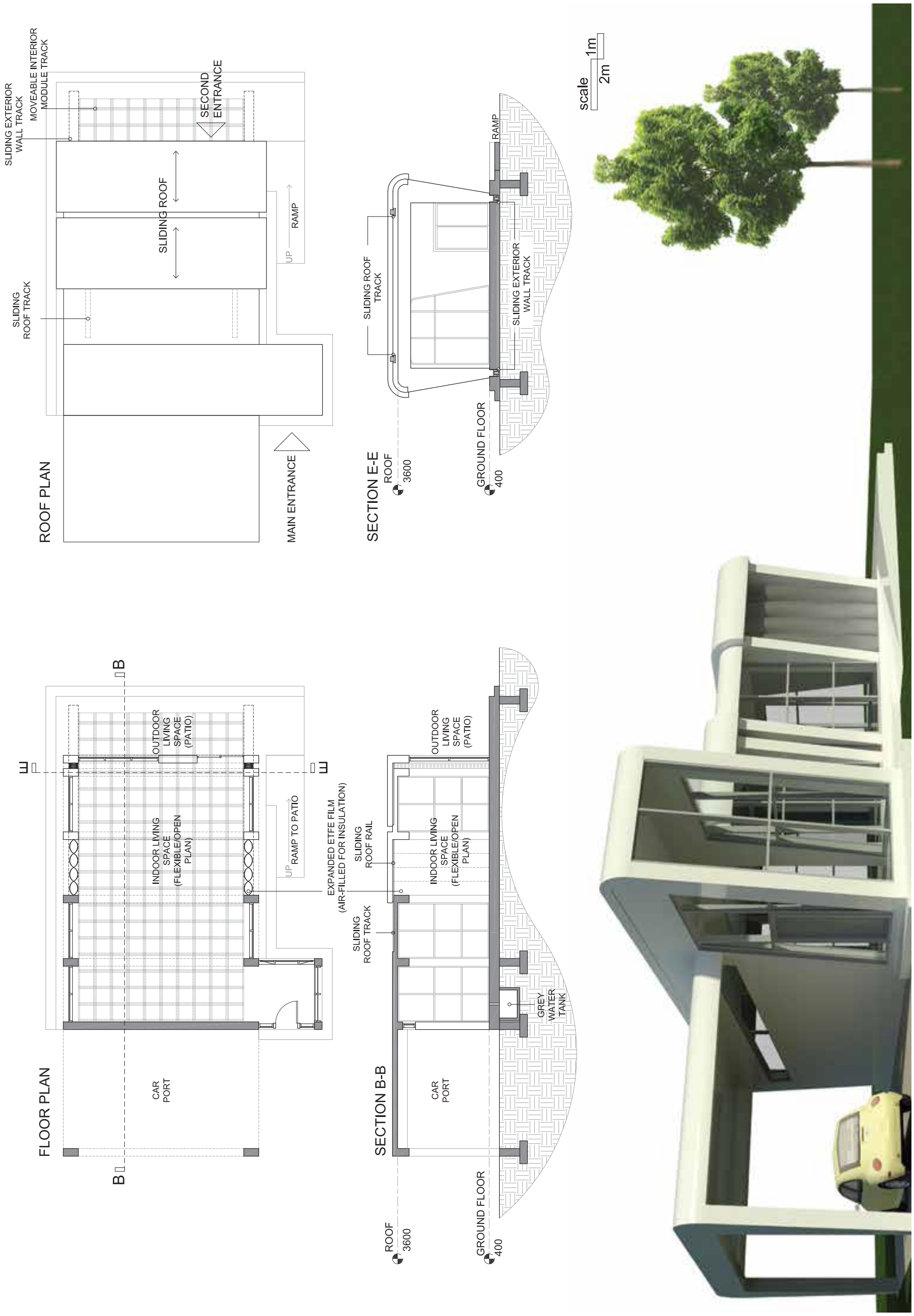


Figure 5.7
Three Stages of Lifecycle Transformations: Stage 2
Source: self-derived

Figure 5.8
Three Stages of Lifecycle Transformations: Stage 3
Source: self-derived

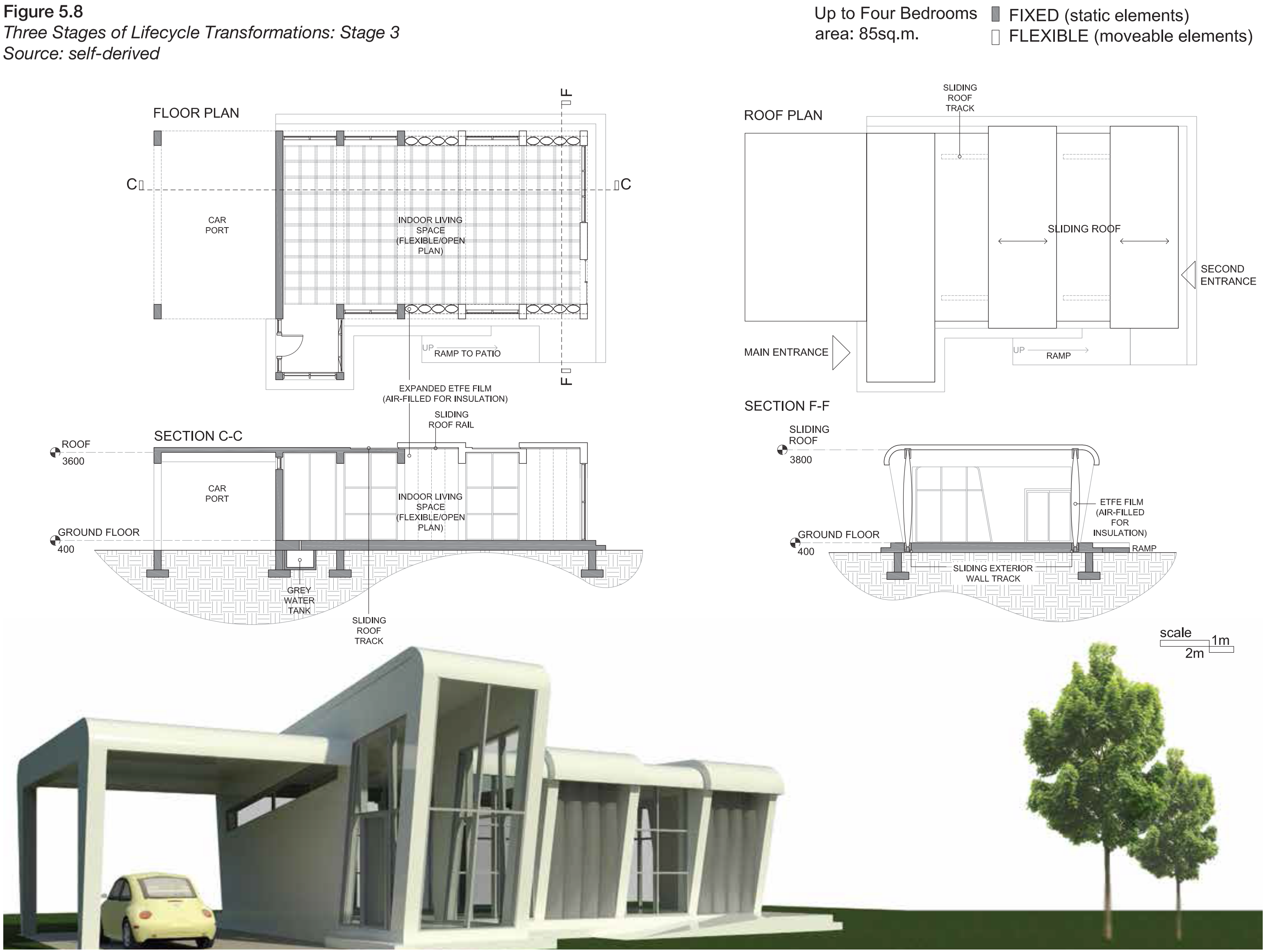


Figure 5.9
Transformative Stages in Axonometric View
Source: self-derived

The potential placements of the models on a suburban lot within Don Mills are illustrated in Figure 5.15. The house has the potential to face the street with two distinct frontages. For a private front, the glazed facades can face the private yards instead of the public street. For a more public frontage, the glazed facade can be placed facing the more public street. Varying street frontage options are also modelled in Figure 5.16.

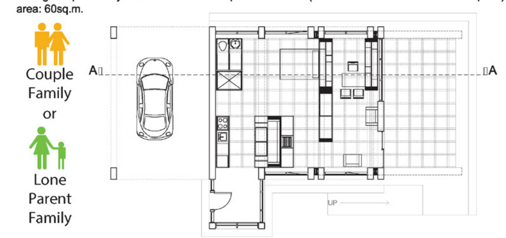
5.4.3 Design Methodology

The first design iteration was conceived as a fixed shell with the moveable activity modules within, that allowed for the flexible arrangement of internal spaces based on the day-to-day activities of a family. This notion accommodated lifecycle changes (i.e. expansion due to increased family size, etc.) through the addition of a vertical floor or occupation of the basement. In a second iteration the field on which the activity modules are permitted to move, was enlarged and manipulated through rotation in order to afford a larger degree of flexibility within the floor plan, as the modules were able to rotate on the larger field as well. However, this led to excessive freedom of arrangement, hence leading to largely wasteful and un-occupied space within the dwelling. The

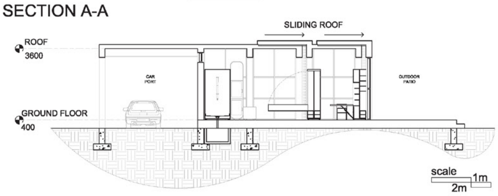
OCCUPATION OPTIONS FOR THE THREE STAGES OF LIFECYCLE TRANSFORMATIONS:

STAGE 1

Young Couple Family: Work from home couple with no kids (One Bedroom with Home Office Option)
area: 60sq.m.

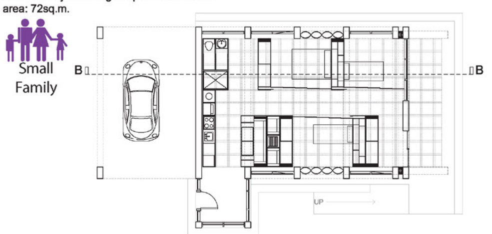


SECTION A-A

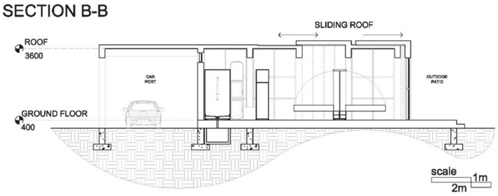


STAGE 2

Small Family: Working couple with two kids
area: 72sq.m.

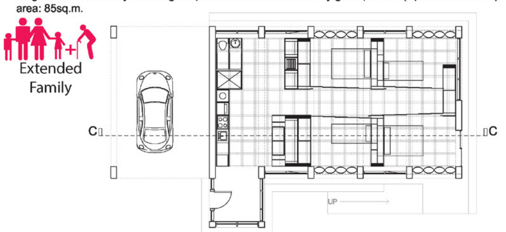


SECTION B-B



STAGE 3

Large/Extended Family: Working couple with two kids and elderly grandparents (Up to 4 Bedrooms)
area: 85sq.m.



SECTION C-C

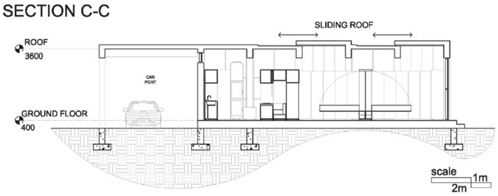


Figure 5.10
Occupation Options
Source: self-derived

STAGE 1:
Area: 60 sq.m.

STAGE 2:
Area: 72 sq.m.

STAGE 3:
Area: 85 sq.m.

current, compact floor plan was conceived as an attempt to limit the flexible movement of the activity modules within the interior space in order to avoid the wasteful expansion of the field and hence the dwelling. The current plan also directly responds to the need for compact living spaces in the busy

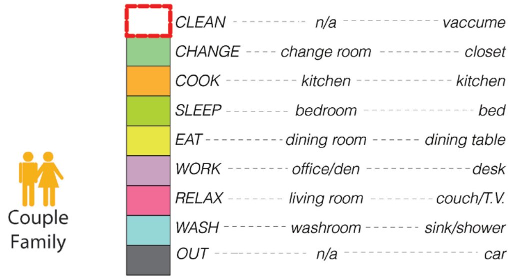
Figure 5.11
Stage 1: Occupation Options
Source: self-derived

Figure 5.12
Stage 1-Couple Family: Typical Weekly Schedule
Source: self-derived

STAGE 1

COUPLE FAMILY: Work from home couple with no kids (One Bedroom with Home Office Option)

area: 60sq.m.



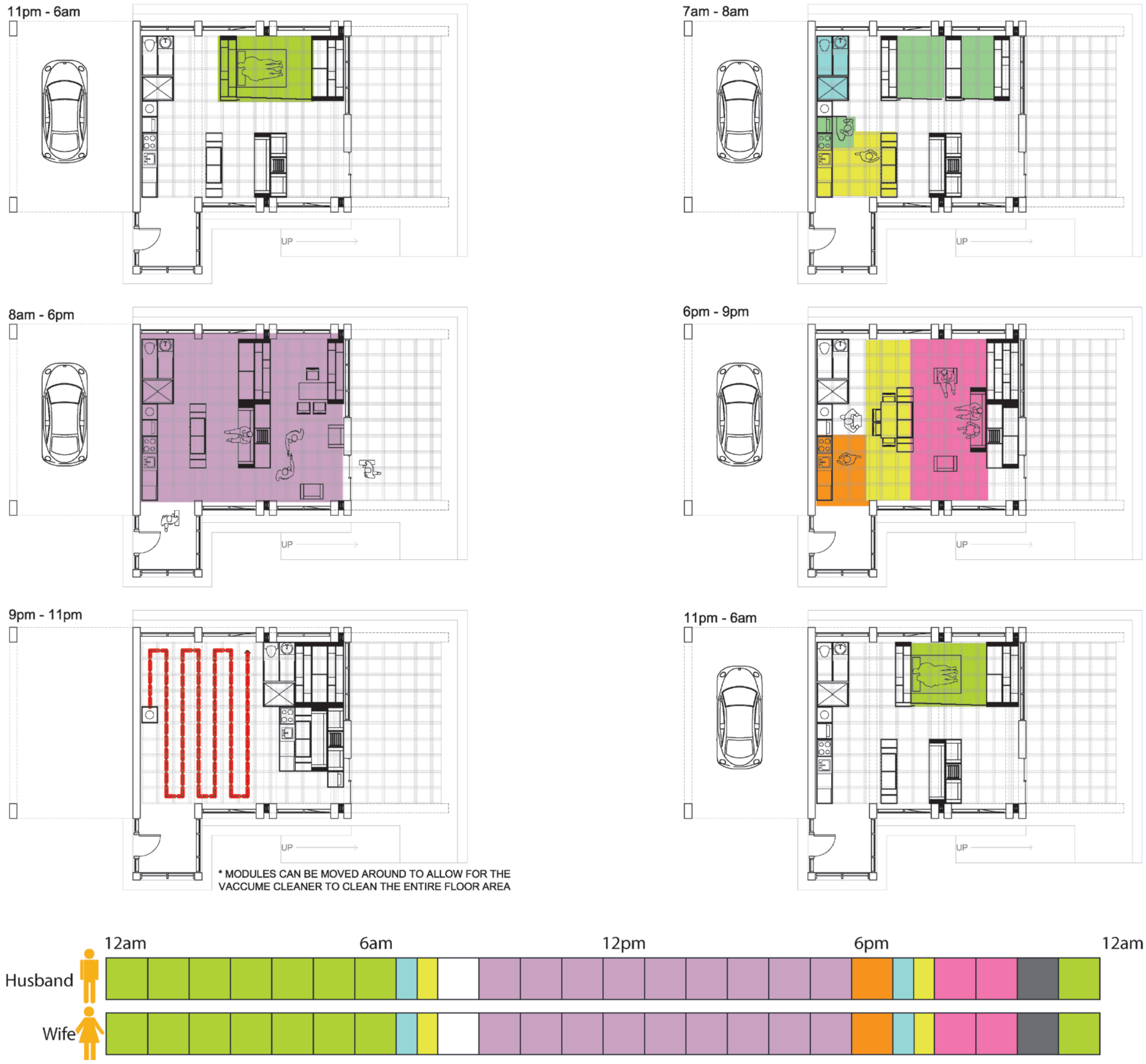


Figure 5.13
Stage 2-Small Family: Typical Weekly Schedule
Source: self-derived

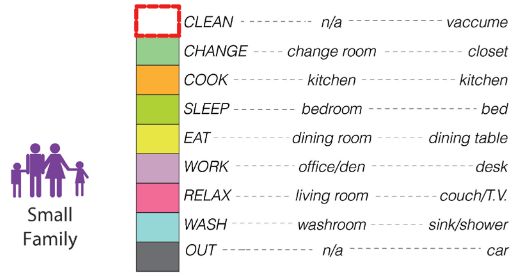


Figure 5.14
Stage 3-Large Family: Typical Weekly Schedule
Source: self-derived

Figure 5.15
Typical Site Configuration Options
Source: self-derived

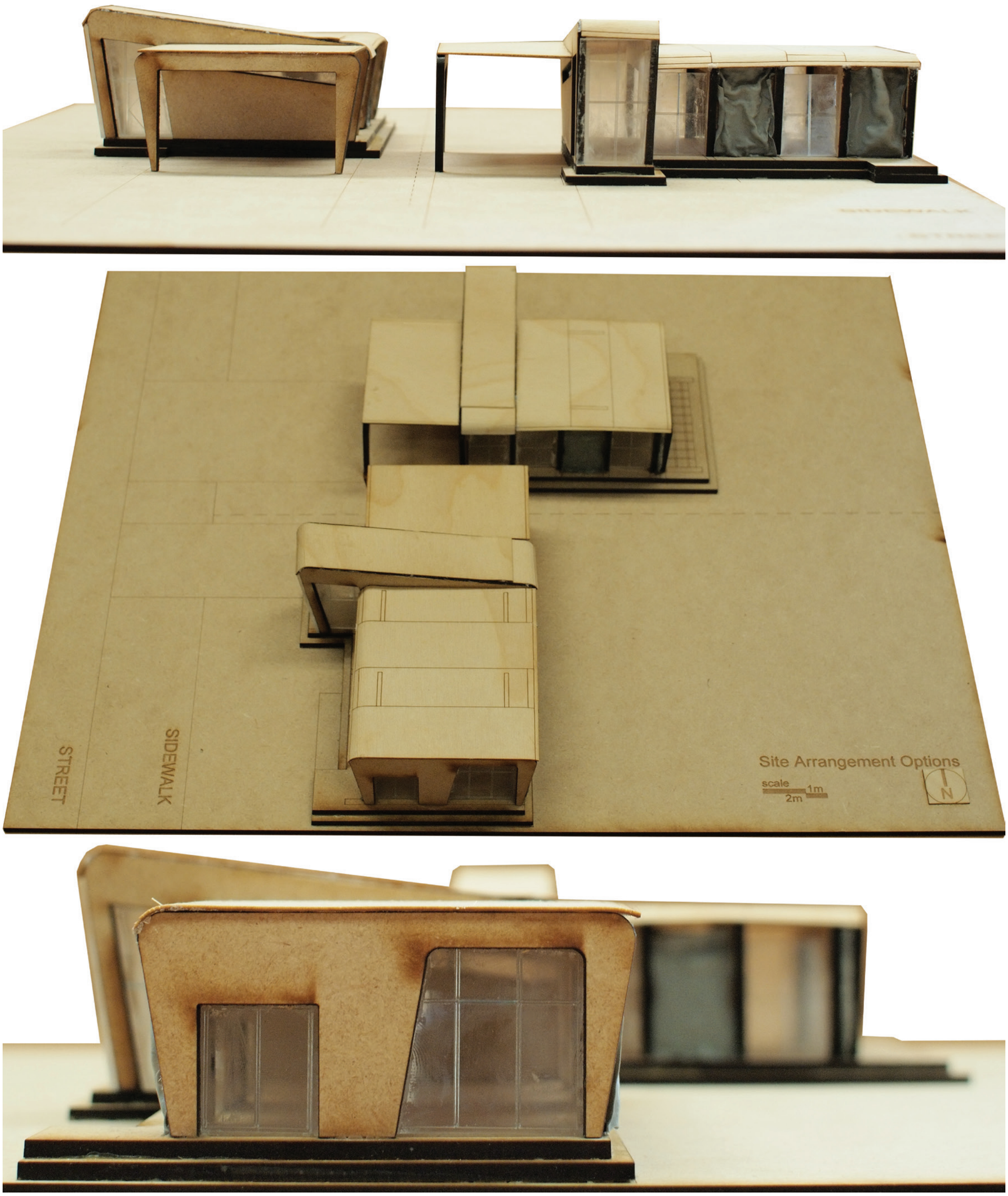


Figure 5.16
Typical Site Configuration Options
Model
Source: self-derived

FINAL RENDERINGS

Figure 5.17
Master Bed Unit Contained
Source: self-derived

Figure 5.18
Master Bed Unit Expanded
Source: self-derived

Figure 5.19
Child Bed Unit Contained
Source: self-derived

Figure 5.20
Child Bed Unit Expanded
Source: self-derived

Figure 5.21
Child Study
Source: self-derived

Figure 5.22
Laundry Unit Expanded
Source: self-derived

Figure 5.23
Bathroom (Occupied)
Source: self-derived

Figure 5.24
Dining Area Contained
Source: self-derived

Figure 5.25
Dining Area Expanded
Source: self-derived

Figure 5.26
Living Area
Source: self-derived

6.0

CONCLUSION

The main objective of this thesis project is to create a time-based, flexible, living system that facilitates the choice in activity combinations for the unique lifestyles of varying family units, while also allowing for an efficient use of space on a day to day basis. It should be noted that this thesis proposes one potential model of the transformable dwelling type, that must not be directly replicated or mass-produced, but rather the idea which ought to serve as a rule for the model (that of the transformable dwelling type) should be considered as a contemporary type of single-family dwelling. Hence this thesis proposes the transformable dwelling type, by testing it though one potential model. The overall idea is that when one is asked what kind of house they live in, instead of responding by saying that they live in a two-bedroom dwelling, or a three-bedroom house, they can say that they live in a transformable dwelling that is able to adapt to their needs over time. Hence, the main system that is applied in the construction of this space is not in the traditional spatial formality or architectural objects, but rather in the relationships between the varieties of actual activities occurring within the space itself.

Exterior Renderings illustrating the three stages of expansion are represented in Figures 5.27, 5.28, 5.29, 5.30, 5.31 & 5.32.

