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Experimental Adaptability

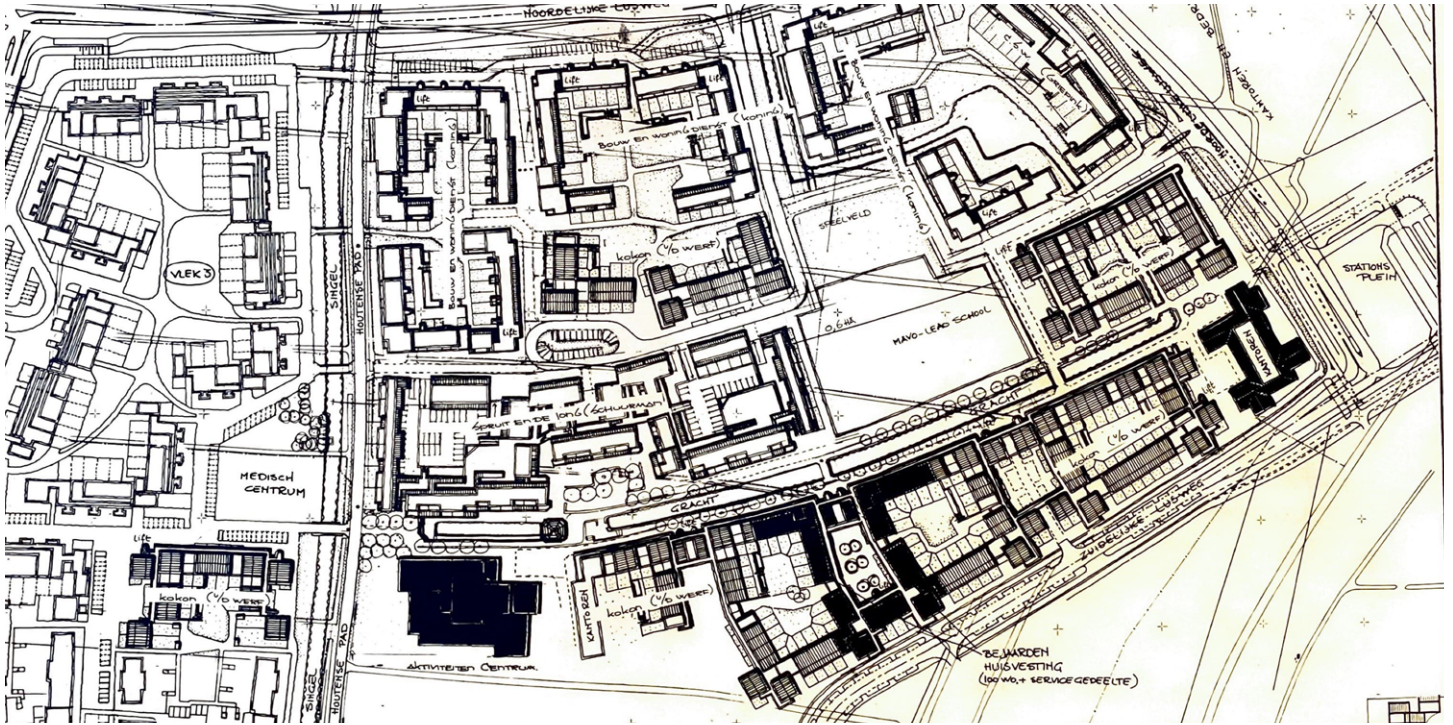
Investigating the Adaptable Qualities of Experimental Lunetten

Abstract

Built in the time-specific context of the seventies, the project of Lunetten is an interesting example of residential innovation in the Netherlands. Nominated experimental by the Dutch Experimental Housing Program of 1968-1980, for its implementation of the design methods of Stitching Architecten Research (SAR), this project shows an early attempt at designing for adaptability with the separate design layers of a public urban tissue, a communal support structure and a private infill. This thesis aims to investigate how durable the experimental adaptability is in the project of Lunetten. More specifically it examines on one side the development of the physical infill structure and on the other side the progress of the infill concept over time. Firstly, the research concludes that apart from façade adaptations, the infill of Lunetten has not managed to adapt in the way it was intended. This because the infill structures of the dwellings either have remained unchanged since its construction or have been completely removed and replaced. Nevertheless, the project's development also shows that the structure of the support indeed is flexible for change, even if it's not through adapting the original infills. Secondly, the research finds that the quality of the infill concept has improved over time, with a professionalised design process and separate technical developments. At the same time it becomes clear that the technical coordination and coherence of the infill, have not yet reached its full potential in the Netherlands.



Fig. 0.1: Experimental façades. Sint Gotthard, Lunetten. By the author, 2023.



1. Introduction

In the neighbourhood of Lunetten in the southeast of Utrecht, the Netherlands, lies a special experimental housing project, that goes under the same name as its neighbourhood. Recognisable by its characteristic and colourful façades, Lunetten bear witness of an innovative residential development from the seventies, where 262 rental households were given the rare opportunity to freely decide on their own dwelling layout and façade expression.