Figure 6.0
Exterior View: Rear-Stage 1
Source: self-derived

Figure 6.1
Exterior View: Rear-Stage 2
Source: self-derived

Figure 6.2
Exterior View: Rear-Stage 3
Source: self-derived

Figure 6.3
Exterior View: Front-Stage 1
Source: self-derived

Figure 6.4
Exterior View: Front-Stage
2Source: self-derived

Figure 6.5
Exterior View: Front-Stage 3
Source: self-derived

7.0

APPENDICES

APPENDIX 1.0
CMHC Housing Matrix -1950

APPENDIX 1.1
Mattamy Homes Matrix -2010

APPENDIX 1.2
Flexible Housing Timeline & Precedents

APPENDIX 1.3
Past Design Iterations

APPENDIX 1.0
CMHC HOUSING MATRIX 1950

This matrix evaluates the post-war single-family homes illustrated within the CMHC pattern book titled Small House Designs - Bungalows, from 1950. The houses are evaluated based on size, function, arrangement and layout, in order to examine the various dwelling conditions of

CHARACTERISTIC	TALLY	CHARACTERISTIC	TALLY	CHARACTERISTIC	TALLY
S SMALL (< 800 sq ft) — TOTAL AREA	15	CAR PORT	0	COAT CLOSET	38
M MEDIUM (801- 999 sq ft) — TOTAL AREA	13	A ATTACHED / D DETACHED — ENCLOSED GARAGE	2 A 1 D	LINEN CLOSET	38
L LARGE (>1000 sq ft) — TOTAL AREA	10	S SLEEPING / L LIVING — LIVING ARRANGE-MENT	16	UTILITY/ LAUNDRY RM.	2
2 — NO. OF BEDROOMS	23	L LIVING / S SLEEPING — LIVING ARRANGE-MENT	0	FURNACE RM.	1
3 — NO. OF BEDROOMS	15	L LIVI NG / S SLEEP ING — LIVING ARRANGE-MENT	16	STORAGE RM.	1
NO. OF BATHROOMS	ALL MODELS HAVE 1 BATHROOM EACH	S SLEEP ING / L LIVI NG — LIVING ARRANGE-MENT	6	HEARTH	15
FRONT ENTRANCE — MAIN ENTRANCE APPROACH	31	SP LIVING/DINING SEPARATE — SEPARATE LIVING/DINING ARRANGE-MENT	6	CHIMNEY	38
SIDE ENTRANCE — MAIN ENTRANCE APPROACH	3	SH LIVING/DINING SHARED — SHARED LIVING/DINING ARRANGE-MENT	17	SEPARATE BATH/WASH RM.	1
SIDE ENTRANCE — MAIN ENTRANCE APPROACH	4	E EATING AREA IN KITCHEN — EATING AREA IN KITCHEN	6		
BACK DOOR — SECONDARY EXT. DOOR	13	N NO DINING RM. — NO DINING ARRANGE-MENT	9		
BACK & SIDE DOOR — SECONDARY EXT. DOOR	4	E — ENTRANCE HALLWAY P — PRIVATE HALLWAY	16 E 38 P		
SIDE DOOR — SECONDARY EXT. DOOR	19	V — ENTRANCE VESTIBULE	29		
EXT. PATIO OR TERRACE	9	B — BASEMENT	37		

1950 SMALL HOUSE DESIGNS BUNGALOWS	TOTAL AREA			NO. OF BEDROOMS	NO. OF BATHROOMS	MAIN ENTRANCE APPROACH	SECONDARY EXT. DOOR (SIDE/BACK)	EXT. PATIO OR TERRACE	CAR PORT	ENCLOSED GARAGE	LIVING ARRANGE-MENT	DINING ARRANGE-MENT	HALLWAY	ENTRANCE VESTIBULE	BASEMENT	COAT CLOSET	LINEN CLOSET	UTILITY/ LAUNDRY RM.	FURNACE RM.	STORAGE RM.	HEARTH	CHIMNEY	SEPARATE BATH/WASH RM.
MODEL NO.	S SMALL (< 800 sq ft)	M MEDIUM (801-999 sq ft)	L LARGE (>1000 sq ft)			MAIN ENTRANCE	SECONDARY DOOR			A ATTACHED D DETACHED	L LIVING S SLEEPING	SP SH E	E ENTRANCE HALL P PRIVATE HALL	V	B								
50-1		M 904.6 sq ft		2	1	FRONT ENTRANCE					L S	SP LIVING/DINING SEPARATE	E P	V	B	✓	✓				✓	✓	
50-2			L 1008 sq ft	3	1	FRONT ENTRANCE	BACK DOOR				S L	N NO DINING RM.	E P	V	B	✓	✓			✓		✓	
50-3		M 910 sq ft		3	1	FRONT ENTRANCE	SIDE DOOR				S L	N NO DINING RM.	P	V	B	✓	✓					✓	
50-4		M 806 sq ft		2	1	FRONT ENTRANCE	BACK & SIDE DOOR				S L	E EATING AREA IN KITCHEN	P	V	B	✓	✓				✓	✓	
50-5	S 780.5 sq ft			2	1	FRONT ENTRANCE	BACK DOOR				L S	N NO DINING RM.	P	V	B	✓	✓					✓	
50-6	S 798.5 sq ft			2	1	FRONT ENTRANCE	SIDE DOOR				S L	SP LIVING/DINING SEPARATE	P	V	B	✓	✓				✓	✓	
50-7	S 681 sq ft			2	1	FRONT ENTRANCE	SIDE DOOR				L S	SH LIVING/DINING SHARED	P	V	B	✓	✓					✓	
50-8	S 779 sq ft			2	1	FRONT ENTRANCE	BACK DOOR				L S	SH LIVING/DINING SHARED	P	V	B	✓	✓					✓	
50-9			L 1045 sq ft	3	1	FRONT ENTRANCE	SIDE DOOR				S L	SH LIVING/DINING SHARED	E P	V	B	✓	✓				✓	✓	
50-10		M 897.5 sq ft		2	1	SIDE ENTRANCE	BACK DOOR	✓		A ATTACHED RIGHT	S L	SH LIVING/DINING SHARED	P	V	B	✓	✓				✓	✓	
50-11	S 700 sq ft			2	1	SIDE ENTRANCE	BACK DOOR				L S	SH LIVING/DINING SHARED	P	V	B	✓	✓					✓	
50-12	S 652 sq ft			2	1	FRONT ENTRANCE	SIDE DOOR				S L	N NO DINING RM.	P	V	B	✓	✓					✓	
50-13	S 730 sq ft			2	1	FRONT ENTRANCE	BACK DOOR				L S	E EATING AREA IN KITCHEN	E P	V	B	✓	✓					✓	

1950 SMALL HOUSE DESIGNS BUNGALOWS	TOTAL AREA	NO. OF BEDROOMS	NO. OF BATHROOMS	MAIN ENTRANCE APPROACH	SECONDARY EXT. DOOR (SIDE/BACK)	EXT. PATIO OR TERRACE	CAR PORT	ENCLOSED GARAGE	LIVING ARRANGE-MENT	DINING ARRANGE-MENT	HALLWAY	ENTRANCE VESTIBULE	BASEMENT	COAT CLOSET	LINEN CLOSET	UTILITY/ LAUNDRY RM.	FURNACE RM.	STORAGE RM.	HEARTH	CHIMNEY	SEPARATE BATH/WASH RM.
50-14	M 984 sq ft	3	1	SIDE ENTRANCE	BACK DOOR				S / L	SP LIVING/DINING SEPARATE	P	V	B	✓	✓				✓	✓	
50-15	M 982 sq ft	3	1	SIDE ENTRANCE	BACK DOOR				S / L	SP LIVING/DINING SEPARATE	P		B	✓	✓				✓	✓	
50-16	S 641 sq ft	2	1	FRONT ENTRANCE	SIDE DOOR				S / L	N NO DINING RM.	P	V	B	✓	✓					✓	
50-17	M 987 sq ft	3	1	FRONT ENTRANCE	SIDE DOOR				S / L	SH LIVING/DINING SHARED	P E	V	B	✓	✓				✓	✓	
50-18	S 732 sq ft	2	1	FRONT ENTRANCE	SIDE DOOR				S / L	N NO DINING RM.	P	V	B	✓	✓					✓	
50-19	M 870 sq ft	3	1	SIDE ENTRANCE	BACK DOOR	✓			S / L	SH LIVING/DINING SHARED	P E		B	✓	✓					✓	
50-20	S 725 sq ft	2	1	FRONT ENTRANCE	SIDE DOOR				S / L	E EATING AREA IN KITCHEN	P	V	B	✓	✓					✓	
50-21	M 950 sq ft	3	1	FRONT ENTRANCE	BACK DOOR				S / L	SH LIVING/DINING SHARED	P E	V	B	✓	✓					✓	
50-22	L 1026 sq ft	3	1	FRONT ENTRANCE	SIDE DOOR				S / L	SH LIVING/DINING SHARED	P E		B	✓	✓					✓	
50-23	S 730 sq ft	2	1	FRONT ENTRANCE	SIDE DOOR				S / L	SH LIVING/DINING SHARED	P	V	B	✓	✓					✓	
50-24	S 784 sq ft	2	1	FRONT ENTRANCE	SIDE DOOR			D DETACHED	S / L	E EATING AREA IN KITCHEN	P	V	B	✓	✓					✓	
50-25	L 1022 sq ft	3	1	FRONT ENTRANCE	BACK DOOR				S / L	SP LIVING/DINING SEPARATE	P	V	B	✓	✓	✓			✓	✓	
50-26	M 963 sq ft	2	1	FRONT ENTRANCE	SIDE DOOR	✓			S / L	SP LIVING/DINING SEPARATE	P	V	B	✓	✓					✓	
50-27	L 1138 sq ft	3	1	FRONT ENTRANCE	SIDE DOOR				S / L	SH LIVING/DINING SHARED	P E		B	✓	✓				✓	✓	

1950 SMALL HOUSE DESIGNS BUNGALOWS		TOTAL AREA		NO. OF BEDROOMS	NO. OF BATHROOMS	MAIN ENTRANCE APPROACH	SECONDARY EXT. DOOR (SIDE/BACK)	EXT. PATIO OR TERRACE	CAR PORT	ENCLOSED GARAGE	LIVING ARRANGE-MENT	DINING ARRANGE-MENT	HALLWAY	ENTRANCE VESTIBULE	BASEMENT	COAT CLOSET	LINEN CLOSET	UTILITY/ LAUNDRY RM.	FURNACE RM.	STORAGE RM.	HEARTH	CHIMNEY	SEPARATE BATH/WASH RM.
50-28	S 775 sq ft			2	1	FRONT ENTRANCE					S SLEEPING L LIVING	N NO DINING RM.	P	V ENTRANCE VESTIBULE	B								
50-29			L 1097 sq ft	2	1	FRONT ENTRANCE	SIDE DOOR				L LIVING S SLEEPING	SH LIVING/DINING SHARED	E P		B								
50-30			L 1192 sq ft	2	1	FRONT ENTRANCE	SIDE DOOR				L LIVING S SLEEPING	SH LIVING/DINING SHARED	E P		B								
50-31	S 717 sq ft			2	1	FRONT ENTRANCE	SIDE DOOR				S SLEEPING L LIVING	N NO DINING RM.	P	V ENTRANCE VESTIBULE	B								
50-32			L 1875 sq ft	3	1	FRONT ENTRANCE	BACK DOOR				L LIVING S SLEEPING	SH LIVING/DINING SHARED	P	V ENTRANCE VESTIBULE	B								
50-33		M 926 sq ft		3	1	SIDE ENTRANCE	SIDE DOOR				S SLEEPING L LIVING	E EATING AREA IN KITCHEN	E P		B								
50-34		M 810 sq ft		2	1	SIDE ENTRANCE	BACK DOOR				S SLEEPING L LIVING	SH LIVING/DINING SHARED	P	V ENTRANCE VESTIBULE	B								
50-35			L 1000 sq ft	3	1	FRONT ENTRANCE	BACK & SIDE DOOR				S SLEEPING L LIVING	SH LIVING/DINING SHARED	E P		B								
50-36			L 1235 sq ft	3	1	FRONT ENTRANCE	SIDE DOOR	BREEZEWAY		A ATTACHED LEFT	L LIVING S SLEEPING	SH LIVING/DINING SHARED	E P										
50-37	S 788.6 sq ft			2	1	FRONT ENTRANCE	BACK & SIDE DOOR				L LIVING S SLEEPING	N NO DINING RM.	E P	V ENTRANCE VESTIBULE	B								
50-38		M 862 sq ft		2	1	FRONT ENTRANCE	BACK & SIDE DOOR				L LIVING S SLEEPING	E EATING AREA IN KITCHEN	E P	V ENTRANCE VESTIBULE	B								

APPENDIX 1.1 MATTAMY HOMES MATRIX 2010

This matrix evaluates recently built single-family homes illustrated within the Mattamy Homes catalogue for 2010. The houses are evaluated based on size, function, arrangement and layout. In comparison to the CMHC Matrix (Appendix 1.0), these houses have a larger total area, which contradicts the need for small, compact dwelling spaces within contemporary society due to efficient lifestyle requirements as well as sustainable design. Several new functions can also be noted indicating evolving lifestyles.

CHARACTERISTIC	TALLY	CHARACTERISTIC	TALLY	CHARACTERISTIC	TALLY
L LARGE (>1000 sq ft) TOTAL AREA	ALL 32	EXT. PATIO OR TERRACE	ALL	OPTIONAL — OPTIONAL FAMILY RM. OR REC. RM.	5
3 — NO. OF BEDROOMS	6	A ATTACHED 2 TWO CAR 3 THREE CAR — ENCLOSED GARAGE	SIINGLE: 8 TWO: 23 THREE: 1	WIC — WALK-IN CLOSET	18
4 — NO. OF BEDROOMS	13	S SLEEPING L LIVING — LIVING ARRANGE-MENT	ALL	WIC — WALK-IN CLOSET (HIS/HER)	7
3, 4 OPT. — NO. OF BEDROOMS	6	B — BREAKFAST AREA IN KITCHEN	5	WIC, OPTIONAL — WALK-IN CLOSET (HIS/HER OPTIONAL)	7
4, 5 OPT. — NO. OF BEDROOMS	7	B SH — BREAKFAST & SHARED DINING ARRANGE-MENT	6	OPTIONAL — HEARTH	ALL
NO. OF BATHROOMS	AVG. 2.5	B SP — BREAKFAST & SEPARATE DIN-ING ARRANGE-MENT	21	OPTIONAL — CHIMNEY	ALL
2.5 3RD BATH OPTION — NO. OF BATHROOMS	15	E ENTRANCE HALL, P PRIVATE HALL — HALLWAY (BOTH ENTRANCE AND PRIVATE)	22	DEN/STUDY PARLOUR LOFT COMPUTER NOOK	DEN/STUDY: 9 OPT OR COMPUTER NOOK: 8
NEW BATHROOM AMENITIES (DOUBLE VANITY + STANDING SHOWER)	ALL INC: 6 OPT: 12	P PRIVATE HALL — HALLWAY (PRIVATE ONLY)	10		
NEW BATHROOM AMENITIES (STANDING SHOWER)	2	F ENTRANCE FOYER — ENTRANCE FOYER	ALL		
OPT. — NEW BATHROOM AMENITIES (ONLY STANDING SHOWER OPTIONAL)	12	B — BASEMENT	ALL		
FRONT ENTRANCE — MAIN ENTRANCE APPROACH	28	COAT CLOSET	ALL		
SIDE ENTRANCE — MAIN ENTRANCE APPROACH	4	LINEN CLOSET	ALL		
BACK DOOR — SECONDARY EXT. DOOR	15	UTILITY/ LAUNDRY RM.	31		
SIDE DOOR OPT. — SECONDARY EXT. DOOR OPTION	17	ADDITIONAL FAMILY RM. OR REC. RM.	8		

2010 MATTAMY HOMES BRAMPTON 2-STOREY	TOTAL AREA			NO. OF BEDROOMS	NO. OF BATHROOMS	NEW BATHROOM AMENITIES	MAIN ENTRANCE APPROACH	SECONDARY EXT. DOOR (SIDE/BACK)	EXT. PATIO OR TERRACE	ENCLOSED GARAGE	LIVING ARRANGE-MENT	DINING ARRANGE-MENT	HALLWAY	ENTRANCE FOYER	BASEMENT	COAT CLOSET	LINEN CLOSET	UTILITY/ LAUNDRY RM.	ADDITIONAL FAMILY RM. OR REC. RM.	WALK-IN CLOSET	HEARTH	CHIMNEY	DEN/STUDY OR PARLOUR OR LOFT
MODEL NO.	S SMALL (< 800 sq ft)	M MEDIUM (801-999 sq ft)	L LARGE (>1000 sq ft)				MAIN ENTRANCE	SECONDARY DOOR		A ATTACHED 2 TWO CAR	L LIVING S SLEEPING	SP SH B	E ENTRANCE HALL P PRIVATE HALL	F	B					WIC			
 30 FT WIDE - PLAN 2			L 1337 sq ft	3	1.5	OPTIONAL	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT	S SLEEPING L LIVING	B	E P	F	B					WIC	OPTIONAL	OPTIONAL	
 30 FT WIDE - PLAN 3			L 1456 sq ft	3	2.5	OPT.	FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT	S SLEEPING L LIVING	B SH	E P	F	B			OPTIONAL		WIC	OPTIONAL	OPTIONAL	
 30 FT WIDE - PLAN 4			L 1597 sq ft	3	2.5	OPTIONAL	FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT	S SLEEPING L LIVING	B SP	P	F	B					WIC	OPTIONAL	OPTIONAL	OPT. DEN IN LIEU OF DINING
 30 FT WIDE - PLAN 5			L 1624 sq ft	3 4 OPT. (FAMILY RM.)	2.5	OPTIONAL	SIDE ENTRANCE	BACK DOOR		A ATTACHED RIGHT 2 TWO CAR	S SLEEPING L LIVING	B SH	P	F	B					WIC	OPTIONAL	OPTIONAL	
 30 FT WIDE - PLAN 6			L 1749 sq ft	3	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPT.	FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT	S SLEEPING L LIVING	B SH	P	F	B					WIC	OPTIONAL	OPTIONAL	
 30 FT WIDE - PLAN 7			L 1832 sq ft	4	2.5	OPTIONAL	SIDE ENTRANCE	BACK DOOR		A ATTACHED RIGHT	S SLEEPING L LIVING	B SP	E P	F	B					WIC	OPTIONAL	OPTIONAL	PARLOUR OR OPT. DEN IN LIEU OF PARLOUR
 30 FT WIDE - PLAN 8			L 1938 sq ft	4	2.5	OPTIONAL	FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT	S SLEEPING L LIVING	B SH	P	F	B					OPTIONAL	OPTIONAL	OPTIONAL	
 30 FT WIDE - PLAN 9			L 2127 sq ft	4	2.5		FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT	S SLEEPING L LIVING	B SP	E P	F	B						OPTIONAL	OPTIONAL	DEN + OPT. LOFT IN LIEU OF BEDROOM 4
 30 FT WIDE - PLAN 10			L 2263 sq ft	4	2.5		FRONT ENTRANCE	BACK DOOR (SIDE OPT.) DOOR		A ATTACHED RIGHT	S SLEEPING L LIVING	B SH	P	F	B					WIC	OPTIONAL	OPTIONAL	OPT. LOFT IN LIEU OF BEDROOM 4
 36 FT WIDE - PLAN 1			L 1638 sq ft	3	2.5	OPT.	FRONT ENTRANCE			A ATTACHED RIGHT 2 TWO CAR	S SLEEPING L LIVING	B	E P	F	B					OPTIONAL	OPTIONAL	OPTIONAL	
 36 FT WIDE - PLAN 2			L 1780 sq ft	3	2.5	OPTIONAL	FRONT ENTRANCE			A ATTACHED RIGHT 2 TWO CAR	S SLEEPING L LIVING	B	E P	F	B					OPTIONAL	OPTIONAL	OPTIONAL	
 36 FT WIDE - PLAN 3			L 1977 sq ft	3 4 OPT. (FAMILY RM.)	2.5	OPTIONAL	SIDE ENTRANCE	BACK DOOR		A ATTACHED RIGHT 2 TWO CAR	S SLEEPING L LIVING	B	E P	F	B					WIC	OPTIONAL	OPTIONAL	DEN IN LIEU OF FORMAL RM.
 36 FT WIDE - PLAN 4			L 2051 sq ft	3 4 OPT. (FAMILY RM.)	2.5	OPTIONAL	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S SLEEPING L LIVING	B SP	E P	F	B					WIC	OPTIONAL	OPTIONAL	

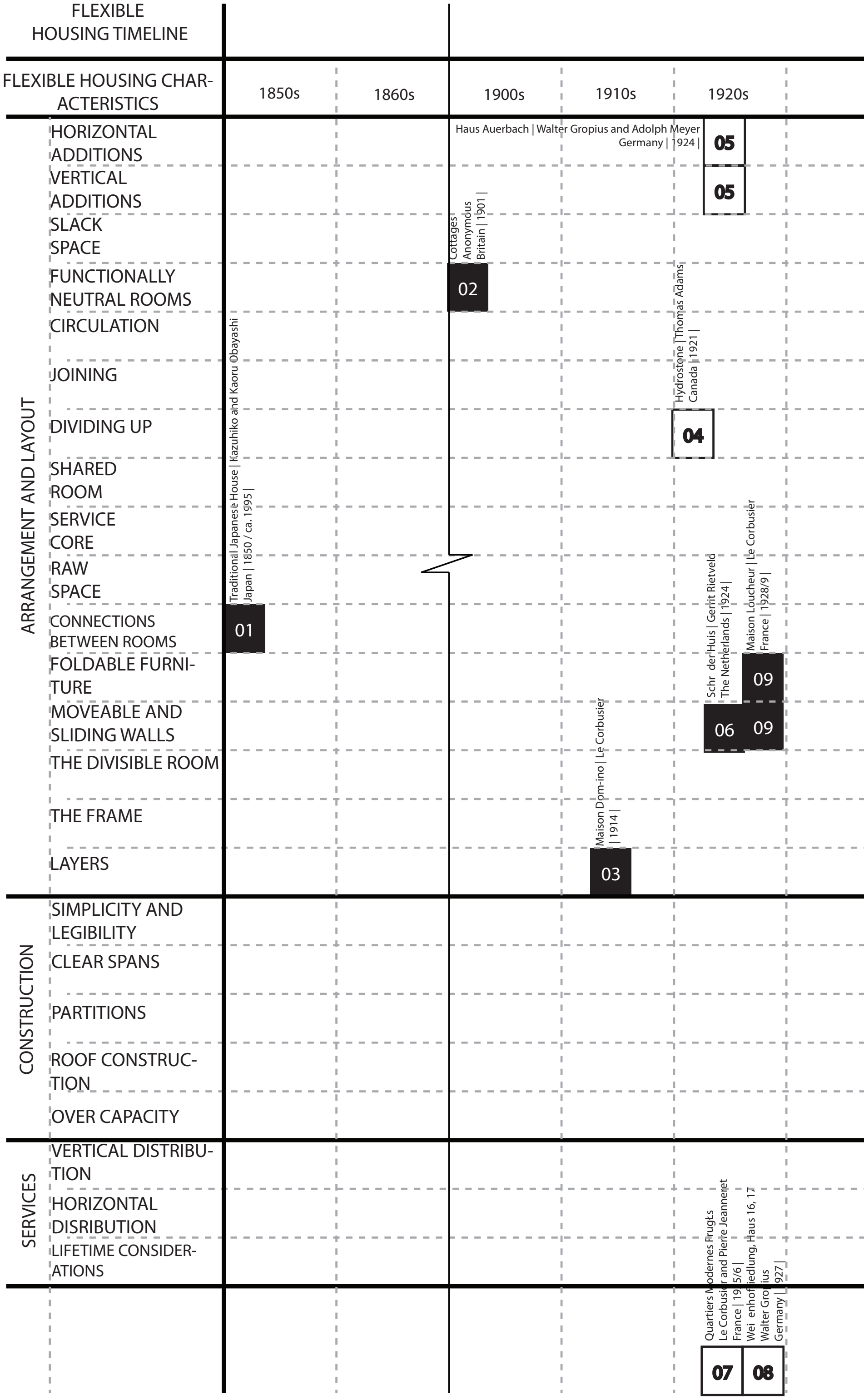
Transformation as a Type

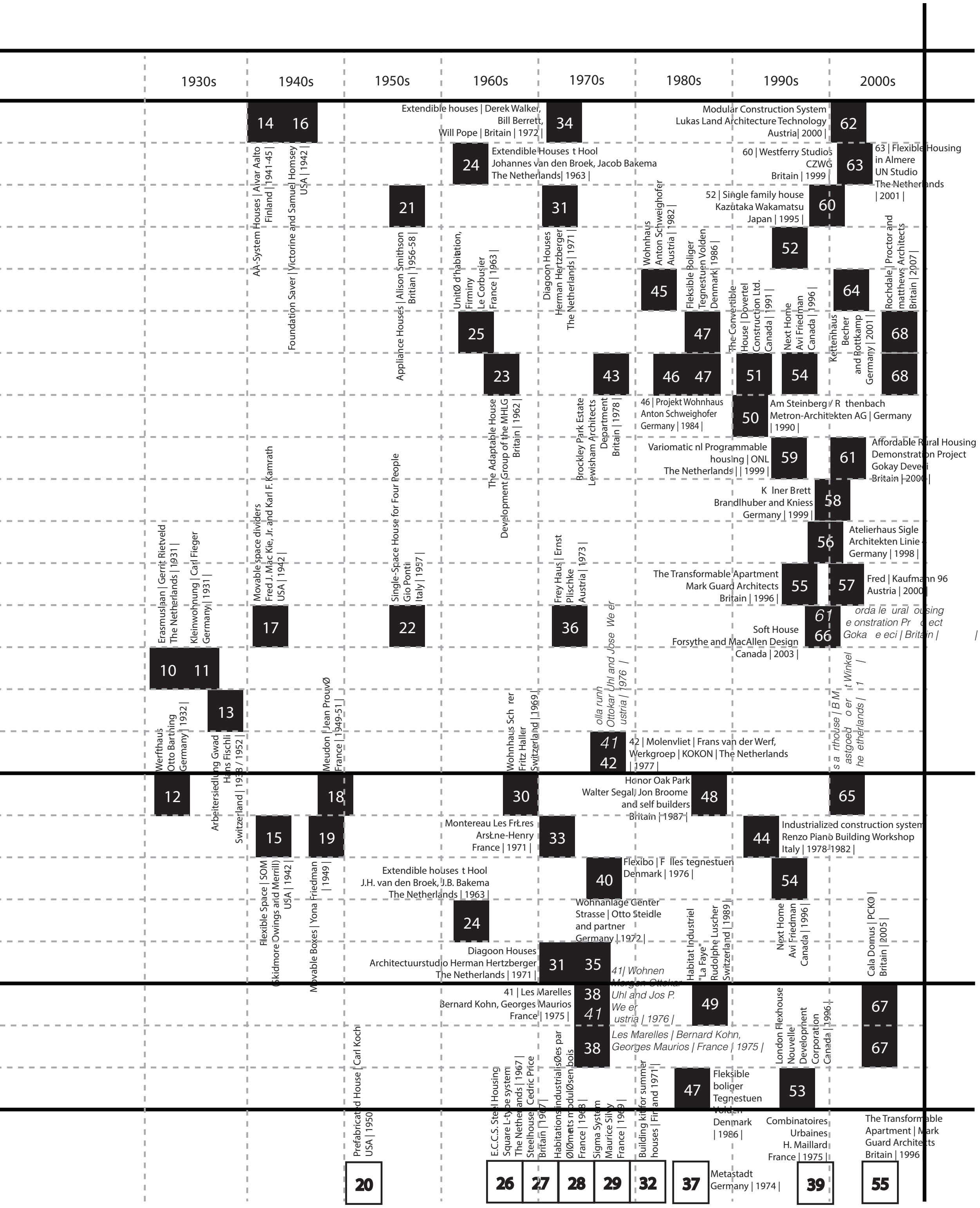
2010 MATTAMY HOMES BRAMPTON 2-STOREY	S SMALL (< 800 sq ft)	TOTAL AREA M MEDIUM (801-999 sq ft)	L LARGE (>1000 sq ft)	NO. OF BEDROOMS	NO. OF BATHROOMS	NEW BATHROOM AMENITIES	MAIN ENTRANCE APPROACH	SECONDARY EXT. DOOR (SIDE/BACK)	EXT. PATIO OR TERRACE	ENCLOSED GARAGE	LIVING ARRANGE-MENT	DINING ARRANGE-MENT	HALLWAY	ENTRANCE FOYER	BASEMENT	COAT CLOSET	LINEN CLOSET	UTILITY/ LAUNDRY RM.	ADDITIONAL FAMILY RM. OR REC. RM.	WALK-IN CLOSET	HEARTH	CHIMNEY	DEN/STUDY OR PARLOUR OR LOFT
 36 FT WIDE -PLAN 5			L 2193 sq ft	3 4 OPT. (LOFT)	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPTIONAL	FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT 2 TWO CAR	S L	B	P	F	B					WIC	OPTIONAL	OPTIONAL	OPT: BEDROOM 4 IN LIEU OF LOFT
 36 FT WIDE -PLAN 6			L 2301 sq ft	4	2.5	OPTIONAL	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B					WIC	OPTIONAL	OPTIONAL	
 36 FT WIDE -PLAN 7			L 2436 sq ft	4 5 OPT. (LOFT)	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPTIONAL	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B					WIC	OPTIONAL	OPTIONAL	OPT: BEDROOM 5 IN LIEU OF LOFT
 36 FT WIDE -PLAN 9			L 1812 sq ft	3 4 OPT. (FAMILY RM.)	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPT.	FRONT ENTRANCE	SIDE DOOR		A ATTACHED BACK 2 TWO CAR	S L	B SP	E P	F	B					WIC	OPTIONAL	OPTIONAL	PARLOUR OR OPT. DEN IN LIEU OF PARLOUR
 36 FT WIDE -PLAN 10			L 2326 sq ft	4	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPT.	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B						OPTIONAL	OPTIONAL	COMPUTER NOOK AND OPT. LOFT IN LIEU OF BEDROOM 3
 36 FT WIDE -PLAN 12			L 2540 sq ft	4	2.5	OPT.	FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	P	F	B				OPT. IN LIEU OF DEN	WIC	OPTIONAL	OPTIONAL	
 38 FT WIDE -PLAN 1			L 2051 sq ft	3 4 OPT. (FAMILY RM.)	2.5	OPTIONAL	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B					WIC	OPTIONAL	OPTIONAL	
 38 FT WIDE -PLAN 2			L 2169 sq ft	4	2.5	OPT.	FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT 2 TWO CAR	S L	B SH	P	F	B					WIC	OPTIONAL	OPTIONAL	
 38 FT WIDE -PLAN 3			L 2380 sq ft	4	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPT.	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	P	F	B				OPT. IN LIEU OF BEDROOM		OPTIONAL	OPTIONAL	
 38 FT WIDE -PLAN 4			L 2458 sq ft	4	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPT.	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B						OPTIONAL	OPTIONAL	
 38 FT WIDE -PLAN 5			L 2584 sq ft	4	2.5	OPT.	FRONT ENTRANCE	BACK DOOR		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B				OPT. IN LIEU OF DEN	WIC	OPTIONAL	OPTIONAL	
 38 FT WIDE -PLAN 6			L 2644 sq ft	4 5 OPT.	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPT.	SIDE ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B						OPTIONAL	OPTIONAL	
 38 FT WIDE -PLAN 7			L 2808 sq ft	4 5 OPT.	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)	OPT.	FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B						OPTIONAL	OPTIONAL	DEN + COMP NOOK
 45 FT WIDE -PLAN 2			L 2648 sq ft	4	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)		FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	P	F	B				OPT. IN LIEU OF BEDROOM		OPTIONAL	OPTIONAL	

2010 MATTAMY HOMES BRAMPTON 2-STOREY	S SMALL (< 800 sq ft)	TOTAL AREA M MEDIUM (801 - 999 sq ft)	L LARGE (>1000 sq ft)	NO. OF BEDROOMS	NO. OF BATHROOMS	NEW BATHROOM AMENITIES	MAIN ENTRANCE APPROACH	SECONDARY EXT. DOOR (SIDE/BACK)	EXT. PATIO OR TERRACE	ENCLOSED GARAGE	LIVING ARRANGE-MENT	DINING ARRANGE-MENT	HALLWAY	ENTRANCE FOYER	BASEMENT	COAT CLOSET	LINEN CLOSET	UTILITY/ LAUNDRY RM.	ADDITIONAL FAMILY RM. OR REC. RM.	WALK-IN CLOSET	HEARTH	CHIMNEY	DEN/STUDY OR PARLOUR OR LOFT
 45 FT WIDE -PLAN 3			L 2812 sq ft	4	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)		FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B						OPTIONAL	OPTIONAL	
 45 FT WIDE -PLAN 4			L 3000 sq ft	4 5 OPT.	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)		FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 3 THREE CAR	S L	B SP	E P	F	B						OPTIONAL	OPTIONAL	
 45 FT WIDE -PLAN 5			L 3144 sq ft	4 5 OPT.	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)		FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B					WIC	OPTIONAL	OPTIONAL	
 45 FT WIDE -PLAN 6			L 3264 sq ft	4 5 OPT.	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)		FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B				OPT. IN LIEU OF DEN		OPTIONAL	OPTIONAL	
 45 FT WIDE -PLAN 7			L 3411 sq ft	4 5 OPT.	2.5 3RD BATH OPTION (RELOC. LAUNDRY TO BASEMENT)		FRONT ENTRANCE	BACK DOOR (SIDE OPT.)		A ATTACHED RIGHT 2 TWO CAR	S L	B SP	E P	F	B						OPTIONAL	OPTIONAL	DEN + LOFT

APPENDIX 1.2 FLEXIBLE HOUSING TIMELINE AND PRECEDENTS

The strategies of flexible housing design mentioned in section 4.1 have been widely explored within precedents throughout history. While some concepts are similar to others, certain precedents include more than one strategy, affording a higher degree of flexibility in some cases. Appendix 1.2 illustrates selected flexible housing precedents that are considered most relevant to the purpose of this thesis, as they explore strategies that can aid within the design of a transformable detached housing typology for the 21st century. The precedents are listed in chronological order following the timeline.




1930s
1940s
1950s
1960s
1970s
1980s
1990s
2000s
Extendible houses | Derek Walker, Bill Berrett, Will Pope | Britain | 1972 |
Modular Construction System Lukas Land Architecture Technology Austria| 2000 |
Extendible Houses t Hool Johannes van den Broek, Jacob Bakema The Netherlands| 1963 |
60 | Westferry Studios CZWG Britain | 1999 |
63 | Flexible Housing in Almere UN Studio The Netherlands | 2001 |
AA-System Houses | Alvar Aalto Finland | 1941-45 |
Foundation Saver | Victorine and Samuel Homsey USA | 1942 |
52 | Single family house Kazutaka Wakamatsu Japan | 1995 |
Appliance Houses | Alison Smithson Britain | 1956-58 |
Unitø d'habitation, Firminy Le Corbusier France | 1963 |
Diagoon Houses Herman Hertzberger The Netherlands | 1971 |
Wohnhaus Anton Schweighofer Austria | 1982 |
Fleksible Boliger Tegnestuen Volden Denmark | 1986 |
The Convertible House | Dovertel Construction Ltd. Canada | 1991 |
Next Home Avi Friedman Canada | 1996 |
Kettenhaus Becher and Rottkamp Germany | 2001 |
Rochdale | Proctor and matthews Architects Britain | 2007 |
The Adaptable House Development Group of the MHLG Britain | 1962 |
Brockley Park Estate Lewisham Architects Department Britain | 1978 |
46 | Projekt Wohnhaus Anton Schweighofer Germany | 1984 |
Am Steinberg / R thenbach Metron-Architekten AG | Germany | 1990 |
Variomatic nl Programmable housing | ONL The Netherlands | | 1999 |
Affordable Rural Housing Demonstration Project Gokay Deveci Britain | 2000 |
K lner Brett Brandlhuber and Kniess Germany | 1999 |
Atelierhaus Sigle Architekten Linie 4 Germany | 1998 |
Movable space dividers Fred J. Mac Kie, Jr. and Karl F. Kamrath USA | 1942 |
Single-Space House for Four People Gio Ponti Italy | 1957 |
Erasmuslaan | Gerrit Rietveld The Netherlands | 1931 |
Kleinwohnung | Carl Fieger Germany | 1931 |
Frey Haus | Ernst Plischke Austria | 1973 |
The Transformable Apartment Mark Guard Architects Britain | 1996 |
Fred | Kaufmann 96 Austria | 2000 |
Soft House Forsythe and MacAllen Design Canada | 2003 |
Werfthaus Otto Barthing Germany | 1932 |
Arbeitersiedlung Gwad Hans Fischli Switzerland | 1938 / 1952 |
Meudon | Jean Prouvø France | 1949-51 |
Wohnhaus Sch rer Fritz Haller Switzerland | 1969 |
42 | Molenvliet | Frans van der Werf, Werkgroep | KOKON | The Netherlands | 1977 |
Honor Oak Park Walter Segal, Jon Broome and self builders Britain | 1987 |
Montereau Les Frtres ArsLne-Henry France | 1971 |
Industrialized construction system Renzo Piano Building Workshop Italy | 1978-1982 |
Flexibo | F lles tegnestuen Denmark | 1976 |
Extendible houses t Hool J.H. van den Broek, J.B. Bakema The Netherlands | 1963 |
Wohnanlage Genter Strasse | Otto Steidle and partner Germany | 1972 |
Flexible Space | SOM Skidmore Owings and Merrill USA | 1942 |
Movable Boxes | Yona Friedman | 1949 |
Diagoon Houses Architectuurstudio Herman Hertzberger The Netherlands | 1971 |
41 | Wohnen Morgen Ottokar Uhl and Jos P. Weber Austria | 1976 |
Habitat Industriel "La Faye" Rudolphe Luscher Switzerland | 1989 |
Next Home Avi Friedman Canada | 1996 |
Cala Domus | PCKO Britain | 2005 |
41 | Les Marelles Bernard Kohn, Georges Maurios France | 1975 |
Les Marelles | Bernard Kohn, Georges Maurios | France | 1975 |
London Flexhouse Nouvelle Development Corporation Canada | 1996 |
Prefabricated House | Carl Koch USA | 1950
E.C.C.S. Steel Housing Square L-type system The Netherlands | 1967
Steelhouse Cedric Price Britain | 1967
Habitations industrialisées par éléments modulés en bois France | 1968
Sigma System Maurice Silvy France | 1969
Building kit for summer houses | Finland 1971
Fleksible boliger Tegnestuen Volden Denmark | 1986 |
Combinatoires Urbaines H. Maillard France | 1975 |
The Transformable Apartment | Mark Guard Architects Britain | 1996
Metastadt Germany | 1974 |
14 16 34 62 24 63 21 31 60 52 45 64 25 47 68 23 43 46 47 51 54 68 50 59 61 58 56 17 22 36 55 57 61 66 10 11 13 41 42 12 18 30 48 65 15 19 33 44 40 54 24 31 35 38 41 49 67 38 67 47 53
20 26 27 28 29 32 37 39 55

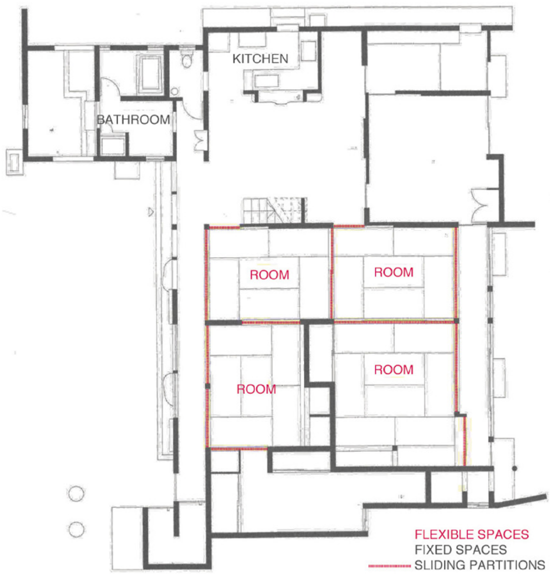


Figure 1.2-1
Traditional Japanese House - Ground Floor Plan
Source: Schneider et. al. (2007)

Precedent 01: Traditional Japanese House

Kazuhiko + Kaoru Obayashi
Japan | 1850/1995
Type: Single-detached house

The house consists of sliding partition walls that allow for a series of interconnected spaces that can be joined or divided as per the user's requirements. Due to the light weight nature of the partitions, the individual rooms cannot be acoustically isolated. This principle drives the flexible notion of indeterminacy. The open plan (Figure 1.2-1) and frame construction address functional and social changes with ease – both on a daily as well as on a periodic basis or across a lifetime. The sliding partitions allow for a change in the size and function of a space instantaneously. However, the actual flexibility of the house is entirely dependent upon the active participation of the users. Flexibility within this precedent is also achieved through a modular approach to design. The size of the rooms is based on the standard measure of tatami mats, with rooms comprised of a set of these mats (i.e. 6 or 8 mats, etc.); these, along with other building components are interchangeable (Schneider et al., 2007).

Precedent 02: Cottages

Britain | 1901
Type: Semi-detached house

The cottage exemplifies the inherent flexibility of generic space, which can be appropriated to changing social needs. This is achieved by keeping no obvious hierarchy between similar rooms (shape and proportion), in order to afford flexibility of function within the spaces provided. Therefore, on the ground floor the separately accessible rooms that would be typically designated as the living and dining rooms can be used to accommodate a variety of functions (i.e. guest room, study space, etc.) (Figure 1.2-2). The first floor contains three equally sized rooms with one shared bathroom. Hence the house could be occupied by either a single family, or even three to four independent persons sharing. Furthermore, there is also potential for the division of the two storey house into two separate units. This is possible due to the positioning of the stairs towards the front of the house (Schneider et al., 2007).

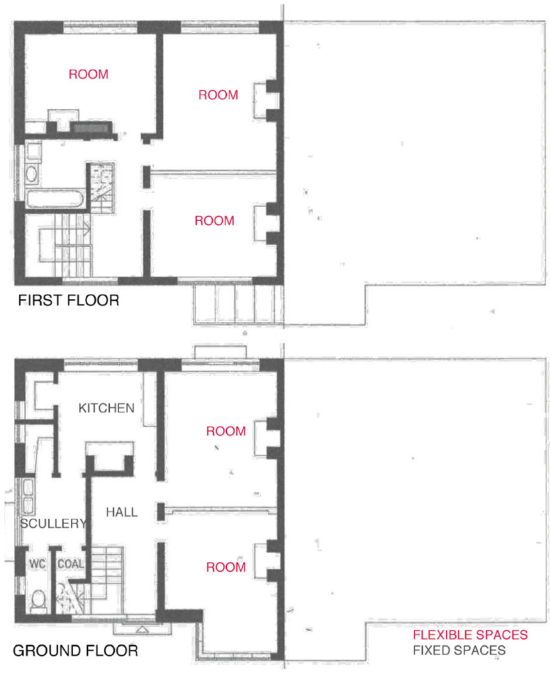


Figure 1.2-2
Cottages - Floor Plans
Source: Schneider et. al. (2007)

Precedent 03: Maison Dom-ino

Le Corbusier

1914

Type: Unrealized

The Maison Dom-ino exemplifies concepts that were adopted within many of Le Corbusier's famous modern villas. It was designed as a building prototype for mass-production, and can be seen as the precursor to the clear separation of support from infill in housing. The principle strategy is to separate the layout of the plan and the structural system in order to provide endless variations in the arrangement of the interior spaces. In general the skeleton consists of free-standing pillars and rigid floors (Figure 1.2-3). The structure becomes fixed, while the infill components are flexible (Schneider et al., 2007).

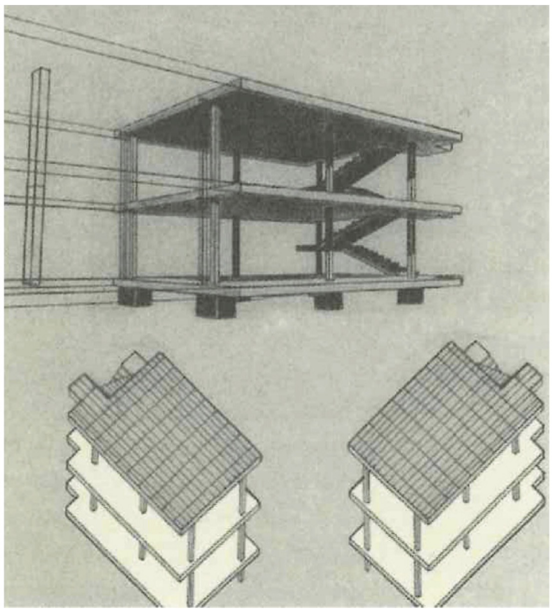


Figure 1.2-3
Maison Dom-ino System
Source: Schneider et. al. (2007)

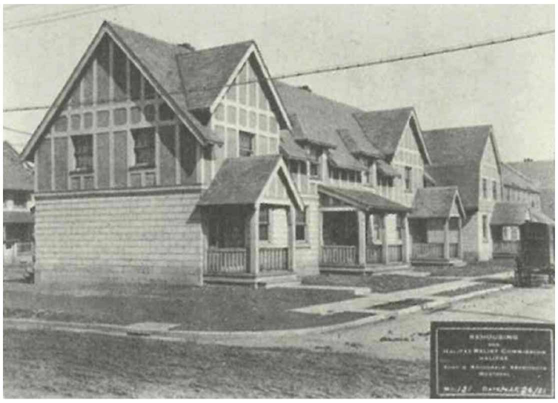


Figure 1.2-4
Hydrostone Development Homes
Source: Schneider et. al. (2007)

Precedent 04: Hydrostone

Thomas Adams

Canada | 1921

Type: Mixed use with single-, semi-detached and terrace houses

Each unit within the development (Figure 1.2-4) is based on a module of 120ft which has the potential to be subdivided into two 60ft, three 40ft, four 30ft, or six 20ft units. By this method flexibility is achieved through the strategy of dividing up. (Refer to section 4.0, strategy 7) (Schneider et al., 2007).

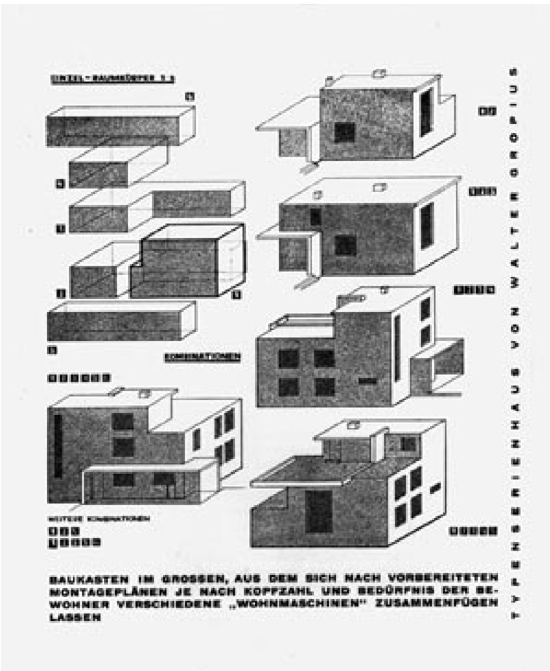


Figure 1.2-5
Haus Auerbach Diagrams
Source: Schneider et. al. (2007)

Precedent 05: Haus Auerbach

Walter Gropius + Adolf Meyer

Germany | 1924

Type: Single-detached house

This house was built based on a system developed by Walter Gropius and Adolf Meyer in 1923. This system was adapted from the individual elements of the 'Baukasten' (building blocks or meccanoo), which is a standardised housing system consisting of various cubic parts. This system allows for the formation of different volumetric combinations based on the number and needs of occupants (Figure 1.2-5) (Schneider et al., 2007).

Precedent 06: Schröder Huis

Gerrit Thomas Rietveld

The Netherlands| 1924

Type: End of terrace

This house has been regarded as the most fascinating epitome of flexibility throughout the twentieth century. However, due to the fact that this house was a highly tuned response to a very particular set of requirements, it is therefore problematic to extrapolate generic principles of flexibility from within it. In general the house is divided up across two storeys, with the central core containing the staircase. The ground floor is organized in a conventional in-flexible layout typical to traditional housing. The flexibility is experienced on the first floor, which accommodates hinged sectional moveable screens that allow for the creation of one single continuous space (Figure 1.2-6). Similar to the traditional Japanese house, here flexibility is largely dependent on the participation of the users. When the screens are removed from the plan they are stored behind short fin walls. When the screens are being used the central screen double up as a door, in order to allow for separate access to each room (Schneider et al., 2007).

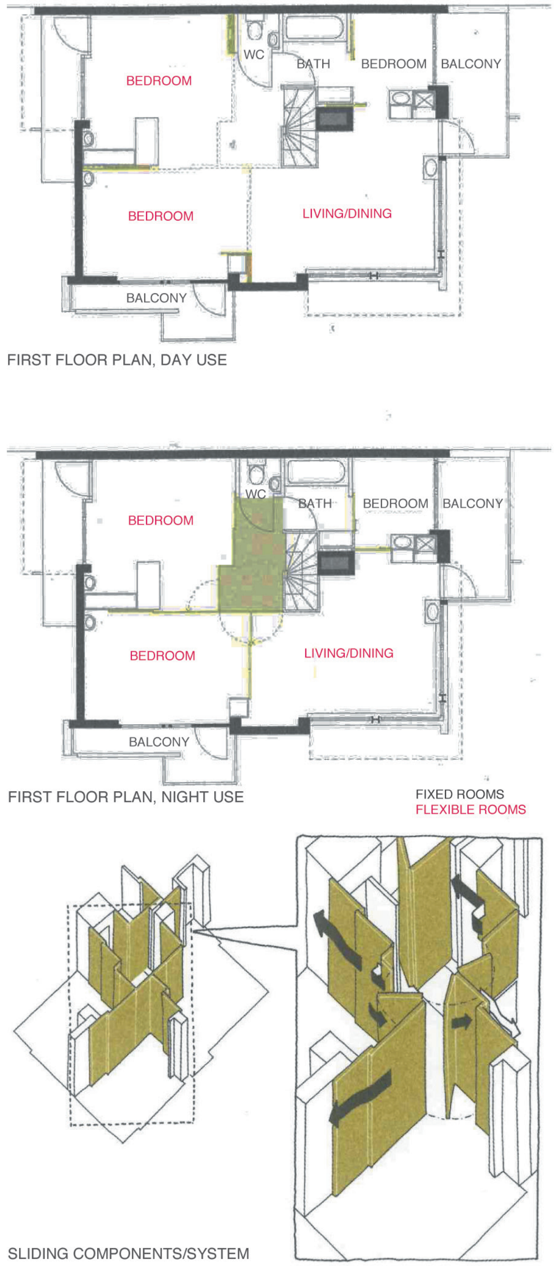


Figure 1.2-6
Schröder Huis Flexible Plans & System
Source: Schneider et. al. (2007)

Precedent 07: Quatiers Modernes Frugès

Le Corbusier

France | 1926

Type: Mixed use with single-, semi-detached and terrace houses

The entire development is based on a single open plan and one cell prototype that have been adapted into numerous variations (Figure 1.2-7). Apart from affording an open plan, the units also have an independent staircase and non-loadbearing interior walls; giving it a degree of

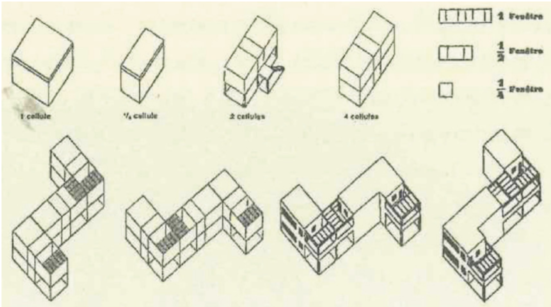


Figure 1.2-7
Quatiers Modernes Frugès
Source: Schneider et. al. (2007)

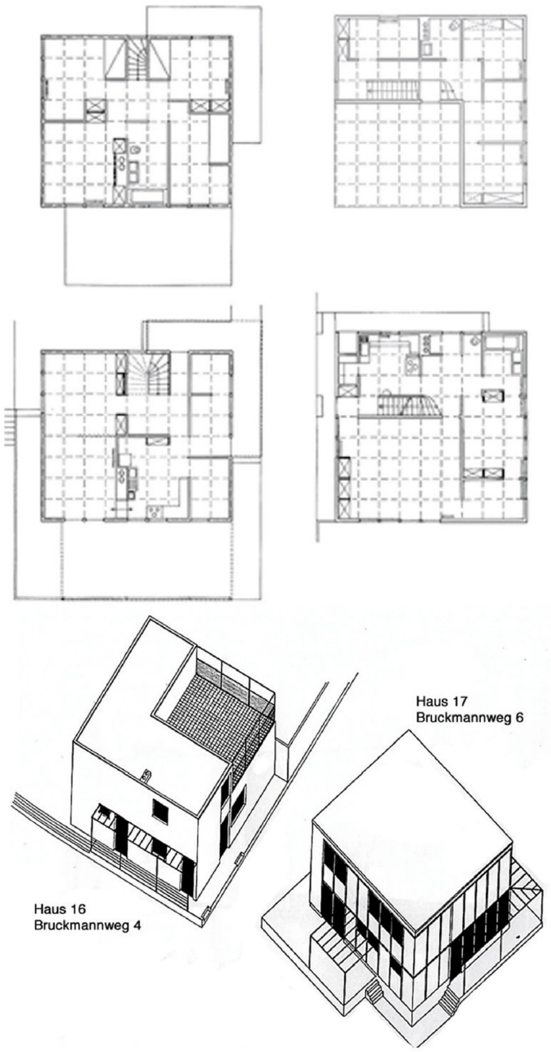


Figure 1.2-8
WeiBenhofsidlung, Haus 16 & 17 - Plans & Drawings
Source: Schneider et. al. (2007)

flexibility within (Schneider et al., 2007). The project is most recognized for its adaptation over time by its occupants, “overwhelming the modernist orthodoxy with an everyday architecture, as documented by Boudon” (Schneider et al., 2007, p.205).