Lunetten, or more specifically Lunetten 4D, is one of the projects of sub-plan 4 in the development of the Lunetten neighbourhood, and is located on five different sites in the district. Sub-plan 4 was the last of a series of expansion plans in Utrecht based on a structure plan from 1954, where the municipality wanted to provide more variation in the district of Lunetten, after great uniformity in the expansion of the Kanaleneiland and Overvecht districts (Barzilay et al., 2018, p.125). Lunetten 4D, hereby referred to as solely Lunetten, was developed from 1972 to 1982, by the architectural office Kokon and the architectural research foundation Stitching Architected Research (SAR), with Frans van der Werf as the project architect. In 1983 these five sites of experimental social housing were completed, ready to house its new residents in almost 200 unique dwelling plans.

At the time Lunetten was developed, the

Fig. 1.1: Sub-plan 4 with Werf's development of Lunetten 4D visible in hatched roof surfaces. From *Lunetten - Vlek 4*, by Boekelman & De Lange, 1977.

Dutch government was running a housing program to promote innovation and experimentation in residential developments, by subsidizing projects of particularly innovative character. Under the name Experimentele Woningbouw (Experimental Housing), this program promoted among other things experiments with attention to flexibility and user participation. Van der Werf is the architect of two projects that were nominated experimental by the program (Barzilay et al., 2018, pp.108, 125), where Lunetten constitutes a follow-up project to his initial Molenvliet experiment. Based on principles and design methods provided by SAR, both of these projects innovatively address adaptability and user participation as core principles, through a method of design based on separate layers of intervention and decision-making.

Lunetten was the biggest and one of the last projects constructed according to the principles of SAR. SAR stopped operating as an organisation in 1985, but the SAR philosophy and methodology have been followed up and further developed under the concept of Open Building (Barzilay et al., 2018, p.125), where Van der Werf has had an instrumental role in the dissemination and practising of its principles.

Open Building is a design strategy that distinguishes between three levels of design on different scales, that together provides a public urban tissue, a collective support structure and a private infill (Van der Werf, 2023b). Van der Werf describes the layer of the infill as the essence of Open Building, and underlines that the infill's ability to adapt is crucial for making Open Building a successful and reliable design approach (OpenBuilding.co, 2023a). This thesis aims to investigate how this adaptability has played out in the experimental project of Lunetten, leaving the main research question to be:

How durable is the experimental adaptability in Lunetten?

The chosen method to investigate this adaptability and how durable it is in practice is to look closer at the mentioned layer of the private infill. Firstly, asking how the internal infill structure has changed over time in Lunetten, and secondly, how the infill concept has developed in the works of Van der Werf.

To answer these questions, this thesis will be structured into three main parts. The first part will provide an overview of the construction of Lunetten, and the societal and time-specific context it was con-

structed in. The second part will discuss the adaptability of the project, by investigating the development of the infill structure in Lunetten over time. While the third part will discuss the durability of the concept, by looking into the development of the infill concept over time in Van der Werf's Open Building projects. Before that, the context and relevance of conducting this research will be elaborated on in the following chapter.

Fig. 1.2: The experimental homes of Lunetten visible with red pitched roofs. From: Collection Het Utrecht Archives, by Photo service HUA, 2002.
<https://hetutrechtsarchief.nl/beeldmateriaal/detail/9379e3d2-7011-d297-e053-4701000acbdb/media/c83e858a-ae7-07e4-c365-2d791bef4c3c?mode=detail&view=horizontal&q=lunetten&rows=1&page=38>



2. Context and Relevance of the Research

Looking to the present one can argue that the Netherlands currently is facing two simultaneous and urgent crises. One is the current housing crisis, demanding a million new homes by 2030, and the other is the accelerating climate crisis. In the intersection of these two urgent and challenging issues, the need for evaluating and rethinking how we build and live continues to be highly relevant and serves as a crucial challenge to solve for the current and coming architectural profession. In the process of solving these fundamental challenges, it can be of great value to look to the past to evaluate the issues of the present.

Learning from our built housing history, the evaluation of and research into our post-war residential areas are essential. This to build knowledge on how to treat and adapt our existing housing stock, where our post-war housing especially will require refurbishment and adaptation in the near future. While at the same time learning of the failures and successes of our housing heritage, as a base for reference and inspiration for the necessary future housing development required to meet the demand for housing.

In the Dutch context, the post-war residential areas constructed during the seventies and eighties constitute a substantial amount of the Dutch housing stock today, and the Experimental Housing Program in this period has catalysed the development of residential areas, housing typologies and forms of housing in this period (Barzilay et al., 2018, p.5). Adding to the research publication executed by the Rijksdienst voor het Cultureel Erfgoed (National Cultural Heritage Agency, RCE) from 2018, *Predicaat Experimentele Woningbouw 1968-1980: Verkenning Post 65*, this thesis aims to contribute to the research on the outcome of the Experimental Housing Program, and investigate whether the built results from this initiative can be viewed as an experimental success.

To reduce the scope and sharpen the focus on the research, Lunetten was chosen as a representative case study, to exemplify and more deeply research some of the innovations the program has contributed to. Lunetten has already raised interest as a research object, with different evaluations and studies executed since its completion in 1983. Some of the main studies and publications conducted on Lunetten have researched the impact and value of user participation

(Molenaar, 2016), the quality of the collective outdoor spaces (Nio et al., 2011) and the historic development of the area (Brinkman, 2004; Bruëns, 2010). Seemingly there is yet no specific research done on the status of the infill structure of the project, that when built was indeed something that made Lunetten a special experiment. Also, the heritage department in Utrecht, mediated through Bettina van Santen (personal communication, February 8, 2023) recognizes this project as valuable heritage. She argues that the experimental internal structure of Lunetten could be worthy of protection, but that they don't (yet) know enough about the state of the infill to specify the scope of possible protection. This experienced gap in research and knowledge, serves as a main argument to investigate Lunetten's infill structure and its adaptable qualities.