Precedent 08: WeiBenhofsiedlung, Haus 16 & 17

Walter Gropius

Germany | 1927

Type: Single-detached house

These two houses by Gropius demonstrate the architect’s abiding interest in the concept of prefabrication. The projects consist of industrially produced components that can be put together in an infinite number of ways, in order to allow a degree of choice for the user (Figure 1.2-8) (Schneider et al., 2007).

Precedent 09: Maisons Loucheur

Le Corbusier

France | 1928/9

Type: Semi-detached

This project was a response to the government program “Loi Loucheur”, under which a total of 200,000 dwellings for sale and 60,000 for rent were built within five years (however, still less than the requirement of 1 million dwellings). Le Corbusier had been working on the idea of an adaptable floor plan since his Maison Dom-ino project (1914). For this particular project he proposed a small raised building of 46m2 which comprised of moveable and fold down furniture in order to utilize the compact space in the most efficient manner throughout the day. According to his calculations, by doubling the uses within each area the house expands to the equivalent of 71m2.

Two units are separated by a thick stone wall which acts as the backbone for the units. The units were envisaged as entirely prefabricated, and were designed for a family with up to four children. All functions are organized around the central freestanding bathroom. The large room can function as a dining room and other daytime activities (Figure 1.2-9). The kitchen can be shut away by means of a sliding screen. Beds disappear beneath built-in wardrobe elements, hence affording space for a work or study table. The area under the building can be appropriated by the user based on their needs. It can function as a car port, storage, workshop, etc. (Schneider et al., 2007).

Precedent 10: Housing Block Erasmuslaan

Gerrit Rietveld

The Netherlands | 1931

Type: Terrace

The houses within this development simplify some of the principles developed by Rietveld in the Schröder Huis. The open floor plan is based on a one-metre module and a structural system that allow free subdivision of the space. Folding concertina walls on the ground floor, guided on floor and ceiling tracks, allow for the space to be adjusted and subdivided in a flexible manner

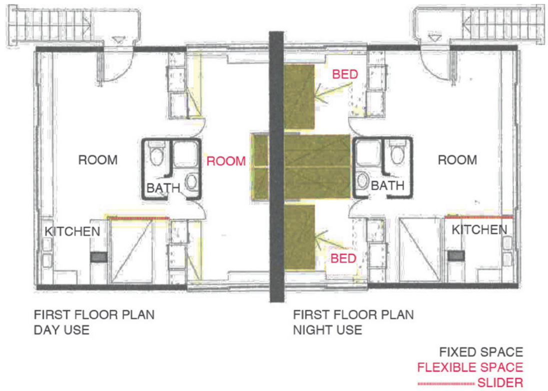


Figure 1.2-9
Maisons Loucheur - Floor Plans (Day Use & Night Use)
Source: Schneider et. al. (2007)

Figure 1.2-10
Housing Block Erasmuslaan - Floor Plans
Source: Schneider et. al. (2007)

(Figure 1.2-10). The upper storeys are divided more conventionally through partitions walls, with all rooms having separate access off the vertical circulation core. Each living unit groups the kitchen, bathroom and staircase to one side and encloses them with fixed walls. These are the only fixed elements in plan, while the remaining space is flexibly arranged with concertina walls (Schneider et al., 2007).

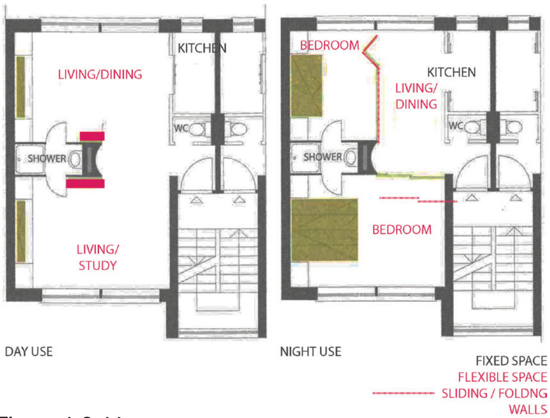


Figure 1.2-11
Kleinwohnung - Floor Plans
Source: Schneider et. al. (2007)

Precedent 11: Kleinwohnung

Carl Fieger

Germany| 1931

Type: Study

This apartment was built as a prototype of minimal dwelling for the berlin building exhibition in 1931. The 40m^2 two bedroom apartment can be transformed into living and dining room plus study space during the day. This transformation is mainly achieved through foldable furniture and sliding walls (Figure 1.2-11). The foldable furniture affords the opportunity for other activities to happen within the same space. The washroom and shower room are the only fixed elements within the plan (Schneider et al., 2007).

Precedent 12: Werfthaus

Otto Bartning

Germany |1932

Type: Study

This project was produced for the 1932 German competition entitled Das Wachsende Haus (The Growing House), which sought to provide solutions for an affordable and adaptable house.

The basis of the competition was to encourage designs that initially comprised of a core house that could be expanded in stages according to the financial means of the occupants. However, the adaptability and extendibility of the house were to be designed-in from the initial design stage, and not as an afterthought. Otto Bartning's submission is translated to Shipyard House, which refers to its place of production. The house is entirely prefabricated comprising of a thin steel frame filled in with panels. The core house is a 25m^2 box which provides a small hall, a bathroom, a kitchen and a combined living/ sleeping area. The idea is that the house can expand overtime using the same set of elements used within the core house (one door panel, one solid panel, one panel with a large window and one with integrated smaller windows) (Figure 1.2-12). Prefabrication allows for the easy and fast assembly and disassembly of the house. The internal plywood partitions are bolted to the floor and ceiling, allowing for quick dis- and re-assembly at another site as well as flexibility of internal and external configurations (Schneider et al., 2007).

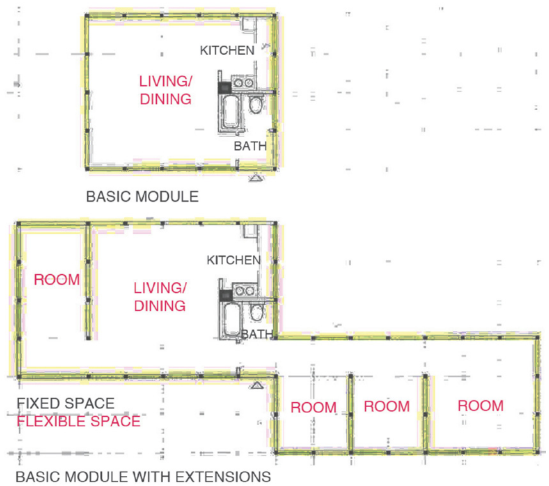


Figure 1.2-12
Werfthaus - Floor Plans
Source: Schneider et. al. (2007)

Precedent 13: Arbeitersiedlung Gwad

Hans Fischli
Switzerland | 1938/1952
Type: Terraced house

Within this house the upper storey can be extended from a basic gallery with bathroom and bedroom to a fully developed upper level that contains a bathroom and up to four bedrooms (Figure 1.2-13) (Schneider et al., 2007).

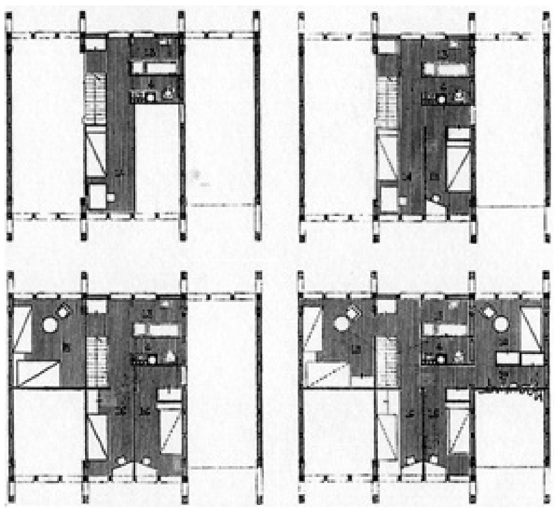


Figure 1.2-13
Arbeitersidlung Gwad - Floor Plans
Source: Schneider et. al. (2007)

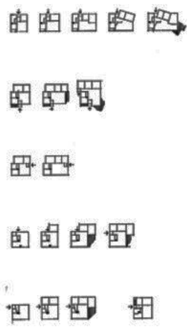


Figure 1.2-14
AA-System Houses Diagrams
Source: Schneider et. al. (2007)

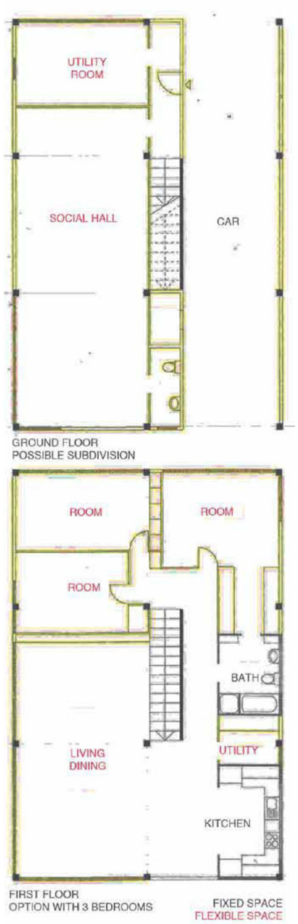


Figure 1.2-15
Flexible Space -Plans
Source: Schneider et. al. (2007)

Precedent 14: AA-System Houses

Alvar Aalto

Finland |1941-45

Type: Detached houses

These prefabricated dwellings were designed to address the housing needs of the people who were left homeless after the war. According to Aalto, this system is an example of “flexible standardisation’, as it comprises a basic core that can then be added to over time. The project utilizes standard building parts referred to by Aalto as “living cells” that have the potential to grow in various ways (Figure 1.2-14) (Schneider et al., 2007).

Precedent 15: Flexible Space

William Wilson Wurster

USA | 1942

Type: Study

This project was conceived for “The new house 194X” competition. The architect’s manifesto stated the inherent and fixed problems of residential dwellings: unalterable areas, arrangements with permanent wall partitions, and a size that is usually limited to minimum initial needs that is impossible to expand except at considerable expense. In response to these, within this project he proposes a fixed outer shell – an undivided space of 36ft by 54ft, which is raised one storey above the ground, with a long staircase in the centre of the narrow plan. Flexibility within this project relies upon the principle of subdivision. Hence, the project provides an abundance of inexpensive space that can be adjusted over time. Within the one-floor house, the architect utilizes the concept of raw space (space that is as simple and economical as loft construction), allowing for maximum openness to complete division (Figure 1.2-15). All internal units are factory-fabricated for space division and storage. These are conceived in two standard sizes in two heights that cater for all needs: closets, shelves, sideboard, storage cupboard, ironing equipment, laundry dry unit, etc. Similar to Maisons Loucheur, additional space beneath the house is provided for expansion or flexible adaptation (Schneider et al., 2007).

Precedent 16: Foundation Saver

Victorine + Samuel Homsey

USA | 1938

Type: Unrealized

This project comprises of one interior partition which contains all necessary plumbing. The remaining spaces are subdivided in a flexible manner by means of movable partitions, in order to address changing family requirements (Figure 1.2-16) (Schneider et al., 2007).

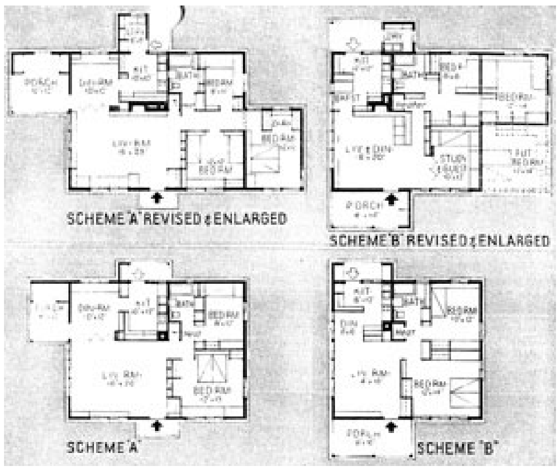


Figure 1.2-16
Foundation Saver - Plans
Source: Schneider et. al. (2007)

Precedent 17: Movable Space Dividers

Fred James MacKie, Jr. + Karl Fred Kamrath

USA | 1942

Type: Unrealised

The project consists of a large open space, based on a modular grid that can be divided into numerous smaller spaces by means of movable partition walls (Figure 1.2-17). These partition walls are stored in closets when not in use

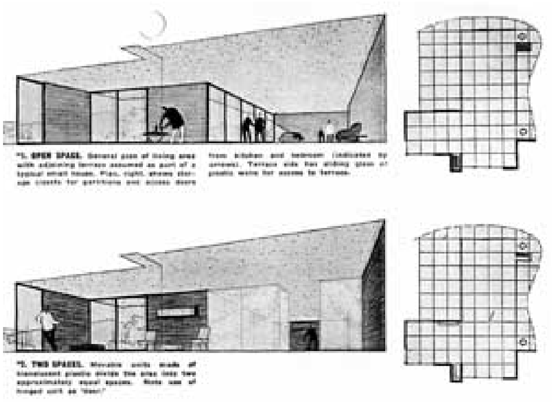


Figure 1.2-17
Moveable Space Dividers-Diagrams & Sections
Source: Schneider et. al. (2007)

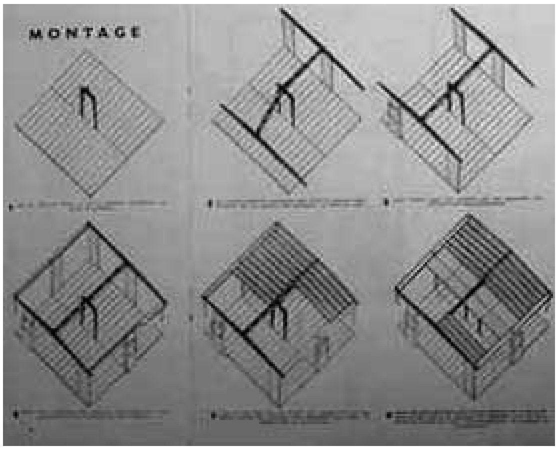


Figure 1.2-18
Meudon Diagrams
Source: Schneider et. al. (2007)

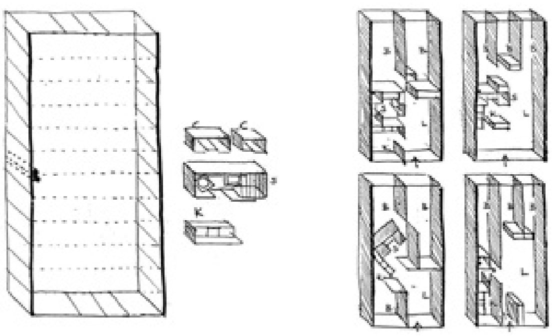


Figure 1.2-19
Moveable Boxes Diagrams
Source: Schneider et. al. (2007)

(Schneider et al., 2007).

Precedent 18: Meudon

Jean Prouve

France | 1949-51

Type: Single-detached house

The Meudon houses were produced as a project for standardised housing commissioned by the French ministry of Reconstruction. They comprise of a kit of parts similar to a Citroen 2CV car (Figure 1.2-18). The plan is based on a 1m module with all panels interchangeable. The initial scheme consists of 14 variations on two unit types (Schneider et al., 2007).

Precedent 19: Movable Boxes

Yona Friedman

1949

Type: Unrealised

During the Second World War, two or more families typically had to share a single room that was commonly divided with furniture. This project is based on that concept, where a shell in the interior layout of the house was left to the inhabitants to determine. All sanitary and kitchen units and closet partitions within the house are conceived as lightweight boxes that can be moved around as the occupant desires (Figure 1.2-19) (Schneider et al., 2007).

Precedent 20: Prefabricated House

Carl Koch

USA|1950

Type: Single-detached house

All fixed elements including the kitchen, bath, utility room, wiring and plumbing, heating, etc. are accumulated within a central core. The walls, floor and roof of the rooms are comprised of hinged and folded panels against the core. Once positioned on site, these panels are unfolded and bolted into position (Figure 1.2-20) (Schneider et al., 2007).

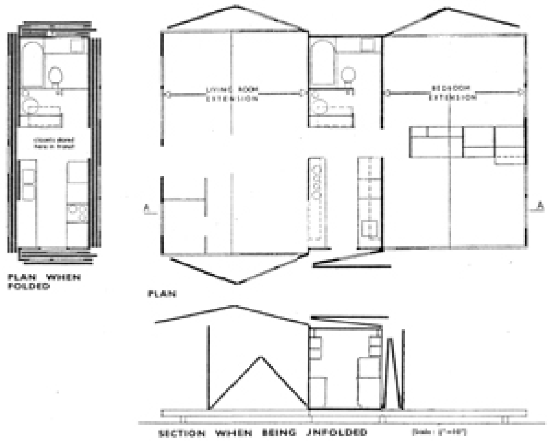


Figure 1.2-20
Prefabricated House Diagrams
Source: Schneider et. al. (2007)

Precedent 21: Appliance Houses

Alison Smithson
Britain | 1956-58
Type: Unrealised

These houses were intended for mass-production and designed to be grouped in a variety of ways. The interior consists of a series of 'appliance' cubicles – updated versions of bathrooms and kitchens – with service connections and storage (Figure 1.2-21). These are the only fixed elements in the plan and they define the architectural form of the house. The service connections are considered 'growth points' for constantly changing appliances. Other activities are dispersed around these appliance cubicles. In plan, the earliest appliance house reverts back to the vernacular village compound. The Strip House (1957-8) is a later version that represents a looser reworking of the modernist open plan with numerous appliance cubicles freely arranged in a large open space, in which activities can occur in a flexible manner (Schneider et al., 2007).

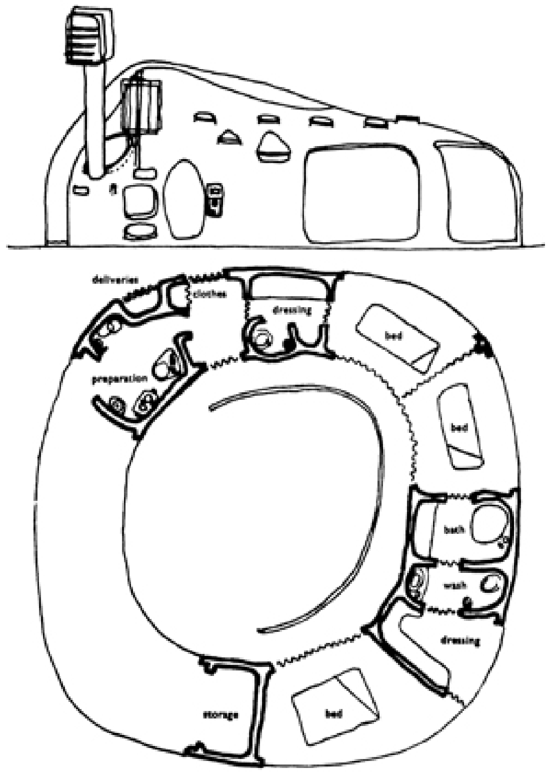


Figure 1.2-21
Appliance House - Plan & Section
Source: Schneider et. al. (2007)

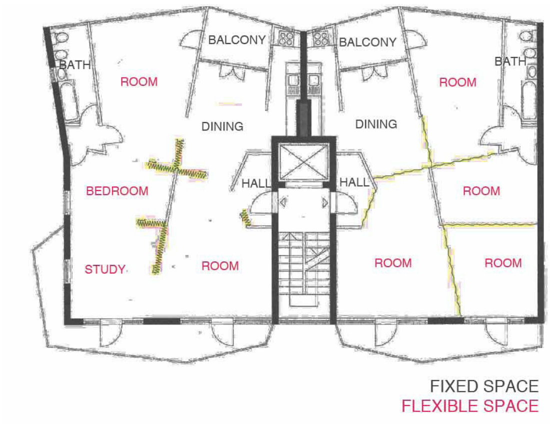


Figure 1.2-22
Typical Floor Plan: Open & Closed Partitions
Source: Schneider et. al. (2007)

Precedent 22: Single-Space House for Four People

Gio Ponti

Italy | 1957

Type: Study

The main concept in this project is that of a single open space that is surrounded by the essential minimum of services, with kitchens and bathrooms pushed to opposite sides. Concertina panels are utilized within the interior space in order to allow for a variety of potential spaces and use patterns (Figure 1.2-22). A series of angled sections of wall provide the connection point for concertina panels. Even though areas can be physically isolated, they cannot be acoustically isolated (Schneider et al., 2007). According to Schneider and Till (2007, p.71) "the occupation of the house, whilst suggestive of flexible use, is actually over-determined by the design".

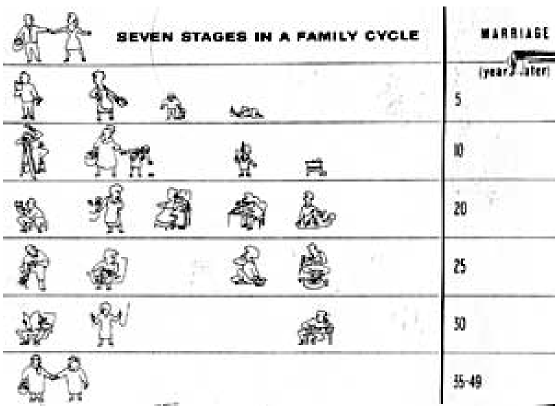


Figure 1.2-23
The Adaptable House - Seven Stages Diagram
Source: Schneider et. al. (2007)

Precedent 23: The Adaptable House

Development Group of the MHLG

Britain |1962

Type: Study

This precedent emphasises the changeability of the plan as a means for providing flexibility. The design of this house was based on the findings published in the seminal Parker Morris report in 1961. According to the report emphasis was placed on adaptability for future needs. While this concept had been previously stressed in the 1930s, it became a central focus again in the 1960s and 1970s. The architects illustrated this concept within a diagram that differentiated between the seven stages in a family's cycle of the period of fifty years (Figure 1.2-23). The stages were as follows: marriage, the arrival of two children within five years, another child within the next five years, the growing up of children, their leaving the house gradually, up until the final stage when the couple is one their own again.

This concept is accommodated within the architecture of the Adaptable House through the provision of a two-storey L-shaped house with a kitchen, dining room/ play space, WC and another additional room on the ground floor (Figure 1.2-24). This additional room can be accessed from the entrance hall as well as through a door in the living room and can be used for a variety of functions (i.e. guest room, rec room, etc.). Depending on the number of occupants within the dwelling, a large space to one side of the staircase can be appropriated into two rooms (Schneider et al., 2007).

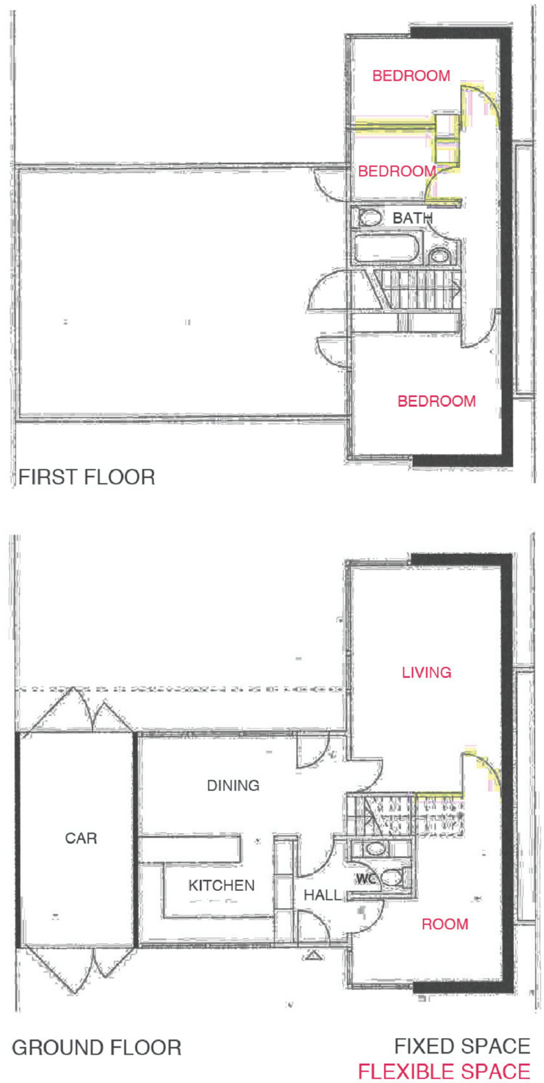


Figure 1.2-24
The Adaptable House - Floor Plans
Source: Schneider et. al. (2007)

Precedent 24: Extendible houses 't Hool

Johannes Van den Broek, Jacob Bakema
The Netherlands | 1963
Type: Study

This project is an example of intentionally planning for future expansion, something that is often overlooked within traditional housing design. The house is narrow following the dimensions of its elongated plot of land similar to a nineteenth century British terraced house. The core house comprises a small front yard, a

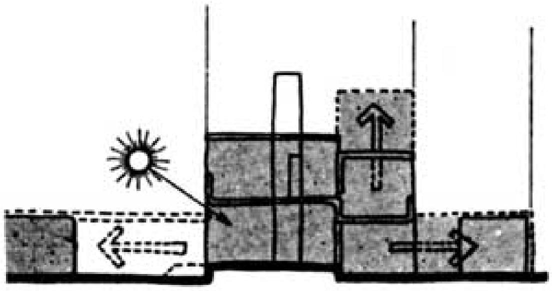


Figure 1.2-25
Extendible House Expansion Diagram
Source: Schneider et. al. (2007)

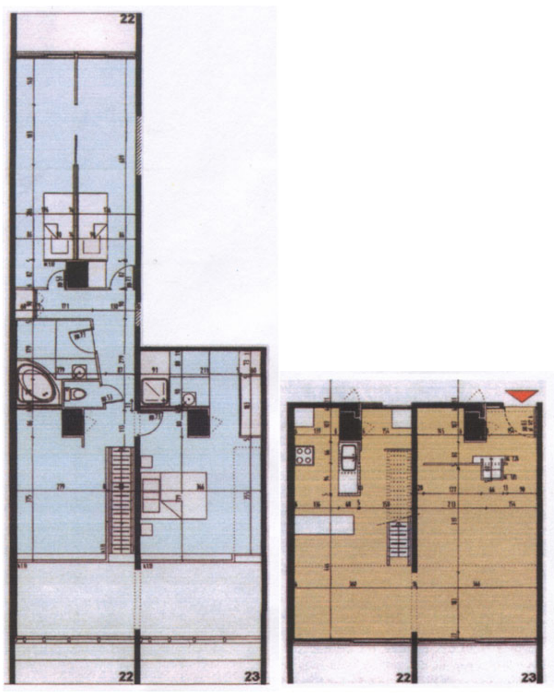


Figure 1.2-26
Unite d`habitation at Firminy - Plans
Source: Schneider et. al. (2007)

kitchen with direct access to the backyard, and a combined dining and living room on the ground floor. The core house in its smallest state also consists of a second storey, which contains three rooms. This unit is designed to be expanded by pushing out horizontally to the front and back, and vertically upwards (Figure 1.2-25). At the front, there is enough slack space to allow for the construction of an additional room (i.e. garage). Similarly the entire back yard can be transformed into a series of rooms that are organised around a courtyard, which almost doubles the usable space on the ground floor. In addition, planning permission also allows for vertical expansion above the first floor flat roof (Schneider et al., 2007).

Precedent 25: Unité d'habitation at Firminy

Le Corbusier
1963
Type: Multi-storey apartment block

This project is based on the 'bottle rack principle', in which an open structural frame (the rack) has the potential to be in-filled with different unit types (the bottles) (Figure 1.2-26). This building was refurbished in 1996 to suit contemporary space requirements. Since its construction it has experienced numerous alterations including the combining of two adjoining units into one (Schneider et al., 2007).

Precedent 26: Square L-Type System

Johannes Van den Broek, Jacob Bakema
The Netherlands | 1967

Type: Study

This project was a response to an international competition, tendered by the European Community for Coal and Steel for a housing group executed with industrialised building elements. The project is a combination of prefabricated systems with a repetitive module that can be deployed into a number of configurations over time (Figure 1.2-27). The competition entry illustrated an urban block with compositions of varying heights from one storey to sixteen storeys. In its entirety the project consists of multiple modules of the same size of 6.3m by 6.3m, which can be stacked vertically and added onto horizontally as well. The basic module has the capacity to be self-sufficient (i.e. a single room or apartment) or can be combined with other modules to fulfill the needs for larger dwellings. The primary construction of repetitive modules enables the system to adapt to different urban planning situations. Once in place the modules are filled in with a secondary system that consists of floor and ceiling panels, a series of differently sized wall and window elements, prefabricated bathroom pods and kitchen units (Schneider et al., 2007).

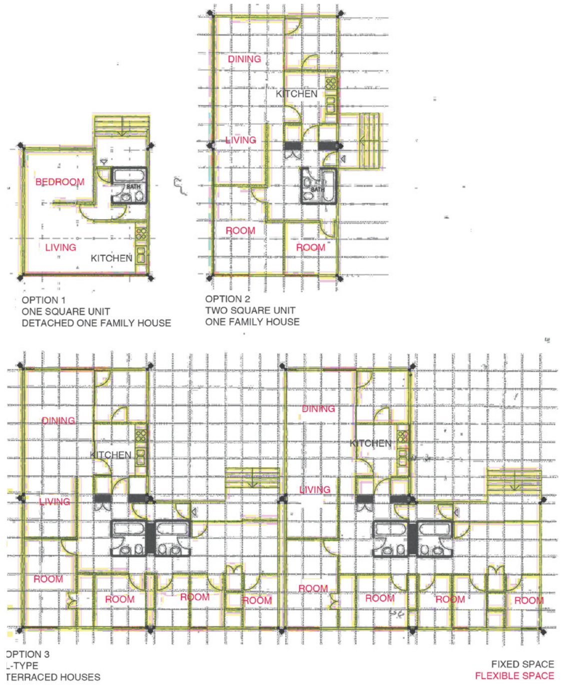


Figure 1.2-27
Square L-Type System Arrangments
Source: Schneider et. al. (2007)

Precedent 27: Steelhouse

Cedric Price
UK | 1967
Type: Unrealised

This project was designed as a response to the increasing requirements for a less definitive space. The main concept was to provide a space

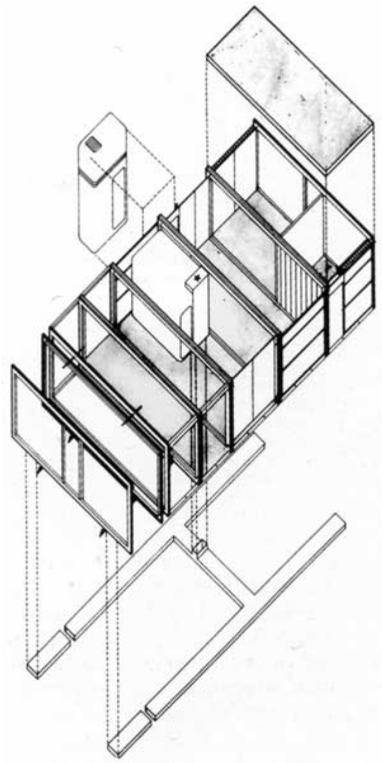


Figure 1.2-28
Steelhouse Components
Source: Schneider et. al. (2007)

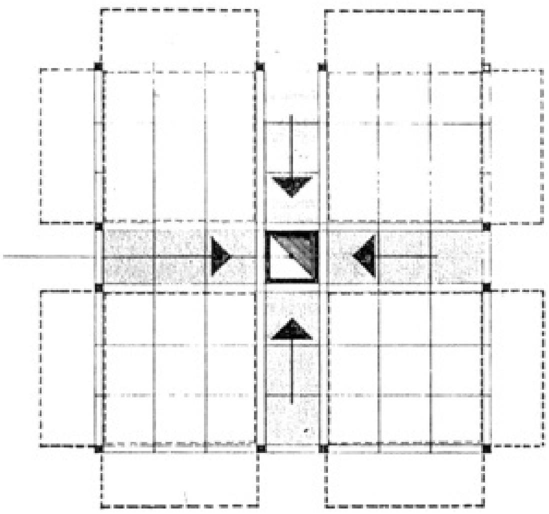


Figure 1.2-29
Habitations industrialisées par élements modulés en bois
Source: Schneider et. al. (2007)

with maximum variation of possible uses. The plan includes a shared activity area that is variable over a 24-hour cycle, alternative access routes (both internal and external), capacity for subdivision into two dwelling units, and the possibility of permanently fragmented 'home' with self-contained units and separate external access (Figure 1.2-28) (Schneider et al., 2007).

Precedent 28: Habitations industrialisées par éléments modulés en bois

Jean Fatosme with Alois Bachmann
France | 1968
Type: Residential and other uses

This project comprises of industrialized houses with standardised timber units in order to create a system for varied uses providing maximum adaptability and possibilities for extension. The plan is cross-shaped with a central installation core, and is divided into 'cabines servantes' (i.e. WC, bathroom cupboards and kitchenette), and boxes (i.e. dining room, bedroom, living room or terrace) (Figure 1.2-29) (Schneider et al., 2007).

Precedent 29: Sigma System

Maurice Silvy
France | 1969
Type: Multi-storey apartment block

This project takes precedence from the Danish Conbox system – a framework in which prefabricated concrete units (Figure 1.2-30) are integrated. The Sigma System relies on a similar process where units are delivered to site almost finished with only joints and mains to be connected on site during assembly (Schneider et al., 2007).

Precedent 30: Wohnhaus Schärer

Fritz Haller

Switzerland | 1969

Type: Single-detached

Fritz Haller proposed 'Maxi architecture' which predicted the following flexible criteria: exterior and interior features like windows and doors could be dismantled and moved within a steel framework whose elements were based on a modular measurement of 120/60cm (Figure 1.2-31). The architect moved forward to conceive Midi and Mini systems that were used for small-scale projects, including the Wohnhaus Schärer (Schneider et al., 2007).

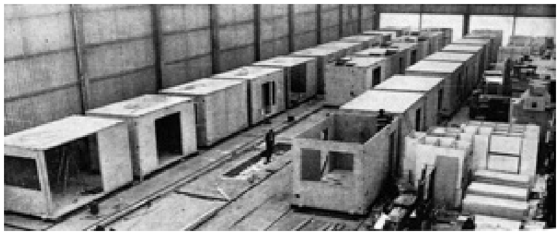


Figure 1.2-30
Sigma System Prefab Units
Source: Schneider et. al. (2007)

Figure 1.2-31
Wohnhaus Schärer - Plan
Source: Schneider et. al. (2007)

Precedent 31: Diagoon Houses

Herman Hertzberger

The Netherlands | 1971

Type: Terrace

These houses were conceived as 'incomplete buildings' since a basic frame left space for the personalised interpretation of the user in terms of number of rooms, positioning and functional uses within the interior. Unlike the typical manner in which dwellings are conceived, these houses hand over the power of design to the occupant. It is up to the occupants to decide the internal arrangement of the space. Changes to family structure can be accommodated by adjusting the house and expanding it to a certain

Figure 1.2-32
Diagoon House - Plan & Section indication Slack Space
Source: Schneider et. al. (2007)

extent. According to the architect, the structural skeleton used in this design is considered a half-product, something that everyone can complete according to his own needs and desires. Within the plan there are two fixed cores, one containing the staircase and the other equipped with the kitchen and bathroom on different levels. The surrounding space is open for flexible use. There is also opportunity for expansion in a few areas of slack space surrounding the house (Figure 1.2-32). Despite their open plan, these houses are not just neutral buildings that offer an infinite number of options; they provide a framework and give indications as to the possibilities of spatial arrangement causing a tension between architectural intent and user control (Schneider et al., 2007).

Precedent 32: Building Kit for Summer Houses

Kristian Gullichsen and Juhani Pallasma

Finland | 1971

Type: Single-detached house

Prefabricated building elements are combined within a kit, and can be arranged in numerous combinations (Figure 1.2-33). Approximately 60 summer houses were designed and built using this building kit (Schneider et al., 2007).

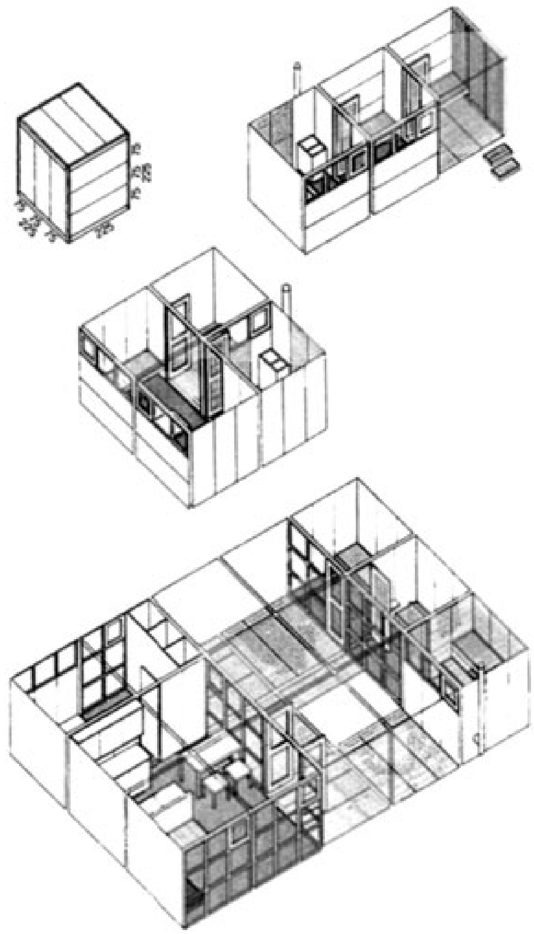


Figure 1.2-33
Building Kit for Summer Houses - Configuration Diagrams
Source: Schneider et. al. (2007)

Precedent 33: Montereau

Les Frères Arsène-Henry

France | 1971

Type: Multi-storey apartment house

This project utilizes some of the principles of

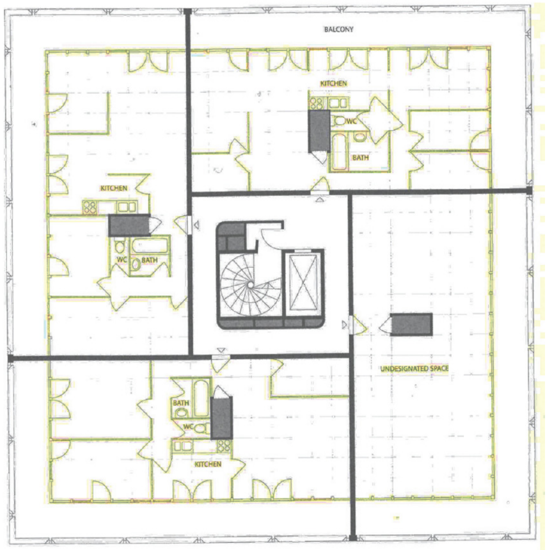


Figure 1.2-34
Montereau - Floor Plan
Source: Schneider et. al. (2007)

the speculative office block in order to achieve flexibility in housing. Unobstructed plans are achieved through the use of long-span concrete floors, so that each dwelling unit is without cross-walls or intermediate columns. Within each floor plan, four apartment units are grouped around a central core containing the communal staircase and an elevator (Figure 1.2-34). Within each unit a vertical core is placed in order to house all service functions. The kitchen and bathroom, typically the most fixed elements of a plan are grouped around this service core, freeing the surrounding space for flexible usage. External space for every room is provided via a balcony that wraps around the entire floor. The interior partitions are made from hollow core chipboard, and held in place with friction screws. During the initial design of each unit occupants were afforded the choice of defining the internal space plan based on their needs. In the end no two plans were the same (Schneider et al., 2007).

Precedent 34: Extendible Houses

Derek Walkker, Bill Berrett, Will Pope

Britain | 1972

Type: Terraced house

This project follows the strategy of potential future expansion within a 1.20m planning module. The basic unit comprises a bathroom/ kitchen and living/sleeping areas (Schneider et al., 2007).

Precedent 35: Wohnanlage Genter Strasse

Otto Steidle and Partners

Germany | 1972

Type: Terrace

These houses were built in three phases in the early 1970s, and show the development and technical refinement of a single principle of flexibility: support and infill. Within the first phase, a row of seven houses were built using a prefabricated reinforced concrete skeleton with corbels on every half storey onto which cross beams can be placed; these were intended to provide a visual indication of the possibility of future change (Figure 1.2-35). The frame is then filled-in with a purpose made system of glazing and solid panels that can be changed at will, though in practice it has not been modified by the tenants. Within the second phase, seven units use the 'Elementa' system, a simplified reinforced concrete skeleton of columns with longitudinal down stand beams and ceiling panels. Prefabricated wet cores are used in order to provide the necessary structural integrity. Within the third phase, a reinforced concrete skeleton system and a more refined proprietary infill cladding issued. There are some differences in the way that structure is expressed within the three phases. The first phase comprises an open structure, unlike the encased structure of the latter two phases. Differences in span are also obvious. The principle of flexibility afforded by the architect in this system is that which provides excess space from the initial stage, which can be claimed over time as usable space.

Figure 1.2-35
Wohnanlage Genter Strasse - Exterior View
Source: Schneider et. al. (2007)

Due to the clarity between loadbearing and non-loadbearing elements, interior walls can be altered easily according to the user's needs (Schneider et al., 2007).

Precedent 36: Frey Haus

Ernst Plischke

Austria | 1973

Type: Single-detached house

Large screens are employed within the building's ground floor in order to open up or close down different areas, so that they can be used independently from each other as one continuous space in order to meet the changing user requirements (Schneider et al., 2007).

Precedent 37: Metastadt

Richard Dietrich

Germany | 1974

Type: Building system (failed)

Similar to the Square L-Type system, this building system was supposed to provide a concept for a flexible model of urbanism. The underlying principle of this scheme is that of a space plan which is supposed to have the capacity of unlimited horizontal and vertical growth (Figure 1.2-36). The main structural module is 4.2m by 4.2m and 3.6m high, with an interior module of 0.6m. The main column support is situated at every 16.8m span, and cantilever spans can measure up to 8.4m. The space frame structure is bolted to allow easy assembly and disassembly, while the various elements of the system including the loadbearing structure,

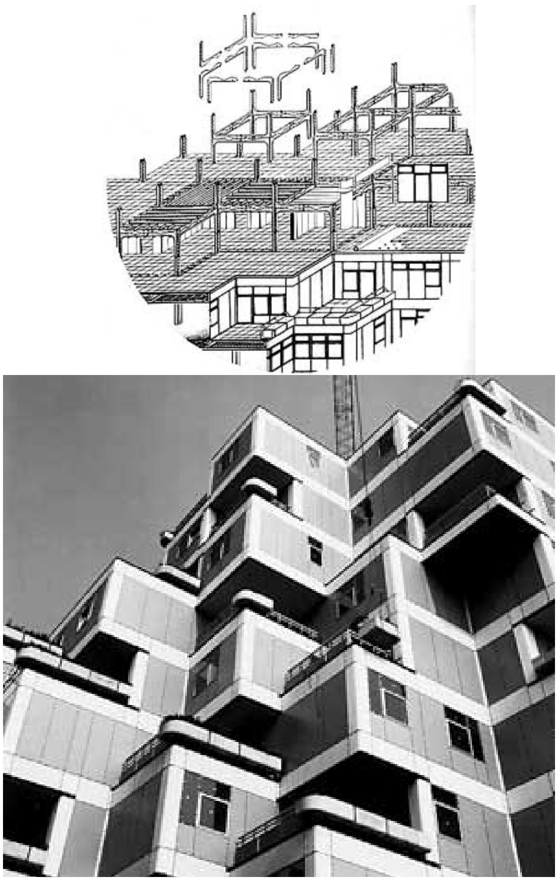


Figure 1.2-36
Metastadt System Diagram and Photograph
Source: Schneider et. al. (2007)

non-loadbearing panels and services were kept independent. This concept is similar to Moshe Safdie's Habitat 67 proposal for the Expo 67. Similar to Safdie's project, Metastadt also failed to match the promises that it proclaimed. The building was demolished in the 1980s (Schneider et al., 2007).

Precedent 38: Les Marelles

Bernard Kohn, Georges Maurios

Location | date

Type: Multi-storey apartment block

Developed as an experimental housing project of 100 dwellings this apartment block was built with the intention to provide a flexible habitat. The basic construction comprises a repetitive square frame (4.65mx4.65m). U-shaped beams collect and distribute horizontal services which rise or drop in massive hollow columns of 0.75m by 0.75m. This network of beams allow for the flexible placement of kitchens and bathrooms along the ducts (Figure 1.2-37). These elements, along with partitions and facades can all be selected from a catalogue and are designed for interchange-ability. The central staircase can serve up to four apartments; hence allowing occupants to determine the size of the units along with their internal layouts. There is no typical plan as each apartment is different in layout as well as the location of its perimeter walls. The only common elements are the use of the same partitions, and elements, but they are never in the same place twice (Schneider et al., 2007).

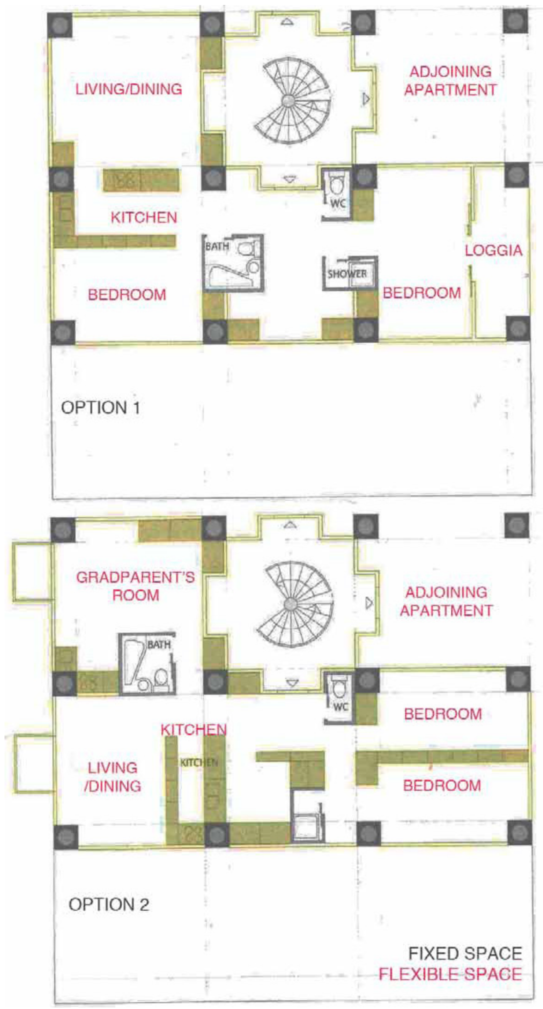


Figure 1.2-37
Les Marelles - Plan Options
Source: Schneider et. al. (2007)

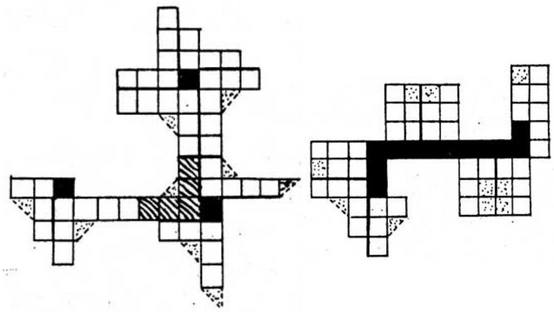


Figure 1.2-38
Combinatoires Urbaines - Concept Diagram
Source: Schneider et. al. (2007)

Precedent 39: Combinatoires Urbaines

Henri-Pierre Maillard
France | 1975
Type: Unrealised

Structural modules of 4.5m by 4.5m can be connected in a multitude of arrangements to form one residential unit (Figure 1.2-38). The project affords the possible use of several forms of construction (Schneider et al., 2007).

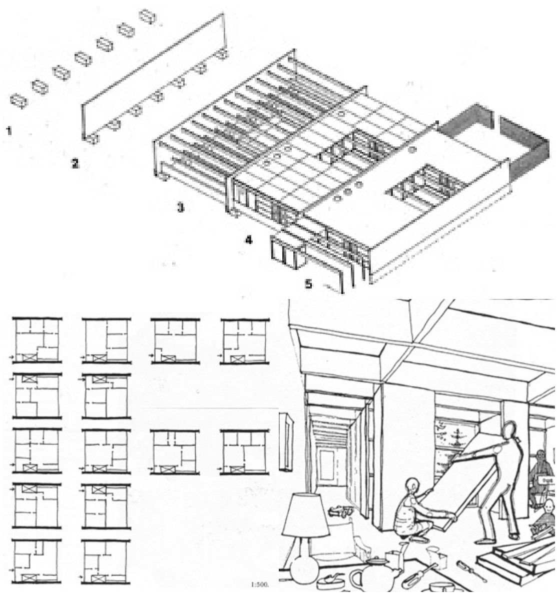


Figure 1.2-39
Flexibo - Concept Diagrams
Source: Schneider et. al. (2007)

Precedent 40: Flexibo

Faellestegnestuen
Denmark | 1976
Type: Terrace

68 one- and two-storey dwellings were designed for Copenhagen's public housing Association (KAB). The basic frame of the building consists of prefabricated components of concrete and laminated timber, and cannot be altered (apart from adding smaller parts such as a pergo(a). however, the interior is based on a modular wall system, which can be changed or appropriated by the occupants. The principle of layers is also employed as a flexible strategy within the project. Parallel concrete walls provide the dividing perimeters of each unit. The only fixed elements within the interior are the bathrooms and kitchen. Within the modular grid system, the interior of each unit can be arranged at will. The construction system allows walls to be moved around with ease, in order to adapt any layout to different needs overtime (Figure 1.2-39). Based on a study conducted three years after

occupation, residents had altered several aspects of the original plan (Schneider et al., 2007).