Today's increasing demand for responsible and efficient use of resources, has made the theme of adaptability itself an essential subject, and has given the concept of Open Building increased relevance in the last decades. Already in 1999 Stephen Kendall, a key writer on Open Building, drew the connections to sustainability in his publication *Open Building: An Approach to Sustainable Architecture*. Here he states that a building's capacity to adapt over time to changing uses and preferences, is one of the most urgent issues contemporary architecture is facing, and argues that the principles of Open Building can provide such adaptable qualities (Kendall, 1999). As will be further addressed in sub-chapter 5.6, this design concept has not lost its actuality since the turn of the millennium, and is still actively used by a growing community of professionals.

Considering all the above, Lunetten is seen as a relevant research object. Both as an example of a Dutch post-war housing project from the seventies, and as one of the first projects where the then-experimental principles of Open Building were applied. Further investigation of how Lunetten's adaptable intentions were applied in practice and how the concept developed over time, can give meaningful insight into the quality and potential of Open Building as a design method.

3. Constructing Lunetten

Before getting into the adaptability of Lunetten's infill, and the development of the infill concept over time, this chapter will first aim to explain the time-specific context Lunetten was constructed in and the experimental principles it was based on. Lunetten was developed in the period between 1972 and 1982, a time frame shared with a great deal of Dutch housing (Abrahamse, 2019, p.5). Both in terms of built results and the development of new societal and architectural ideas, this is a period that has left a clear mark on the Netherlands as we know it today.

3.1 A Critical Decade

As Martien de Vletter (2004) clearly states in his book *The Critical Seventies*, the seventies was a very special decade in the Netherlands, with developments that came to 'shake the country to its very foundations' (back cover). The field of architecture and urban planning was no exception, as the seventies was a time for great shifts in architectural and urbanist ideas.

The developments in architecture and urban planning in the seventies were affected by multiple societal developments. It was a decade where the welfare state was established, the Netherlands evolved into a multicultural society, and liberation and democratisation were increasingly viewed as important values (De Vletter, 2004, p.38). Simultaneously, also the growing dissatisfaction with the built results of the modernist post-war reconstruction period, was an essential cause of the changes seen in the seventies. Responding to the housing shortage of the post-war period, high-rise structures constructed with a focus on functionality and efficiency, were built in large-scale developments up until the late sixties. Produced in high speed and quantity, based on standardisation and cheap materials, these modernist ideas were towards the seventies accused of producing lifeless and monotonous living environments (p.41).

It was in the sixties predicted that the Netherlands would massively increase in population in the coming decades, reaching 20 million inhabitants by the year 2000. To prepare for this, in a way that would not repeat the issues of the post-war reconstruction, the minister of housing and spatial planning

W.F. Schut, among others, introduced several policy changes in the seventies (De Vletter, 2004, p.40). Policies that created an important ground for housing development in this decade, and as we will see more closely in the following section, it enabled several influential housing experiments in the Netherlands.

Given the developments above, the architecture and urbanism of the seventies gained a new and clear characteristic. The Dutch architecture of the seventies wanted primarily to achieve community, safety and a sense of belonging, with small groups of dwellings in overlapping grids providing protected communal spaces (p.13). New typologies were devised, with pitched roofs, extensive brick use, and whimsical and varied floor plans. Above all, there was a growing interest in the city (p.39). A typical representation of the developments of the seventies is the so-called 'bloemkoolwijk' (cauliflower neighbourhoods), which emerged rapidly in the Netherlands throughout both the seventies and eighties. As visible in fig 3.2, the cauliflower neighbourhood got its name from the characteristic irregular plans resembling a sliced cauliflower, with low-rise buildings grouped around public spaces intended for the residents (Abrahamse, 2019, p.4).

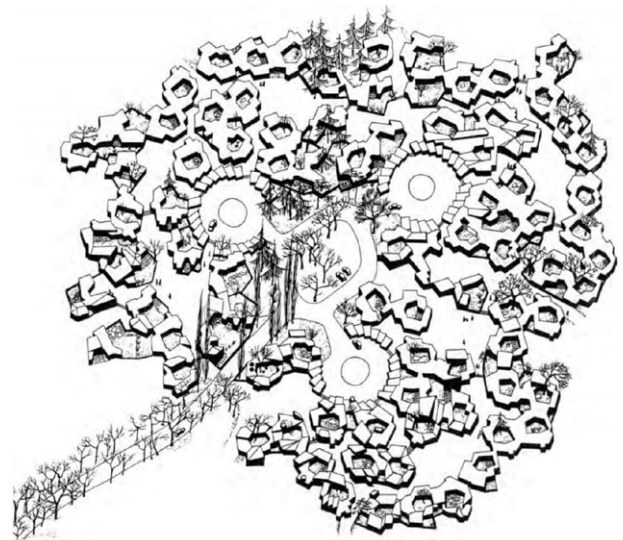


Fig. 3.1: Visualisation of a cauliflower neighborhood. From: *Baksteen*, by Nick de Boer, 1967.
<https://www.atheneum.nl/media/364392/bloemkoolwijken-p23.jpg>

Counting 800.000 homes built in these characteristic neighbourhoods, the cauliflower districts constitute 40% of all the homes built in the Netherlands from 1970 to 1985. The characteristic cauliflower neighbourhoods and the remaining housing of this period,

together constituting a quarter of the current housing stock in the Netherlands (p.5), and serve as a demonstration of the great impact the seventies have had on the Dutch urban landscape.