Precedent 41: Hollabrunn

Ottokar Uhl and Josef Weber

Austria | 1976

Type: Terrace

This project addresses the issue of building for the unknown future user. The SAR method of support and infill developed by Habraken is considered as the starting point: primary and secondary structure are separated; a modular dimensional system is adopted to coordinate all elements; the system is designed to be open to accommodate any materials and forms of technology; zones are defined to accommodate various functions (Figure 1.2-40). With the help of the architects and sociologists, occupants were able to choose the arrangement of walls within the support structure of the dwelling as well as the size and arrangement of the units (Schneider et al., 2007).

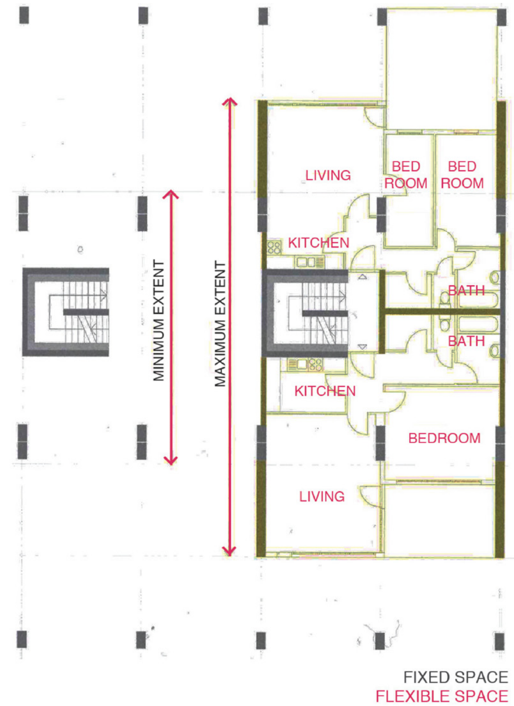


Figure 1.2-40
Hollabrun - Flexible Floor Plan
Source: Schneider et. al. (2007)

Precedent 42: Molenvliet

Werkgroep KOKON

The Netherlands | 1977

Type: Urban block

Similar to Hollabrunn, this project fulfills the promises of the SAR support and infill methodology as well (Schneider et al., 2007).

Precedent 43: Brockley Park Estate

Lewisham Architects Department

Britain | 1978

Type: Terraced Houses

This project comprises 89 residential units with two to three storeys. It can accommodate large and small families while also responding to changes in family size. The standard dwelling unit comprises a two-storey house, in which the two large upper rooms are designed so that they can be divided to create four smaller rooms. The front extension can be used as an independent or semi-independent unit, since it shares a hallway. This ‘granny pod’ can be used as a children’s room, a study, or rented out. The flat roof of the pod also allows for vertical expansion for another storey above (Schneider et al., 2007).

Precedent 44: Industrialized Construction System

Renzo Piano Building Workshop

Italy | 1978-82

Type: Terraced house

Developed for a plan for a public housing project with 100 homes, this project is based on the idea of evolving houses. Initially the concept grew out of the idea of a mass-production building system that allows for freedom of layout in the interior space. The experimental prototype comprises two U-shaped factory-made components that form a tunnel (6m high and 12m long), which allows for various layouts on either one of two floors. A simple metalwork system works to partition the interior both horizontally and vertically, using trusses and movable panels for walls and windows (Schneider et al., 2007).

Precedent 45: Wohnhaus

Anton Schwighofer
1982
Type: Study

In plan the apartment comprises four identically sized rooms that have individual access from a central space containing the entrance hall, bathroom, kitchen and one more unspecified area (Figure 1.2-41). Flexibility is achieved through the principle of indeterminacy, both socially and functionally as the rooms within themselves are multifunctional and their use is not prescribed through specific dimensions or location within the unit. There is a possibility of the unit to be inhabited by a family of four unrelated individuals. There is also a possibility for the unit to be an office space or small workshop as opposed to a residential unit. The central space affords a certain degree of flexibility as well as it can be temporarily divided off from the others (Schneider et al., 2007).

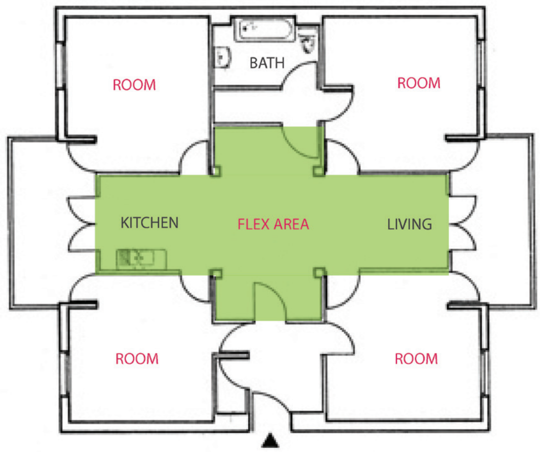


Figure 1.2-41
Wohnhaus - Flexible Floor Plan
Source: Schneider et. al. (2007)

Precedent 46: Projekt Wohnhaus

Anton Schwighofer
Germany | 1984
Type: Study

Typical to Schweighofer's work, this project is also characterised by the aim to develop in-determined spaces as a principle for flexibility. Within this project a set of apartments can adapt over time as the initial double height space

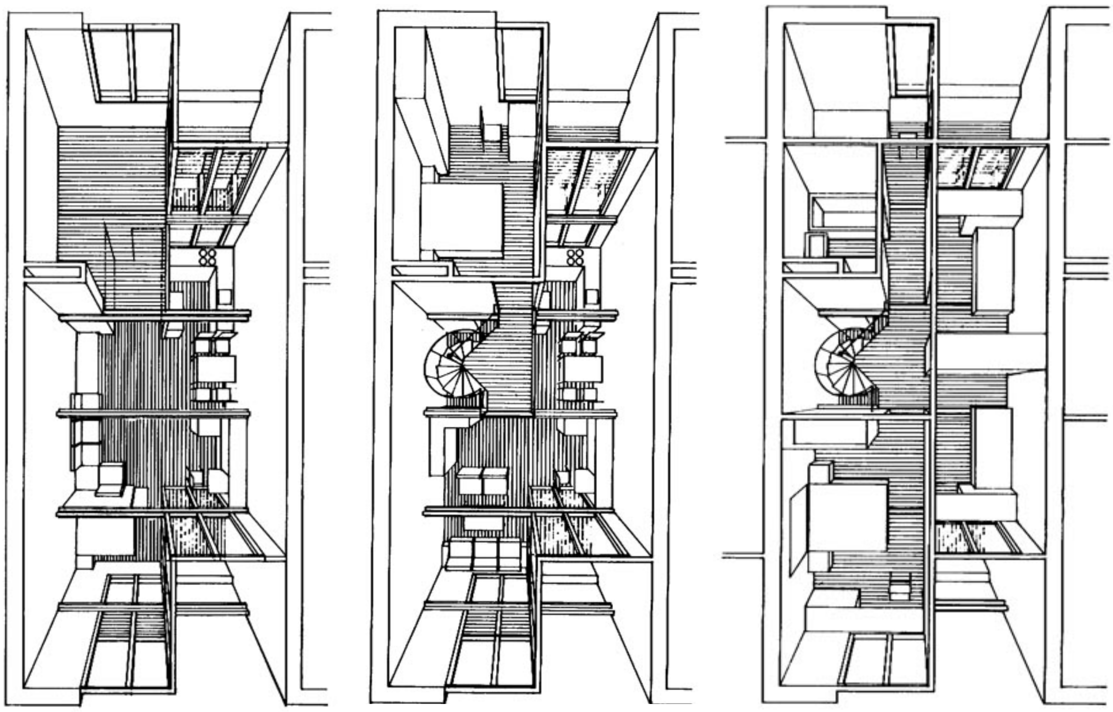


Figure 1.2-42
Aerial View of Projekt Wohnhus - Interior Options
Source: Schneider et. al. (2007)

can be occupied with an additional platform to realise an additional storey within. Over a period of time a one-storey double height unit can be transformed into a two-storey unit (Figure 1.2-42). The potential upper level is implied through beams at regular intervals. Floors can be laid on these beams in order to afford a range of spatial arrangements. Hence a 49m^2 apartment can be transformed into a space of 97m^2, and can also be used as a live/work unit (Schneider et al., 2007).

Precedent 47: Fleksible boliger

Tegnestuen Volden

Denmark | 1986

Type: Study

This project exemplifies the scenario for how one floor in a multi-storey apartment house can be changed over a period of 44 years. The square plan comprises a central circulation core and one apartment with an entrance to each side of the staircase (Figure 1.2-43). Bathrooms are situated within the same central zone as the staircase, situated along the party walls. A service duct is located centrally against the rear façade. The variations in inhabitants played out over 44 years develop around possibilities of dividing the single unit into two units by means of partition walls. By doing so the floor area can be modified to accommodate a variety of occupant groupings: four adults sharing one apartment, two equally sized apartments being used by two separate families, one small bedsit on one side of the stairs and a larger unit to the other side, or a section that can be separated as a semi-independent unit (Schneider et al., 2007).

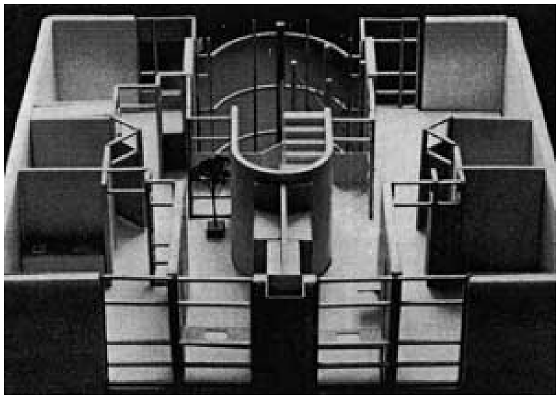


Figure 1.2-43
Fleksible Boliger - Model
Source: Schneider et. al. (2007)

Precedent 48: Honor Oak Park

Walter Segal, Jan Broome + self-builders
Britain | 1987
Type: Detached houses

This project represents a version of the building system that was developed by Segal and Broome in order to increase the choice open to individual self-builders not only during the initial building process but also in the future. Designed to empower self-builders to take control of both the design and construction of their homes, this was unlike the mass housing schemes that had been developed within the public sector, with inflexible designs giving the occupants no control over the design of their dwelling. The main element of flexibility within the Segal system is lightweight

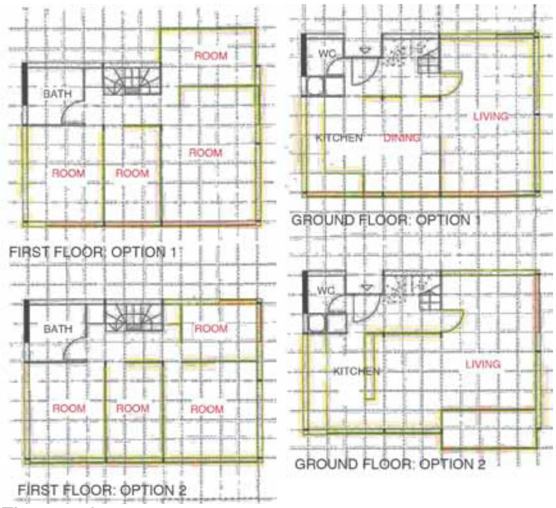


Figure 1.2-44
Honor Oak Park Plans - Floor Plan Options
Source: Schneider et. al. (2007)

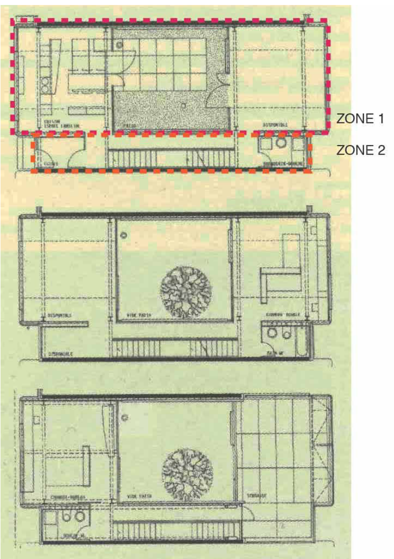


Figure 1.2-45
Habitat Industriel `La Faye` - Plans
Source: Schneider et. al. (2007)

dry and demountable construction systems with a modular frame that accepts standard panel sizes. Changes can be made within a set of precise rules: the overall dimensions and grid are provided, and the location of the service and circulation core is set together with the position of the structural members. While the exterior may appear uniform, no two unit plans are the same (Figure 1.2-44) (Schneider et al., 2007).

Precedent 49: Habitat Industriel 'La Faye'

Rudolphe Luscher
Switzerland | 1989
Type: Mixed use with live/work terraced houses

Each unit comprises two zones: a narrow one with a staircase and servicing rooms and a wider zone with equally sized rooms separated by a courtyard/atrium over three storeys (Figure 1.2-45) (Schneider et al., 2007).

Precedent 50: Am Steinberg/ Röthenbach

Metron-Architekten AG
Germany | 1990
Type: Terrace

This project utilizes the Schalltzimmer concept of 'switch rooms' within a series of two-storey rows of terraced houses. Spaces can be allocated to one or the other unit (Figure 1.2-46) (Schneider et al., 2007).

Precedent 51: The Convertible House

Dovertel Construction Ltd.

Canada | 1991

Type: Single detached house

Refer to article 3.1.2.1 Case Study 1 in Context and Case Studies.

Precedent 52: Single family house

Kazutaka Wakamatsu

Japan | 1995

Type: Single House

This project consists of a series of rooms arranged at various levels around a central staircase. Even though some rooms have specific functions attached to them, the house can be used by a group of unrelated adults, or even as a live/work unit with the garage converted into an office space (Schneider et al., 2007).

Precedent 53: London Flexhouse

Nouvelle Development Corporation

Canada | 1996

Type: Single-, semi-detached or terrace

Winner of the CMHC's National FlexHousing Design Competition, this project is a three-storey unit that can be subdivided into either two or three units (similar to The Convertible House). The potential for a home office as well as a greenhouse on the second or third floor is afforded within the design, along with lifetime considerations including wide corridors and flights of stairs, height adjustable kitchen and bathroom cabinets and counters, a fully

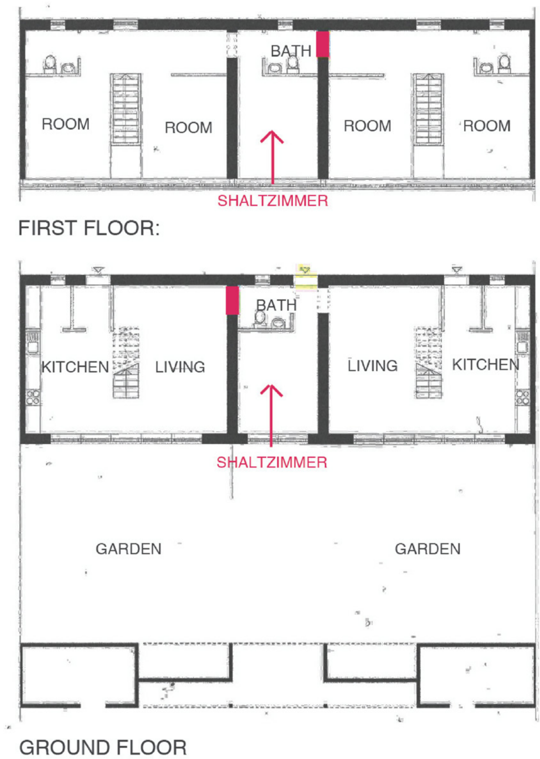


Figure 1.2-46
Shaltzimmer: Switch Rooms
Source: Schneider et. al. (2007)

Figure 1.2-47
Flexhouse - Floor Plans
Source: Schneider et. al. (2007)

accessible ground floor and a space that can accommodate a lift to all floors. Hence, it is one of the few precedents of flexible housing that caters to the needs of the elderly or disabled. With regards to design, the subdivision of the house is made possible by the position of the entrance and its relation to the internal staircase which gives the potential for two separate entrance doors (Figure 1.2-47) (Schneider et al., 2007).

Precedent 54: Next Home

Avi Friedman
Canada | 1996
Type: Single-, semi-detached or terrace

Much of Avi Friedman's work is concerned with the adaptability of buildings that offer responses to societal changes and demographic shifts, as well as to issues of affordability. These concepts are inherent within the Next Home, as it enables a greater choice for the occupants throughout the buildings lifetime. Built as a detached, semi-detached or row house, each unit can be occupied by a single user group or each storey can be used independently from the others. The position of the vertical circulation core coupled with the easy to remove joists between levels, which allow for the installation of internal stairs, the dwelling can be occupied by up to three independent groups (Schneider et al., 2007).

Precedent 55: The Transformable Apartment

Mark Guard Architects
Britain| 1996
Type: Apartment

This project is a contemporary exploration of the concept of foldable and moveable furniture in order to maximize available space through flexibility of use (Figure 1.2-48). This concept is further explored within the more recent and compact example of the Obtibo Prototype Flat (Refer to article 3.1.3.1).

Figure 1.2-48
The Transformable Apartment - Flexible Plans
Source: Schneider et. al. (2007)

Precedent 56: Atelierhaus Sigle

Architekten Linie 4
Germany | 1998
Type: Single house

The timber structure combines residential functions with an artist's studio, creating a flexible approach. The loadbearing elements, which are relatively closely spaced, are placed on a regular grid along the long edges of the building. The open interior space plan can be divided freely using short wall panels and furniture units, none of which touch the perimeter walls (Schneider et al., 2007).

Precedent 57: Fred

Oskar Leo + Johannes Kaufmann
Austria | 1999
Type: Add-on/extension

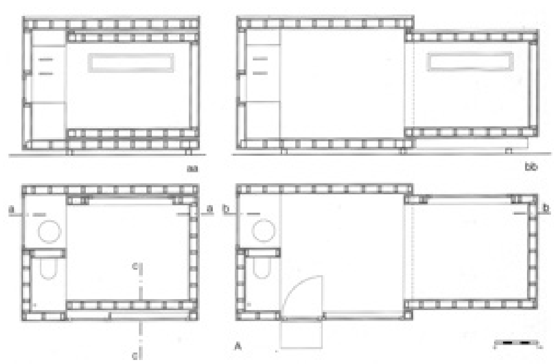


Figure 1.2-49
Fred - Module Expansion Diagram
Source: Schneider et. al. (2007)

The basic module explores the concept of built-in expandability as the timber container consists of two boxes: one outer box (3m by 3m by 3m) and one which is slightly smaller that slides inside the bigger one. When expanded an area of 8m^2 extends to 15m^2 (Figure 1.2-49). The fixed module contains a kitchen, a bathroom, a small room with WC and integrated shower, while

Figure 1.2-50
Kolner Brett - Floor Plans
Source: Schneider et. al. (2007)

the remaining area is open for interpretation (Schneider et al., 2007).

Precedent 58: Kölner Brett

Brandlhuber & Kniess

Germany | 1999

Type: Multi-storey apartment house

Comprising of twelve identical spatial modules that are partially on two levels, the project affords an average usable surface area of 140m^2 per unit. The functionally neutral modules provide a spatial indeterminacy that is generally found within industrial or commercial buildings. Occupants are free to personalise the raw space based on their needs (Figure 1.2-50) (Schneider et al., 2007).

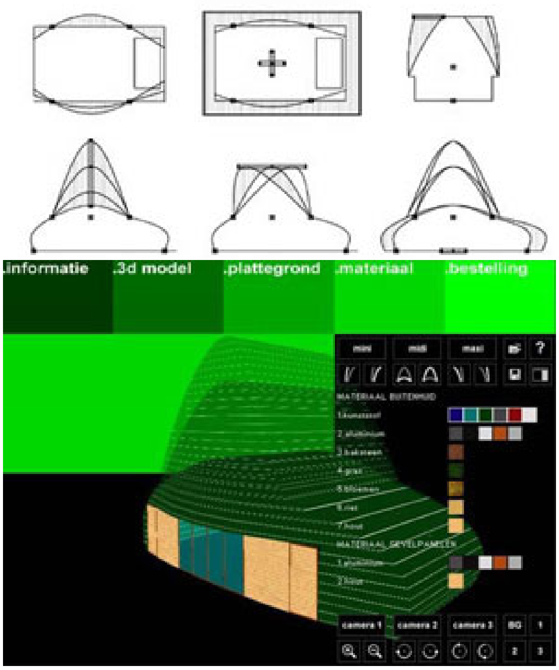


Figure 1.2-51
Variometric nl Programmable Housing
Source: Schneider et. al. (2007)

Precedent 59: Variomatic nl – Programmable Housing ONL

The Netherlands | 1999

Type: single-detached house

Designed to be elastic in all directions (height, depth and width), the form of this house is determined by the clients, along with the position of services and materiality (Figure 1.2-51). The only fixed elements are the staircase, WC and technical room (Schneider et al., 2007).

Precedent 60: Westfurry Studios

CZWG

Britain | 1999

Type: Live/work

Undivided and double height studio spaces (approximately 70m^2) are marketed as live/work units. The base shell allows for the opportunity of user appropriation over time (Schneider et al., 2007).

Precedent 61: Affordable Rural Housing Demonstration Project

Gokay Deveci
Britain | 2000
Type: Single-detached, terrace

Based around a modular grid of 2.4m or 2.7m; the main characteristics include a central manufactured service core, lightweight wall construction and a flexible and extendable internal layout (Figure 1.2-52). Although simple and economic in construction, the houses provide long-term flexibility within the open square plan. The only fixed element is the bathroom pod and a kitchenette, positioned centrally in plan, leaving the perimeter space open for flexible adaptation (Schneider et al., 2007).

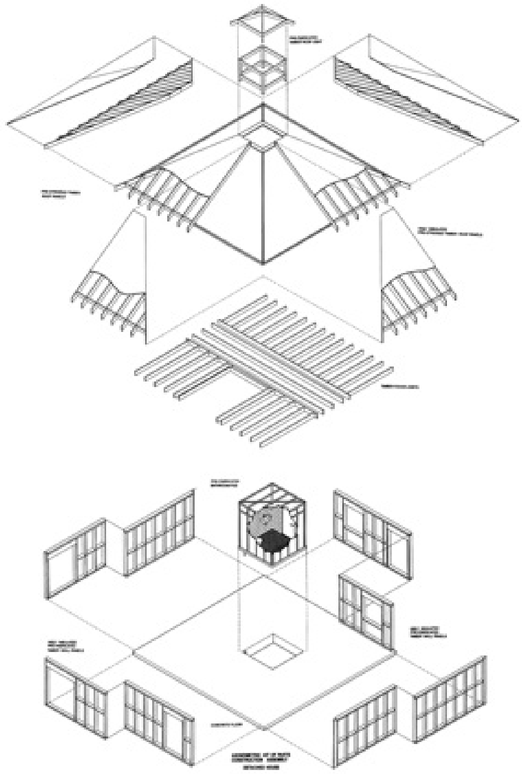


Figure 1.2-52
Affordable Rural Housing - Exploded Axonometric
Source: Schneider et. al. (2007)

Precedent 62: Modular Construction System

Lukas Land Architecture Technology
Austria | 2000
Type: Single-detached house

Figure 1.2-53
Modular Construction System
Source: Schneider et. al. (2007)

Based on a modular timber component system (Figure 1.2-53), the planning and modification of buildings of different shapes and sizes is made possible. Single components can be joined and separated by screw and pin connections, which ensure the greatest possible flexibility. Hence allowing for the modules to be attached and removed without affecting the existing structure (Schneider et al., 2007).

Figure 1.2-54
Flexible Housing in Almere
Source: Schneider et. al. (2007)

Precedent 63: Flexible Housing in Almere

UN Studio
The Netherlands | 2001
Type: Single- + semi-detached, terrace

Each house consists of two basic modules of 10m by 6m in plan and 3m in height. The upper volume is shifted by 2.5m relation to the lower one, creating a staggered section with a separate entrance zone on the ground floor and a terrace for the first floor. This basic volume can be extended in two ways: by adding another half volume on top of the upper 10m by 6m volume, or by means of a prefabricated box, 2.5m by 6m, which can be added onto the basic volumes at various locations (Figure 1.2-54) (Schneider et al., 2007).

Precedent 64: Kettenhaus

Becher + Rottkamp
Germany | 2001
Type: Live/work

A basic module of 6.5m by 10m (2.75m high), can be divided up in various ways in order to afford numerous alternative layouts for a variety of uses (Schneider et al., 2007).

Precedent 65: Smarthouse

BAM Vastgoed + Robert Winkel
The Netherlands | 2001

Type: Single-detached house

Based on a standardised frame within a steel building system, this house works around a minimum of parts, which are bolted together to make variation quick and easy (Schneider et al., 2007).

Precedent 66: Soft House

Forsythe + MacAllen Design

Canada | 2003

Type: Apartment

This house comprises a textile system for prefabricated interior walls, which are made from a soft, translucent fabric that can be used to change the interior spaces by manipulating the private and common spaces within (Figure 1.2-55) (Schneider et al., 2007).