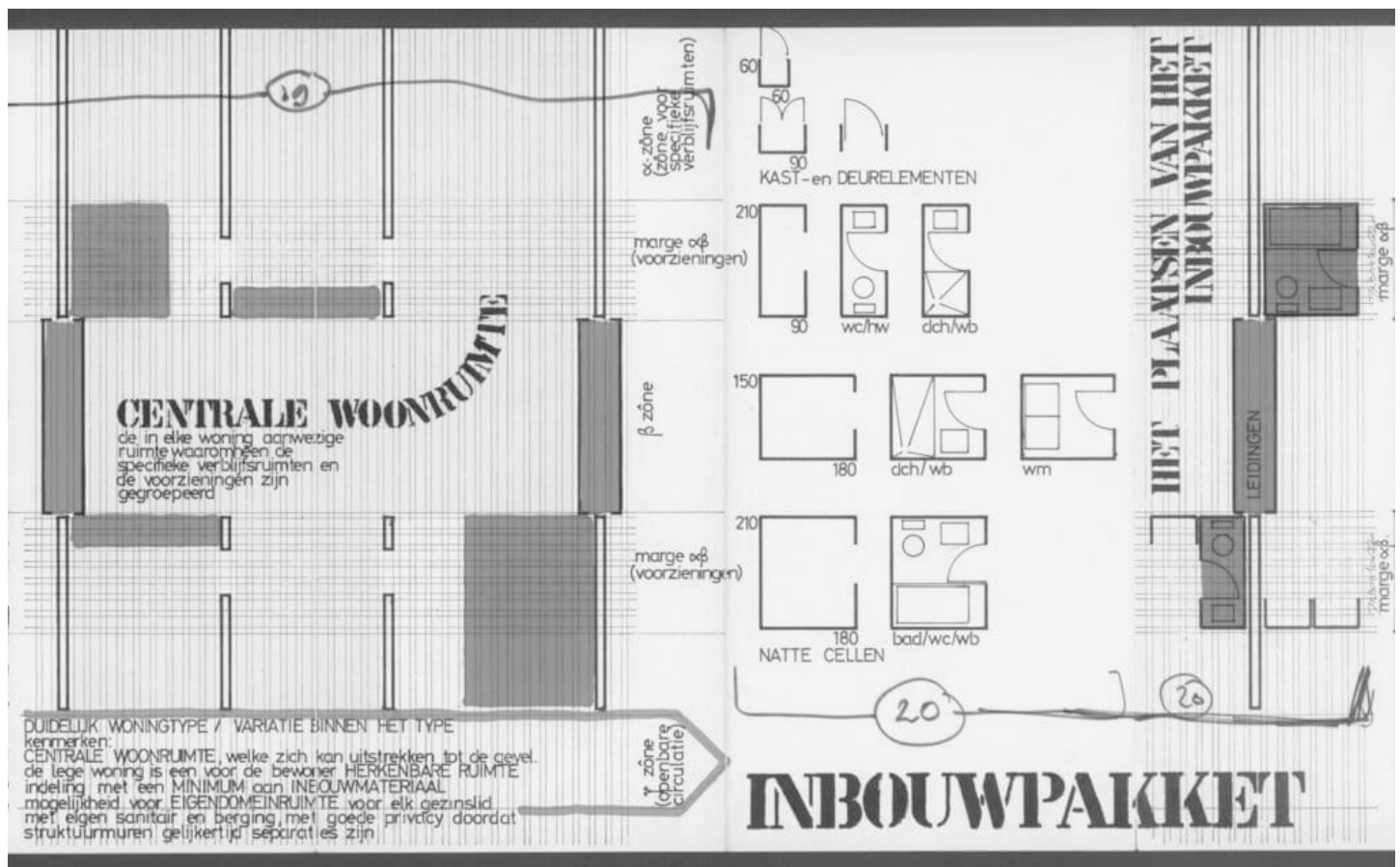
3.3 Experimental Ideas

Adding to the policy changes implemented around the seventies, Minister Schut introduced the program for experimental housing in 1968. As a counter-reaction to the dissatisfaction with the monotone and uniform housing from the post-war reconstruction period, this program aimed to subsidise and promote innovations and experiments in housing that would contribute to a better quality of living (Barzilay et al., 2018, p.19). The intention was to give both private and public housing projects a helping hand in executing new experimental ideas, with the hope that the ideas could be repeated afterwards without subsidies. The program committee assessed whether submitted plans had the potential to be implemented into regular housing construction practice. Another factor for promoting innovation was that the municipality could grant the designated housing projects

exceptions from certain building regulations, for aspects that were part of the experiment. Part of the assessment criteria was that an idea was only viewed as experimental during a first implementation, and a repetition could in principle no longer be assigned experimental (p.20). As further discussed in sub-chapter 5.1, this became a relevant subject for discussion in Van der Werf's Open Building practice in the seventies and eighties. The results of the programme, consisting of 64 realised projects, represent several important innovations in the field of housing, including attention to flexibility, resident participation, compact building and mixing of housing types (p.5).

Among the different methods of innovation, the implementation of the design methodology developed by the SAR was a source of multiple nominations to the Experimental Housing Program. Founded in 1964 by John Habraken, the SAR's main aim of work was to clarify and develop concepts and methods for design, where experimental architectur-

Fig. 3.2: Poster on the methodology of support and infill (inbouwpaakket). From: Collection Het Nieuwe Instituut, by SAR, 1967. https://placesjournal.org/wp-content/uploads/2023/04/SAR_a67-01b.DETAIL.CMS_.jpg



al theory could be translated into building practice (Bosma et al., 2000, p.7). In Habraken's first book *Supports: an Alternative to Mass Housing* (originally published in Dutch in 1961) he analyses the Dutch mass housing constructions of the time and accuses them of monotony and lack of user participation. As a radical alternative, he proposes a concept of dividing the mass housing production into two separate parts. One being the *support* as a communally shared base structure, and the other being the *infill* as a private area of responsibility. This conceptual division desired to use industrial manufacturing methods to provide variation and individual character to the millions of houses needed in the coming decades. With Habraken as the first director, the SAR would in its operating period between 1964 to 1990 work to convert this theory into practice (Bosma et al., 2000, p.8).

For developing Habraken's theory on support and infill, the SAR followed separate lines and scales of research leading to the development of different design methodologies, that later were actively used in several housing projects. Importantly among these, is the methods of SAR65 and SAR73, named after their years of publication (p. 216). The SAR65 method was developed to reconstruct the decision-making process in housing construction, in addition to providing specific principles for constructing an autonomous support building, with a dimensional-coordination system and principles for zones and margins, as indicated in fig. 3.2. The idea was that if a support structure is built according to these principles, a separate infill package could easily be added later (p.219). While SAR65 dealt with the scope of the housing building, SAR73 was rather addressing the design of the direct housing environment, the so-called urban tissue. Developed by Frans van der Werf, together with Hent Reijenga, this methodology provided a set of tools for designing an urban tissue to improve the quality of urban space, with decision-making as a central theme (p.255).

The SAR stopped operating as an organisation in 1990, but the ideas and methodology developed by Habraken and his research office have been adopted by the movement of Open Building. Based on clearly recognisable principles, Open Building is defined as a design method divided into separate layers of intervention, with a focus on participation and adaptability. As a design concept that is still develop-

ing worldwide in both the commercial and residential sphere (Kendall & Teicher, 2002, pp.8-9), it is a variety of different specific definitions describing Open Building Design. This thesis will rely on the specified definition provided by Van der Werf, who mainly has used and applied the concept to residential projects.

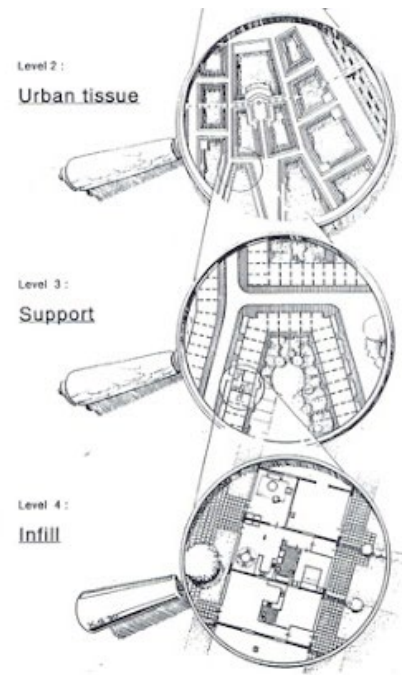


Fig. 3.3: The levels of Open Building. From: *Open Ontwerpen*, by Frans van der Werf, 1993.

As visualised in fig. 3.3, Van der Werf (2023b) defines Open Building as a design strategy that distinguishes between three levels of design interventions, all connected to different scales. The first level of intervention is the *urban tissue*, where the design of the public spaces is created by a spatial pattern that structures the morphology of the city as a recognizable whole. The second level, the *support*, is defined as the collective base building, consisting of the permanent and load-bearing structure and collective access spaces, and provides the possibility for parcellation. The last level is the *infill*, which includes the private interior design of the dwelling. The infill is the level where the residents are given the freedom to freely shape their private surroundings, including components like partitions, doors, windows, piping and wiring. This layering of design and decision-making intend to provide spatial and visual diversity within a coherently composed living environment (Van der Werf, 2023b).