Figure 1.2-55
Soft House - Interior Configurations
Source: Schneider et. al. (2007)

Precedent 67: Cala Domus

PCKO

Britain | 2005

Type: Terrace

This project comprises the concept of the 'Living Wall', which is designed to allow flexibility in the provision and adaption of services. The 'Living Wall' is a dedicated zone of space running from the front to the rear of each unit (Figure 1.2-56), providing for all horizontal and vertical service distribution including piping, wiring and storage as well (Figure 1.2-57). All wet rooms are also attached to this system. Excess capacity is allotted to allow for adaptation and renewal of existing services, or the exchange of entire existing items

Figure 1.2-56
Cala Domus Living Wall
Source: Schneider et. al. (2007)

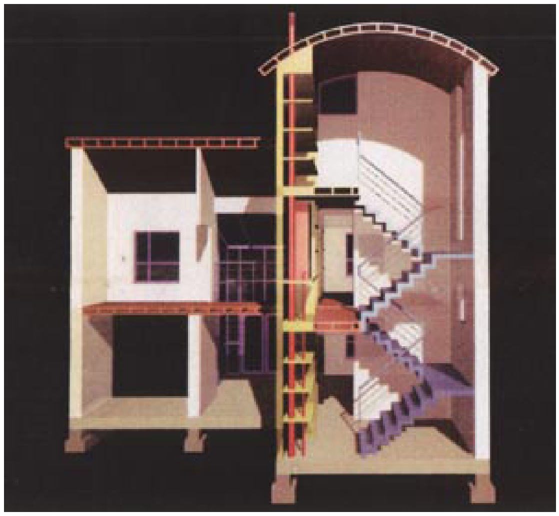


Figure 1.2-57
Cala Domus Living Wall Section
Source: Schneider et. al. (2007)

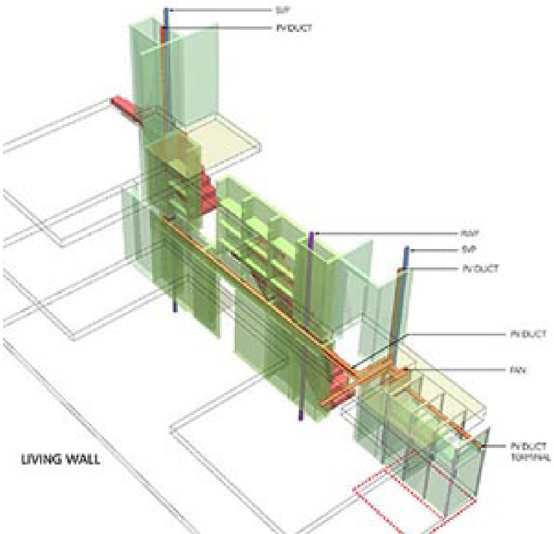


Figure 1.2-58
Cala Domus Living Wall System Diagram
Source: Schneider et. al. (2007)

with new technology (Figure 1.2-58) (Schneider et al., 2007).

Precedent 68: Rochdale

Proctor and Matthews Architects

Britain | 2007

Type: Apartments and terraced houses

Flexibility is achieved through the combination or division of houses over time in order to accommodate extended families (Figure 1.2-59). For example a two-bedroom unit can be combined with a five-bedroom unit in order to create a seven-bedroom house, etc. (Schneider et al., 2007).

Figure 1.2-59
Rochdale - Combination/Division of Houses
Source: Schneider et. al. (2007)

APPENDIX 1.3
PAST DESIGN ITERATIONS

Appendix 1.3 illustrates the various design iterations that were conceived in an attempt to derive a flexible housing typology for the 21st century.

DESIGN 1: Modular as a means for Flexi1bility

DESIGN 2: Moveable Activity Modules - Iteration 01

DESIGN 3: Moveable Activity Modules - Iteration 02

DESIGN 4: Moveable Activity Modules - Iteration 03

DESIGN 5: Moveable Activity Modules - Iteration 04

DESIGN 6: Moveable Activity Modules - Iteration 05

DESIGN 1: Modular as a means for Flexibility

The initial attempt at a flexible dwelling was conceived within an arrangement of modules, in an attempt to achieve flexibility through modularity. Prefabricated modules could be added or removed based on occupant requirements. This concept has been explored in the past in precedents such as Walter Gropius' Haus Auerbach (1924). Although the concept presents flexibility in the amalgamation of modules to produce infinite arrangements, the spaces within the modules remain constant within a prescribed perimeter space; hence limiting the internal flexibility of the spaces within.

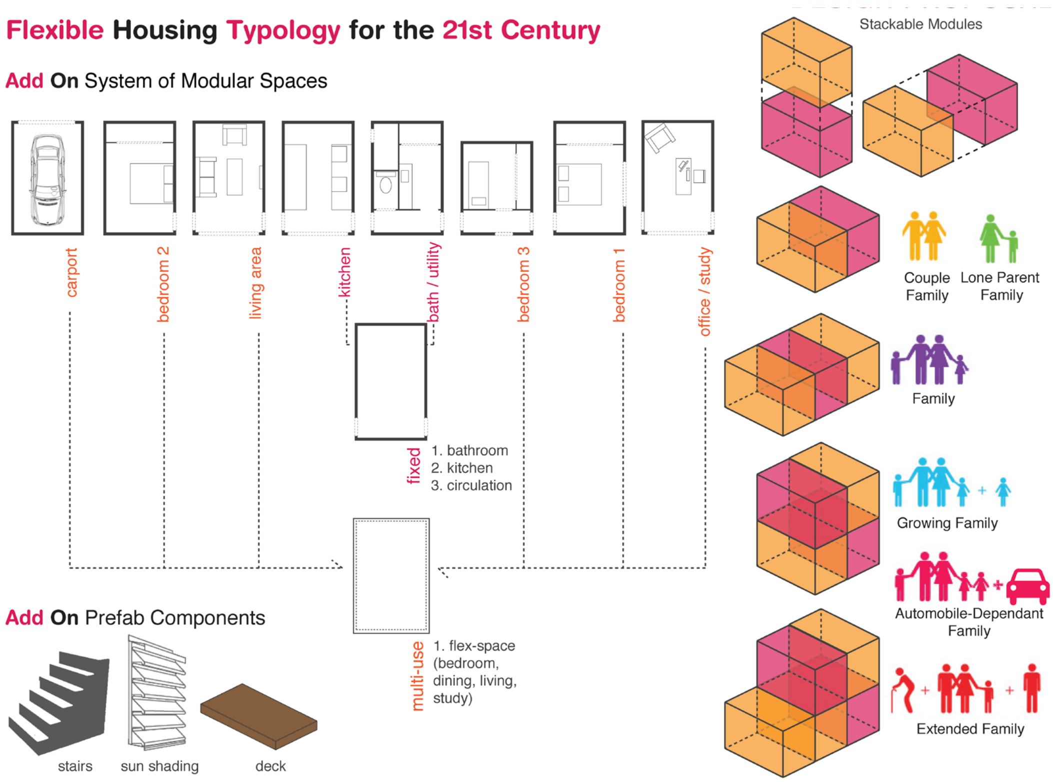


Figure 1.3-1
Fixed vs. Flexible Modules
Source: self-derived

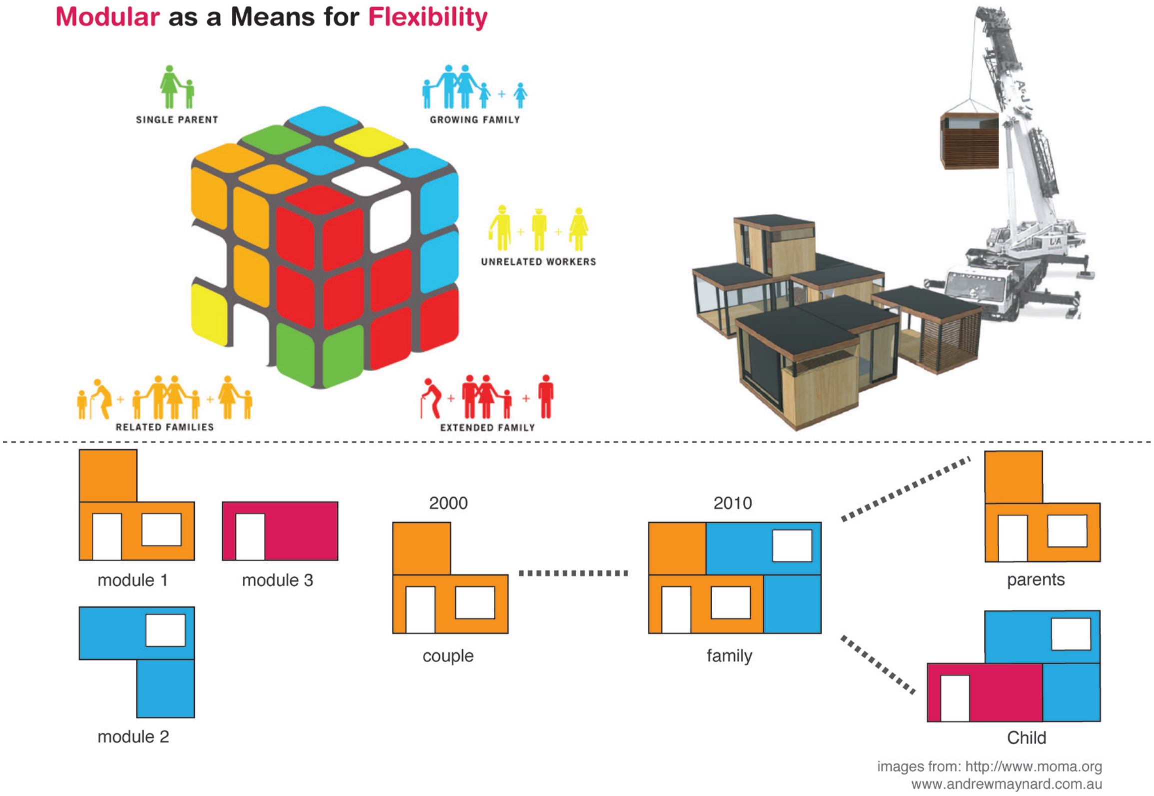


Figure 1.3-2
Stackable Module Arrangments
Source: self-derived

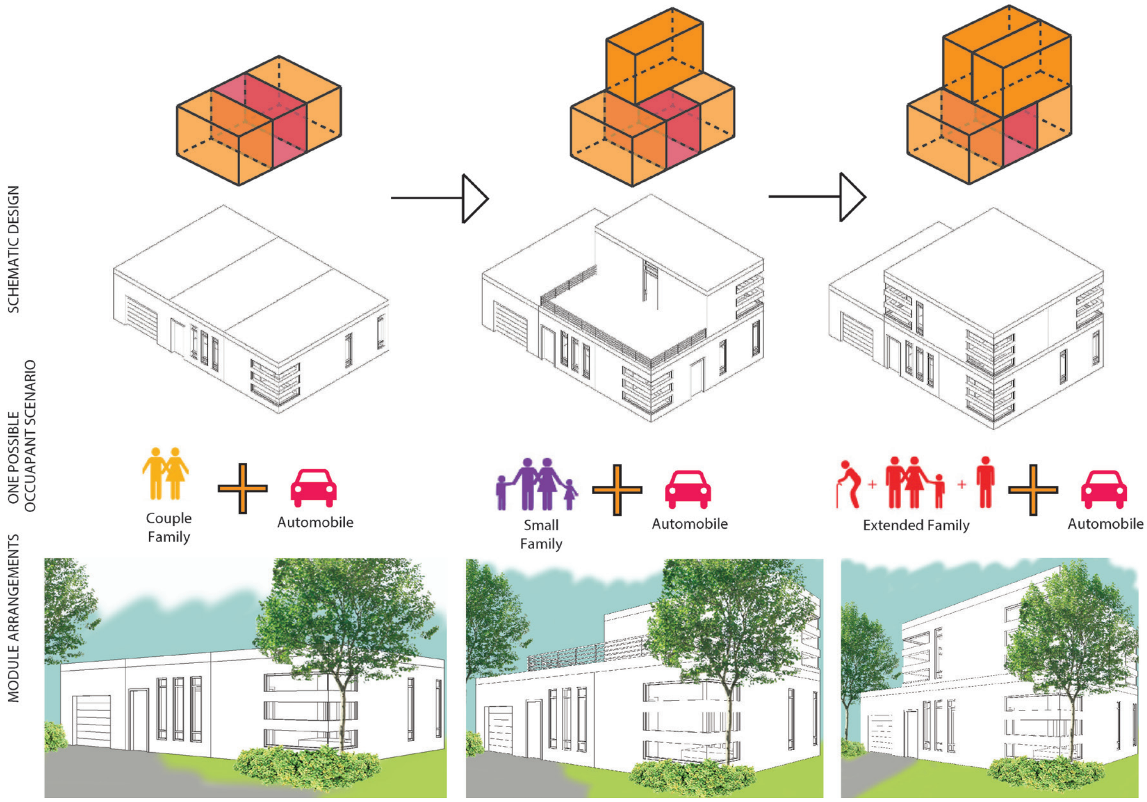


Figure 1.3-3
Module Arrangments Across Lifecycle
Source: self-derived

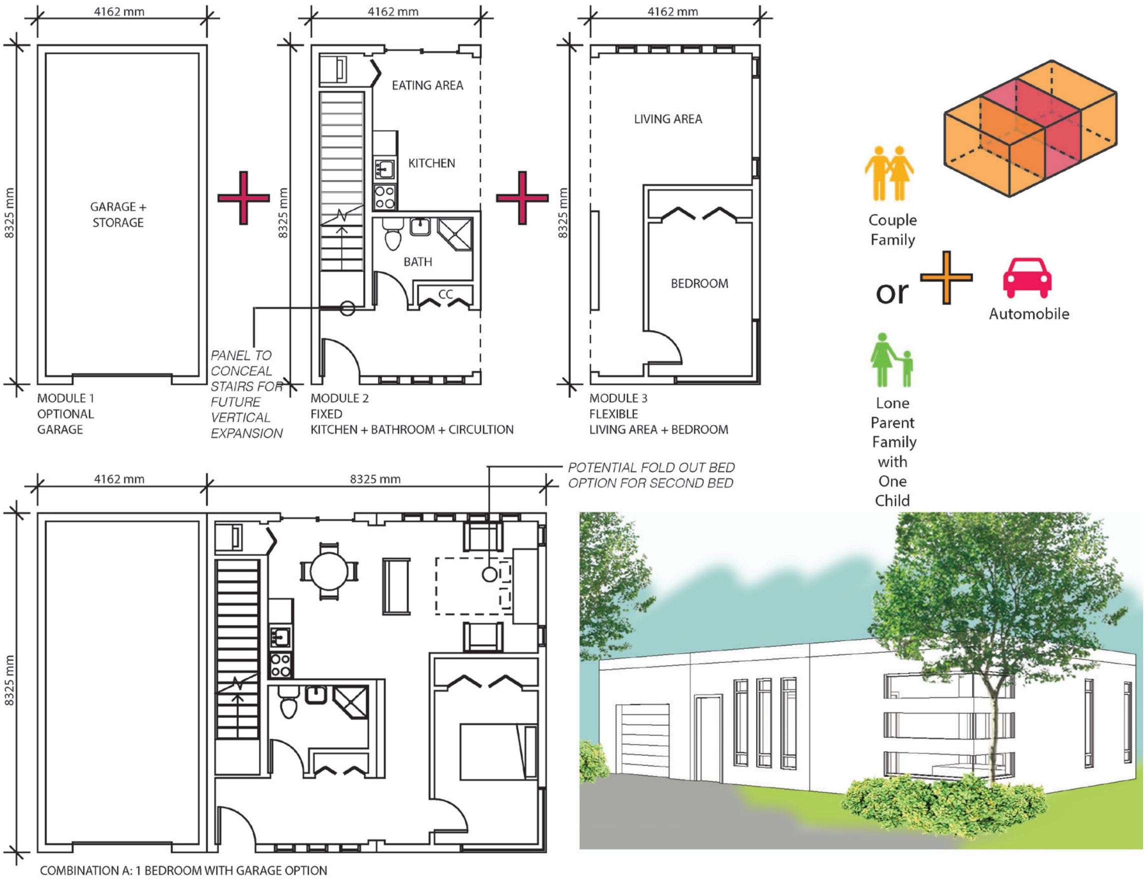


Figure 1.3-4
Stage 1 - Plans & Exterior View
Source: self-derived

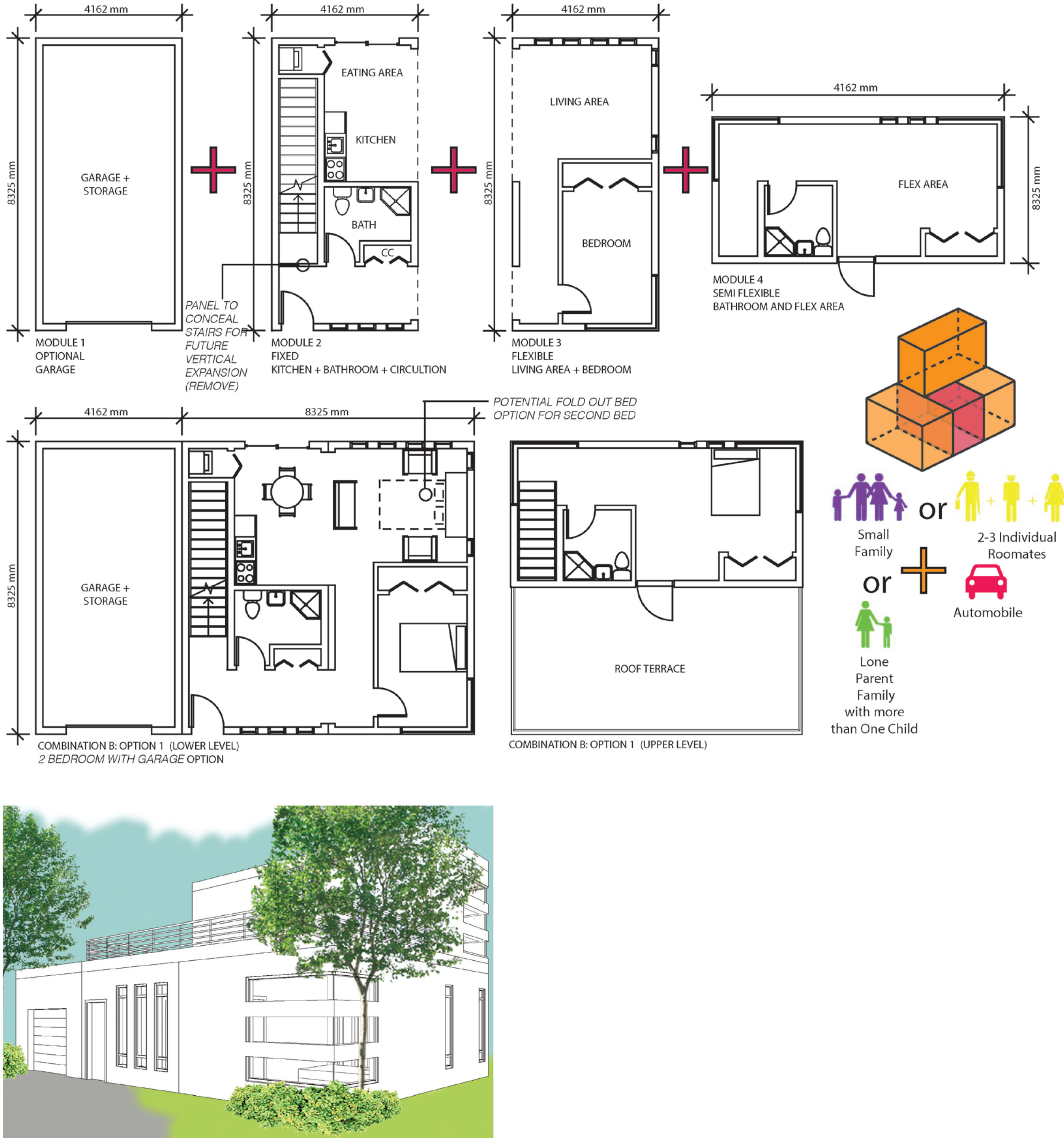


Figure 1.3-5
Stage 2 - Plans & Exterior View
Source: self-derived

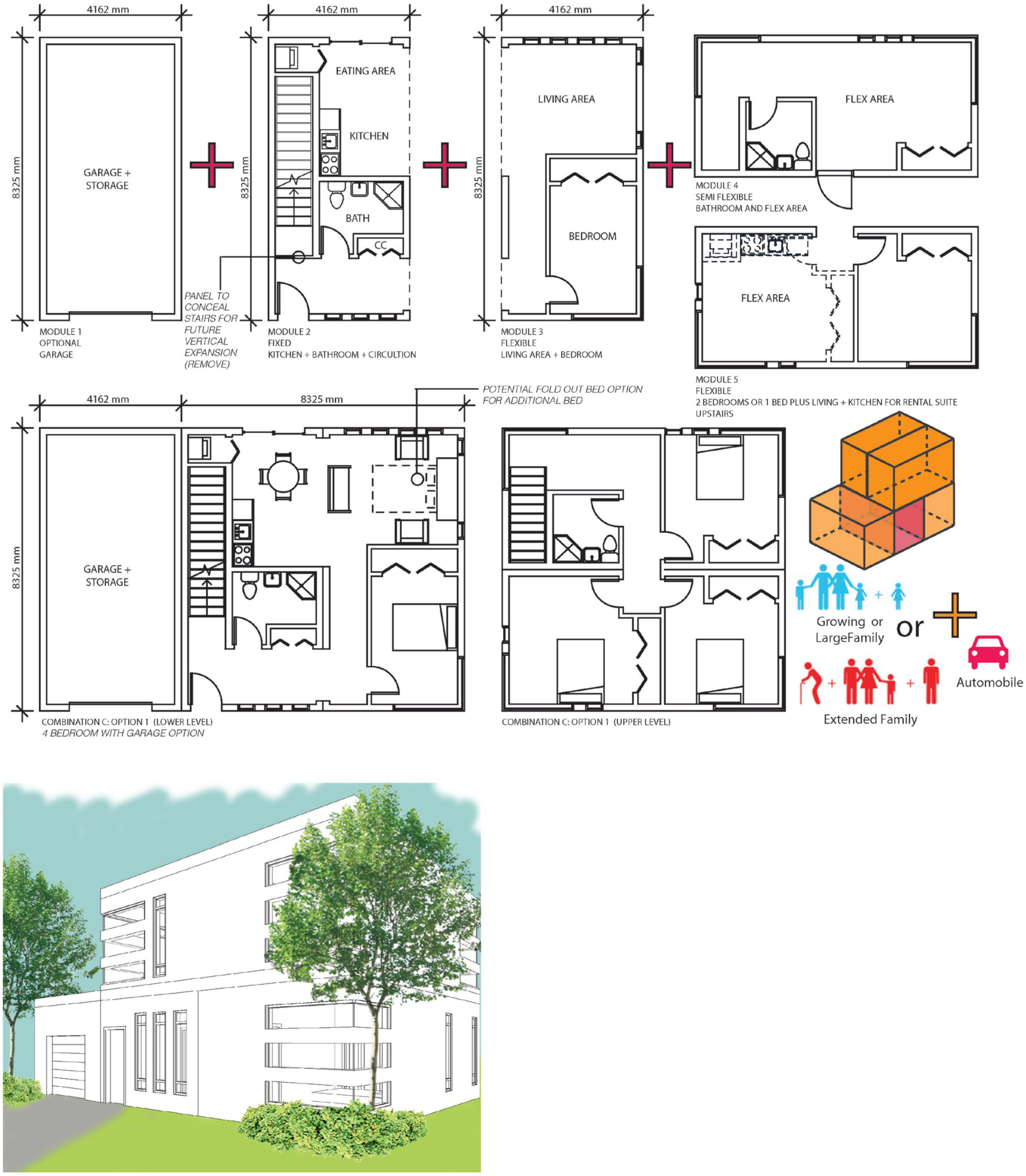


Figure 1.3-6
Stage 3 - Plans & Exterior View
Source: self-derived

DESIGN 2: Moveable Activity Modules - Iteration 01

Since modularity in the previous iteration did not afford a high degree of flexibility within the interior spaces, the next iteration sought to develop a more flexible interior environment; one that was not defined by rooms but rather by activity spaces. Hence the moveable activity modules were proposed (Refer to Section 5.0 for details). These modules act as partitions between activity areas allowing for the flexible generation of activity spaces, rather than prescribing a fixed room for each activity. While the modules have stuck through to the current design proposal, the problem with the initial iterations was a fixed envelope which contained a flexible interior space. Hence, the only way to accommodate expansion of livable space due to occupant needs across the lifetime of a family was to incorporate the moveable modules in the basement as well, allowing for more bedrooms to be added.