Fig. 3.4: Model photo showing the support structure of Molenvliet. From: *The Molenvliet Project*, by Frans van der Werf, 2017. <https://thematicdesign.org/wp-content/uploads/2017/05/Molenvliet%20for%20Thematicdesign.org%20-new%20main%20text.pdf>

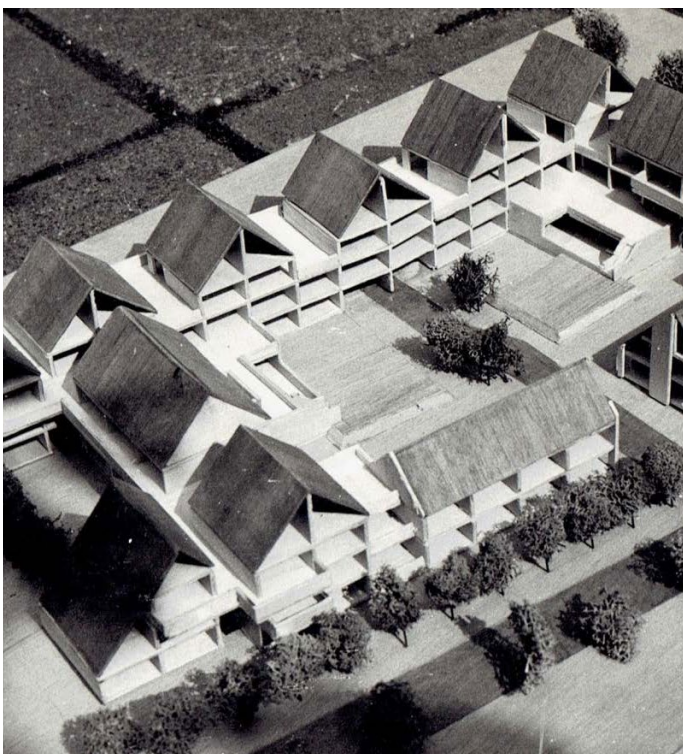


Fig. 3.5: Model photo showing the support structure of Lunetten. From: *Lunetten 4D*, by Frans van der Werf, 2017. <http://thematicdesign.org/wp-content/uploads/2017/06/Lunetten%20for%20Thematicdesign.org%20-%202021-6-17%20main%20text75.pdf>

3.4 Experimental Implementation

Van der Werf has played an important role in the implementation of the ideas of the SAR and Open Building in the Netherlands, and has, as further addressed in chapter 5, over the years contributed to a series of Open Building developments. His first Open Building implementation was the Molenvliet project completed in 1978, located in Papendrecht outside Rotterdam. With subsidies from the Experimental Housing Program, Van der Werf could now apply the theory and methodology of tissue-support-infill into practice for the first time. Resulting in a hundred homes with freely decided layouts from its residents. Shortly after this first Open Building experiment, Van der Werf once again got to test these ideas in practice, with the development and construction of Lunetten. Completed in 1983, also Lunetten got granted experimental by Minister Schut's housing program, and became a follow-up to the initial Molenvliet experiment. As the second of Van der Werf's experimental implementation of the SAR's methodology, also Lunetten received subsidies and permissions for free lay-outing of each unit. (Van der Werf, 2017, p.7).

As visible in fig. 3.4-3.5, the support structure and urban tissue of Molenvliet and Lunetten have clear similarities, where a high-density low-rise fabric is placed around communal courtyards. A new feature of Lunetten's urban tissue, was thought that it was implemented on five different sites in the neighbourhood. As shown in fig. 1.1, this was part of the development of sub-plan 4 in the area, where different architects and practices worked together with developing the sites in the urban fabric of the neighbourhood (p.2).

Within this publicly defined urban tissue, the support structure of Lunetten was designed as dense, low-rise base buildings, including dwelling units, storage, parking and office space. With a focus on providing a wide variation, the residential buildings consist of 15 different dwelling types, including both flats, duplexes and row houses (p.4). The parcellation of the support structure was based on a square grid of 5400 x 5400 mm, where each dwelling unit was defined by different combinations of this modular measurement. On the level of the support structure, the architect decided on the dwelling types and their location, the entrances, the private outdoor spaces and the fixed placement of the technical shaft and staircases (p.6).

In total the support structure provided 262 dwelling units for free infill by its residents, in addition to 173 rooms for students and young workers grouped into pre-designed clusters of 6 to 7 rooms (p.7). Variations dwelling plans with support and infill is exemplified in fig. 4.1 and fig. 4.3.

Before the resident participation could take place in the infill process, the architect had to design a fictional infill layout of each dwelling type according to the housing regulations. This both to indicate the unit's capacity, the price of the infill, the subsidy and the resulting basic rent, but also to have a backup layout in case of residents withdrawing from the project. In Lunetten the actual participatory infill designs were then later arranged by the housing association Lunetten BV, where an external architect was hired as a user consultant to manage the process. In the end, the result of the infill process was 175 unique dwellings designed with its future residents, while the remaining 87 dwellings received the fictional layout (p.8). The physical internal infill structure was delivered in its totality by the supplier Bruynzeel, with a developed infill system called 'Bruynzeel Inbouwpakket'. Also, the dwelling façades were included in the self-decided infill structure. Within a flexible wooden façade system delivered by the Swedish subcontractor Miresjö, the residents could choose doors, windows and panels of different dimensions and colours (p.12). As a result, the great freedom and variation within this project is also visible in its façade expression, like one can see in fig 4.2.



Fig. 3.6: During installation of the infill package. Showing the fixed position of staircase and central shaft, along with the structure of the adjustable partition walls. From: *Lunetten 4D*, by Frans van der Werf, 2017.

<http://thematicdesign.org/wp-content/uploads/2017/06/Lunetten%20for%20Thematicdesign.org%20-%202021-6-17%20main%20text75.pdf>

4. An adaptable project?

The Development of the Infill Structure.

As already addressed in chapter 2, the development and status of the dwelling interiors serve as a research gap in Lunetten. To investigate the reality of the projects intended adaptability, the quality of the infills in these dwellings is a necessary base of departure. Mainly based on interviews with architect Frans van der Werf and a handful of Lunetten residents, this chapter will discuss to what degree the Lunetten dwellings have been able to adapt to changing needs, preferences and not the least changing residents over time.

4.1 Infill at Completion

In the investigation of the infill development over time, a natural starting point is to assess how the experiment was perceived and experienced at the point of completion. Lunetten was an object for both praise and criticism during its development and after its completion. In evaluating the success of the infill one can distinguish between the process of user participation to create the infill, and the physical infill result as a product of that process.

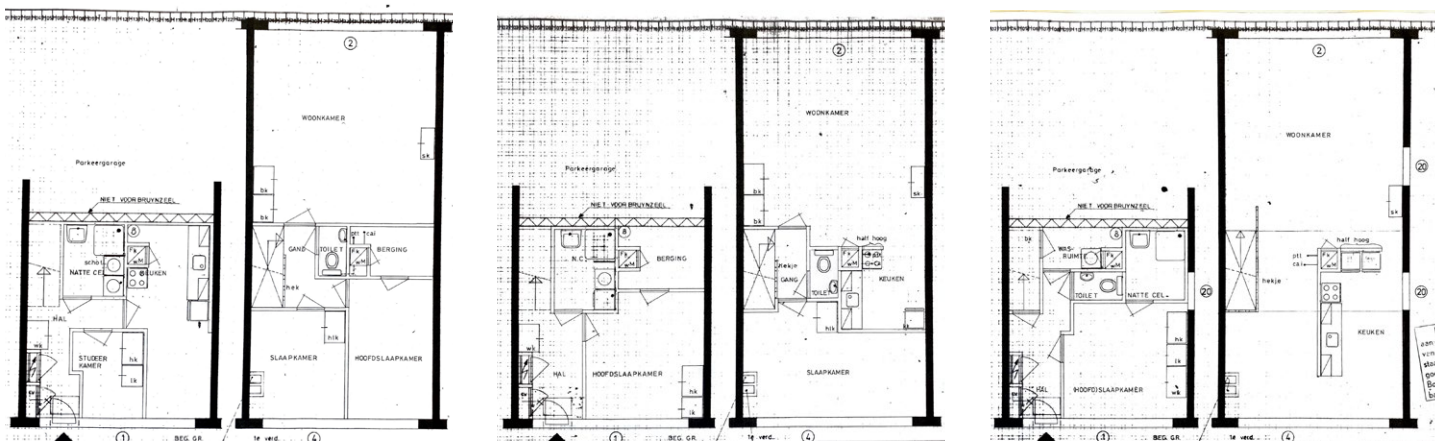
Barzilay et al. (2018) explain that an evaluation of the user participation was conducted already in 1977, while the project was still under development. It concludes that residents had an influence on the project, and that there certainly was a great variation of dwelling types in the project. As exemplified in fig. 4.1, hardly any dwelling was alike. The evaluation also stated that the residents gained increased community, as they through the participation process knew

each other from before they moved in (p.125). Also Nio et al. (2011) conclude that Lunetten can be seen as a successful example of participation, with the result that the residents also over time have had a greater sense of community and a good ability to organize themselves (Barzilay et al., 2018, p.125).

Despite the success of extensive user participation and the following degree of dwelling variety, Lunetten also got a fair share of criticism in the time after the completion. In an issue of the magazine *De Onderste Steen* from 1983, it is stated some initial evaluations of the then newly built Lunetten. Among other points of improvement, they addressed that low quality and defects in the construction were particular issues. Some of the main critiques regarded elevated bathroom floors, shower cubicles in front of windows, partition walls running into window panels, and plumbing ducts led through the middle of rooms. Also, the insulating effect of the adjustable chipboard partition walls is described as totally negligible, to the extent that 'every fart is heard three rooms away' (Brinkman, 2004, pp.51-53).

Martin Brinkman (personal communication, February 13, 2023), a local historian on the district of Lunetten, explains that the general impression of Lunetten was divided. On one side the project was treated as somewhat of an attraction at completion, with guided tours and busses entering the neighbourhood. While on the other side, it started to appear posters saying 'Experiment failed', with following criticism of clumsy layouts, sloppy finishing and too thin partition walls.

Fig. 4.1: Variations of infill layouts in the same dwelling type. Support structure indicated with black section. From: Collection Het Utrecht Archives, by Bruynzeel, 1982.



Brinkman himself lived in the experimental homes for about four years right after the completion in 1983. As the apartment he moved into initially was assigned to someone else, that withdrew before completion, he did not have the opportunity to decide or discuss the layout of the dwelling. Even though he was very happy to have a home for himself, he leaves no doubt that the internal partition was, to put it mildly, not ideal. As intended by the infill concept, Brinkman explains that the partition walls in principle could have been moved, but that it in practice was too complicated and expensive for anyone to actually do it (Brinkman, personal communication, February 13, 2023).

In many ways, one can argue that the initial evaluation of the infills in Lunetten was divided. On one side the process of constructing the infill was overall viewed and experienced as a great success, where one in an increasingly professional manner managed the process of resident participation and provided great dwelling variety. On the other side, the physical and technical aspects of the infill packages evidently had some room for improvement. The infill elements and belonging detailing required higher quality, while at the same time the freely decided layout designs were not always satisfactory in the case of switching residents.