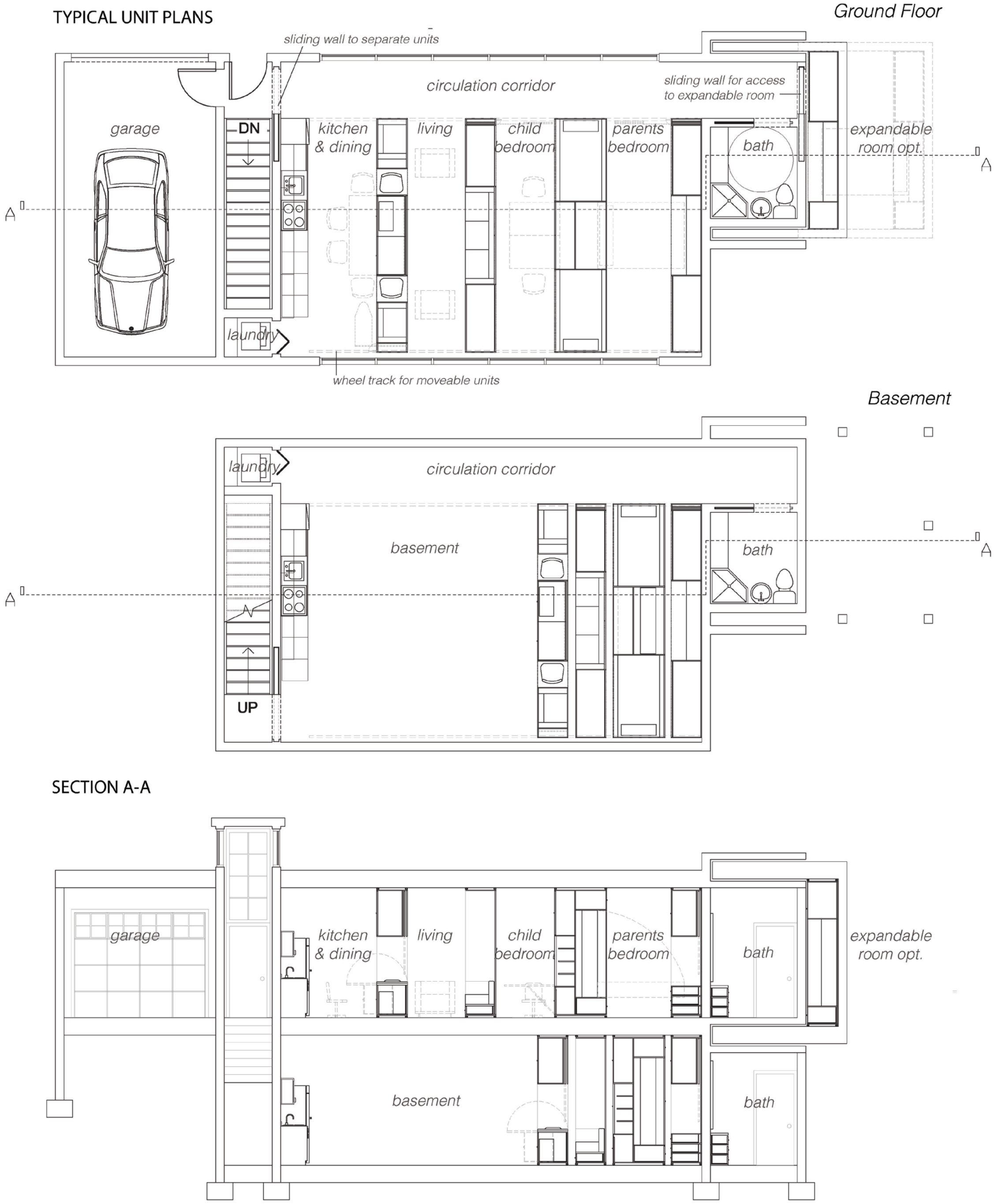


Figure 1.3-7
Design 2: Iteration 01-Plans & Section
Source: self-derived

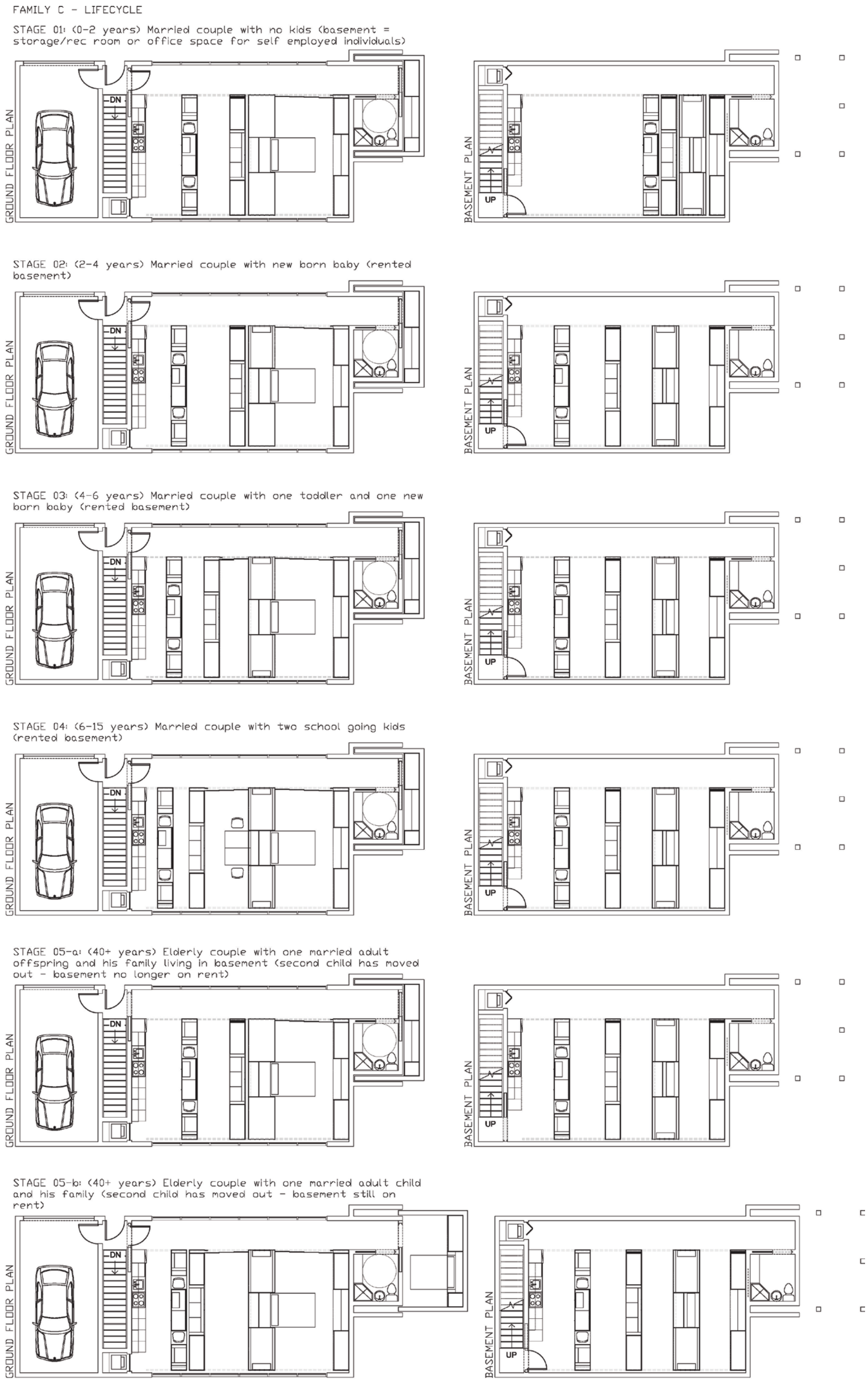


Figure 1.3-8
Design 2: Iteration 01-Lifecycle Analysis Diagrams
Source: self-derived

Figure 1.3-9
Design 2: Iteration 01-Typical Weekday Arrangments
Source: self-derived

DESIGN 3: Moveable Activity Modules - Iteration 02

This iteration allows for moveable exterior walls and rotatable modules to manipulate the exterior shell of the dwelling, in order to provide flexible options based on space as well as weather requirements. For example, the house has fewer exposed faces in the winter while the summer option permits more exposed faces as well as rotating walls that can open up to the outdoors. This option, although more flexible, provides a lot of excess space, proving to be quite inefficient.

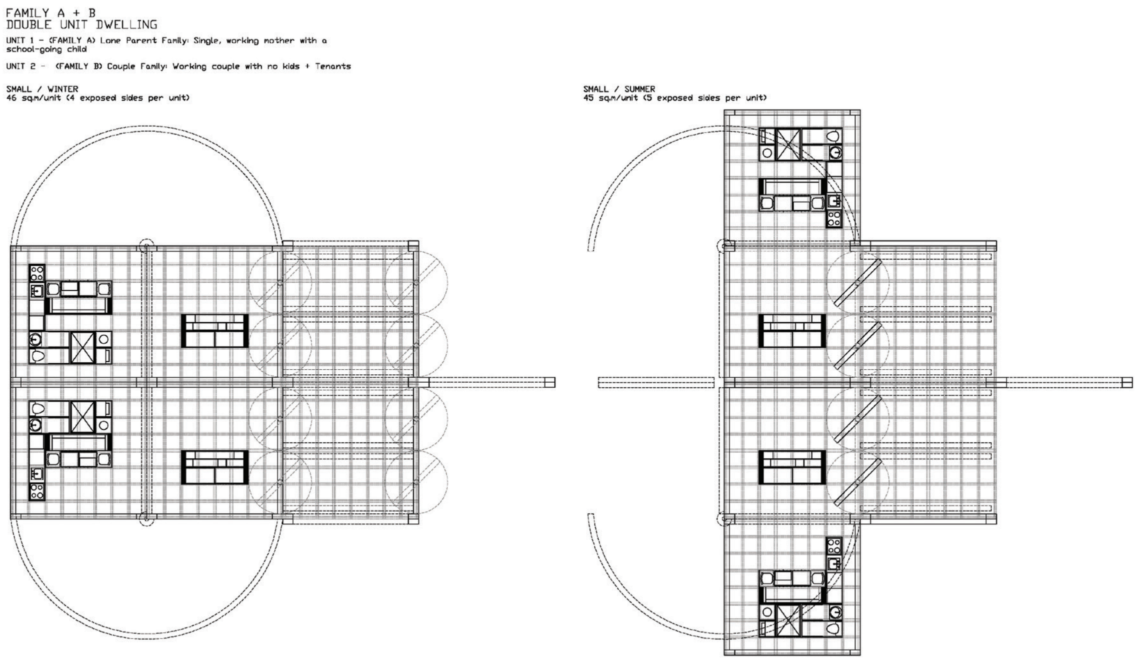


Figure 1.3-10
Design 3:Winter & Summer Dwelling Options
Source: self-derived

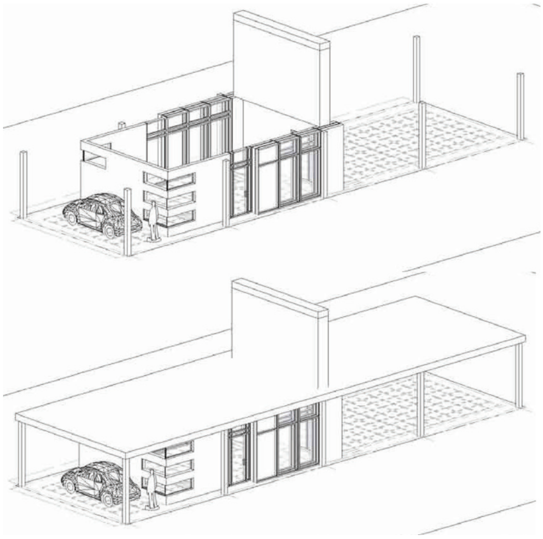


Figure 1.3-11
Design 4: Axonometric View
Source: self-derived

DESIGN 4: Moveable Activity Modules - Iteration 03

This iteration shifts back to a simple rectangular, compact plan as an attempt to limit the flexible movement of the activity modules within the interior space in order to avoid the wasteful expansion of the field and hence the dwelling. This option manipulates the exterior envelope through the use of sliding exterior walls that allow for the expansion of the dwelling over time.

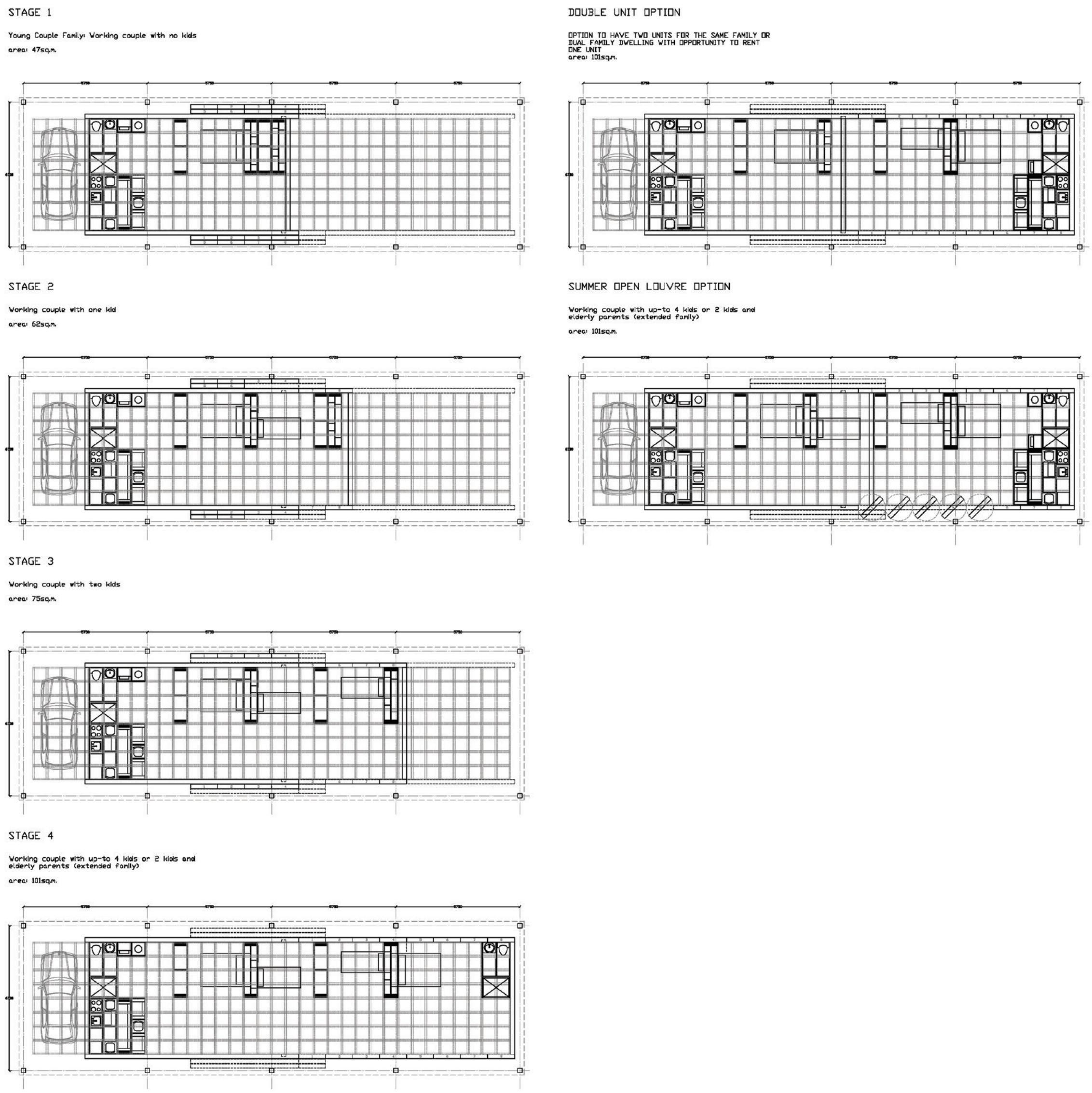


Figure 1.3-12
Design 4: Lifecycle Stages & Corresponding Expansion
Source: self-derived

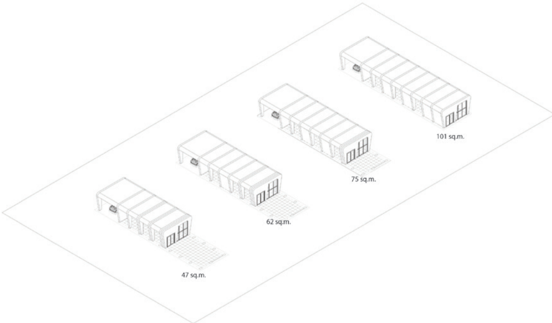


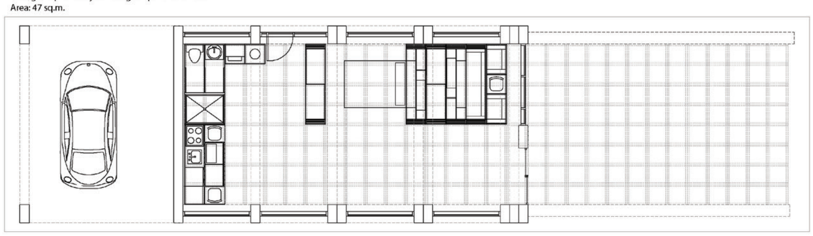
Figure 1.3-13
Design 5: Transformative Stages in Axonometric View
Source: self-derived

DESIGN 5: Moveable Activity Modules - Iteration 04

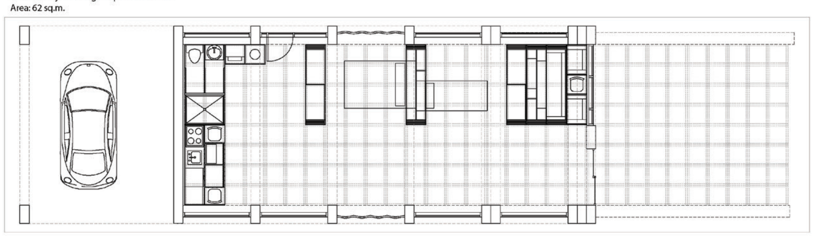
This iteration manipulates the exterior envelope through the use of sliding exterior walls that move on tracks along the floor. The envelope has glazed solid panels to allow for daylight, along with opaque, flexible folding panels that can be compressed when folded or expanded when unfolded in order to increase the area of the interior space. When the requirement for more space is present, the house will expand and compromise some of the outdoor patio space in exchange for additional interior space.

Figure 1.3-14
Design 5: Expandable Envelope Model
Source: self-derived

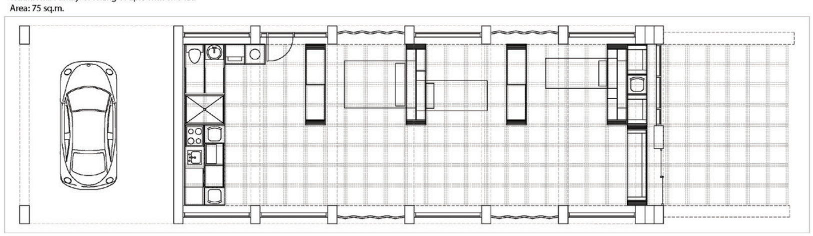
STAGE 1
Young Couple Family: Working couple with no kids
Area: 47 sq.m.



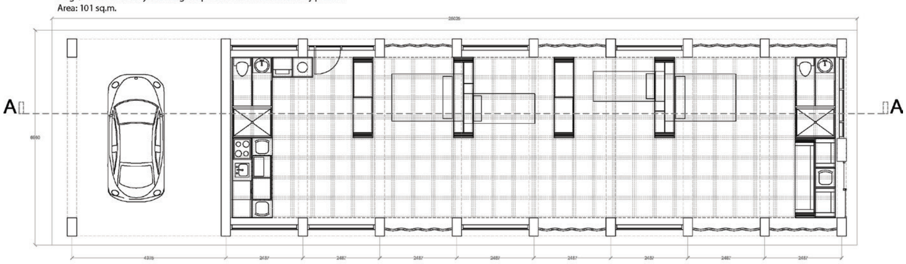
STAGE 2
Small Family: Working couple with one kid
Area: 62 sq.m.



STAGE 3
Traditional Family: Working couple with two kid
Area: 75 sq.m.



STAGE 4
Large/Extended Family: Working couple with two kids and elderly parents
Area: 101 sq.m.



SECTION A-A

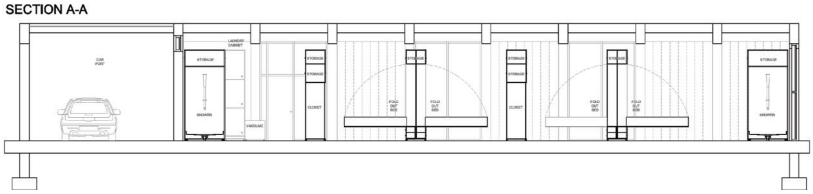


Figure 1.3-15
Design 5: Transformative Stages Over a Lifetime
Source: self-derived

DESIGN 6: Moveable Activity Modules - Iteration 05

This iteration manipulates the exterior envelope through the use of sliding exterior walls, and expandable ETFE membrane, which can be filled with air for insulation purposes. This combined system allows for the expansion of the dwelling into four stages over time. The main problem with this iteration resulted from a close analysis of the daily activity diagrams, which indicated an excess of circulation/un-used space within the interior of the dwelling. Furthermore, the building envelope was largely narrow in plan, causing several siting issues, where the face of the house would appear away from the street. The shell also failed to express a prominent approach/frontage and entrance to the dwelling. All of these issues were addressed in the final iteration illustrated in section 5.0.

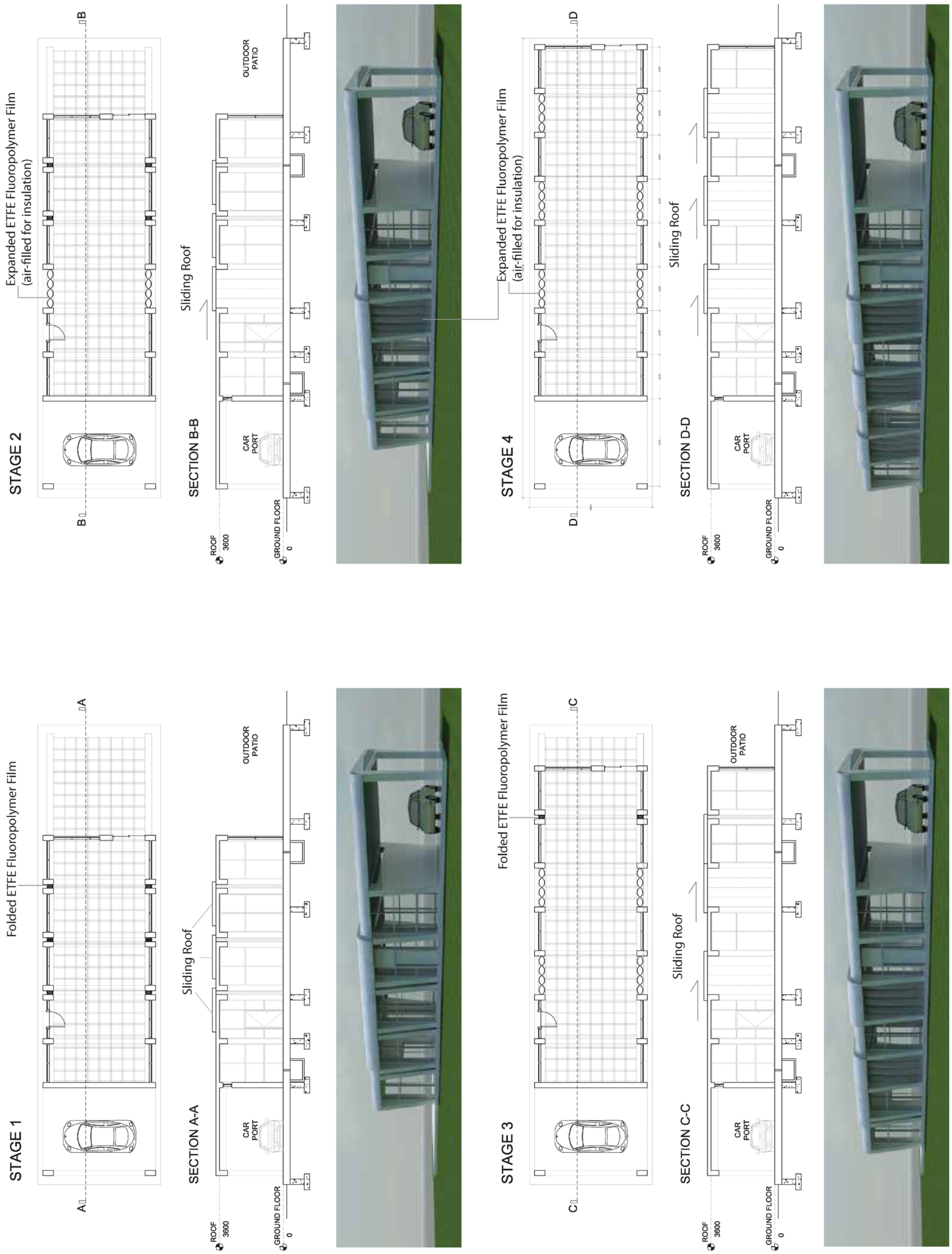


Figure 1.3-16
Design 6: Expandable Envelope Stages
Source: self-derived

Figure 1.3-17
Design 6: Family A - Weekly Spatial Configurations
Source: self-derived

Figure 1.3-18
Design 6: Family B - Weekly Spatial Configurations
Source: self-derived

Figure 1.3-19
Design 6: Family C - Weekly Spatial Configurations
Source: self-derived

Figure 1.3-20
Design 6: Family D - Weekly Spatial Configurations
Source: self-derived

Figure 1.3-21
Design 6: Exterior View - Stage 1
Source: self-derived

Figure 1.3-22
Design 6: Exterior View - Stage 2
Source: self-derived

Figure 1.3-23
Design 6: Exterior View - Stage 3
Source: self-derived

Figure 1.3-24
Design 6: Exterior View - Stage 4
Source: self-derived

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