Fig. 4.2: Newly built homes with visible variations of colour in the facade infill. By Maarten Brinkman, 1983.

4.2 Rental Restrictions

One of the features that makes the user participation extra special in Lunetten is the fact that when built the whole project was social housing. This gave rental residents a special opportunity to extensively shape and customize their immediate living environment. The combination of rental dwellings and customization is though an interesting combination due to two different aspects.

Firstly, because rental living initially allows and facilitates for more rapid change of residents, and therefore individually specified customization becomes challenging in change of residents (as insinuated by Brinkman in his description of his experimental dwelling). For this combination to work, it is especially important that the layout is possible to adapt to changing residents.

Secondly, the rental contracts for social housing usually don't allow for the renting resident to do significant changes to their dwellings. This legislation, even though decided by the out-renting housing associations themselves, serves as a general standard in such rental contracts. This is also the case for Lunetten, as Bo-Ex, one of Lunetten's housing associations, confirms that their residents are in the position to ask or request changes, but unless it is for ultimately good or critical reasons the request will be denied (M. Leermarkers, data analyst, BO-EX, personal communication, March 28, 2023). In practice, this means that changes in a rental dwelling's interior structure will usually not occur, especially not with the motivation of personal preferences.

In many ways, it serves as a great contradiction to combine a housing concept dependent on adaptability, with a form of living where the contractual standard prevents change or adaptation. Even though the act of giving social housing residents the opportunity of resident participation is a great quality in itself.

4.3 Social Housing for Sale

Based on the legal restrictions of changes in social housing, one might assume that the dwellings of Lunetten have kept their initial infill design throughout these last 40 years. This is though not the case, as a change of ownership started to develop in Lunetten's social housing stock close to the turn of the century.

Unlike in some other countries, the Dutch housing associations, that manage most of the social housing in the Netherlands, can freely buy and sell their dwellings, often to improve their financial position. Unoccupied social housing properties can be put on the open market for sale, while properties with current renters must first be offered to their tenants, who then also can choose to continue to rent. From 1998 to 2002 Dutch housing associations reconfigured a great amount of their housing stock, where 105.000 dwellings were sold to the private market (Elsinga & Wassenberg, 2014, p.131)

This rearranging in the social housing also became visible in Lunetten, where the three different housing associations, combined in a partnership under the name 'Lunetten BV', started to sell parts of their properties. As a consequence, the initial all public rental dwellings in Lunetten is today changed into an estimate of about a quarter of privately owned dwellings.

The local government is aware and critical of this trend of sale in the social housing sector. In the *Prestatieafspraken 2022-2026*, the Municipality of Utrecht, in cooperation with the housing associations, laid certain restrictions on the sale of properties to the private market. Primarily this prevents the associations to sell property close to the city centre, intending to retain sufficient diversity in the central areas. The restriction does not apply to the district of Lunetten, even though the Municipality do express that they wish for the housing associations to keep as many units as possible within the social housing sector (M. Leermarkers, data analyst, BO-EX, personal communication, March 28, 2023).

4.4 Infills Today

Supported by experiences and knowledge from architect Van der Werf (personal communication, March 2, 2023) and a few of Lunetten's residents (personal communication, March 11, 2023), one can assume that at least the main part of the initial infill structure and design in Lunettens dwellings are intact and unchanged, in the around three-quarters of the dwellings that still are rental social housing. A new question that arises is then what development that took place in the dwellings that were sold to the private market, and that now is owner-occupied homes. Did this new freedom for change, result in that the flexible

infill packages finally could be adapted to changing preferences and residents in the way it was intended? A home visit and interview with two privately owned households in Lunetten gave some clear indications of the private infill development.

As part of the social housing sale around the shift of the century, with a sales peak in 1998 with 18.000 sold dwellings (Elsinga & Wassenberg, 2014, p.131), both of the visited households bought their dwellings from the housing associations in 1998. Household 1 rented their unit for two years before the buy, and Household 2 moved directly in as homeowners. At the point of the purchase, both the units still had the original infill, with both wall partitions, kitchen, electricity ducts, bathrooms and façade composition in its initial state. In the same way that Brinkman (personal communication, February 13, 2023) expressed his issues with the infill already in the early eighties, also Household 1 and 2 had quite a few points of preferred improvements when moving into these dwellings. Electricity plinths along the walls both towards the floor and the ceiling, raised bathroom floor of 30 cm high, chipboard walls without insulation, and for them unpreferable floor plans, gave both households a wish for extensive change and renovation.

Despite intended flexible electricity and demountable walls, the wish for change resulted in more or less a complete removal of every single piece of the original infill package. Answering the question of whether they ever considered keeping or reusing parts of the infill, they both expressed that the technical and visual quality of the original interior was not at a desirable standard. At the same time, if the original elements would be repurposed, they would either way be dependent on available spare parts. Even though spare parts were limitedly available in storage at some point, it was in 98 practically no longer possible to find infill elements, because the infill supplier Bruynzeel dissolved right after their work with Lunetten. Even without the intention of repurposing the partition walls, Household 2 did discover that the adjustable partition walls (see fig. 3.7) indeed were suitable for demounting, and if nothing else at least made the demolition of the interior a good deal easier.

Over time the infill packages was in these two dwellings replaced with more standard, conventional building solutions, and to the knowledge of Household 1 and 2 this has also been the case for the re-

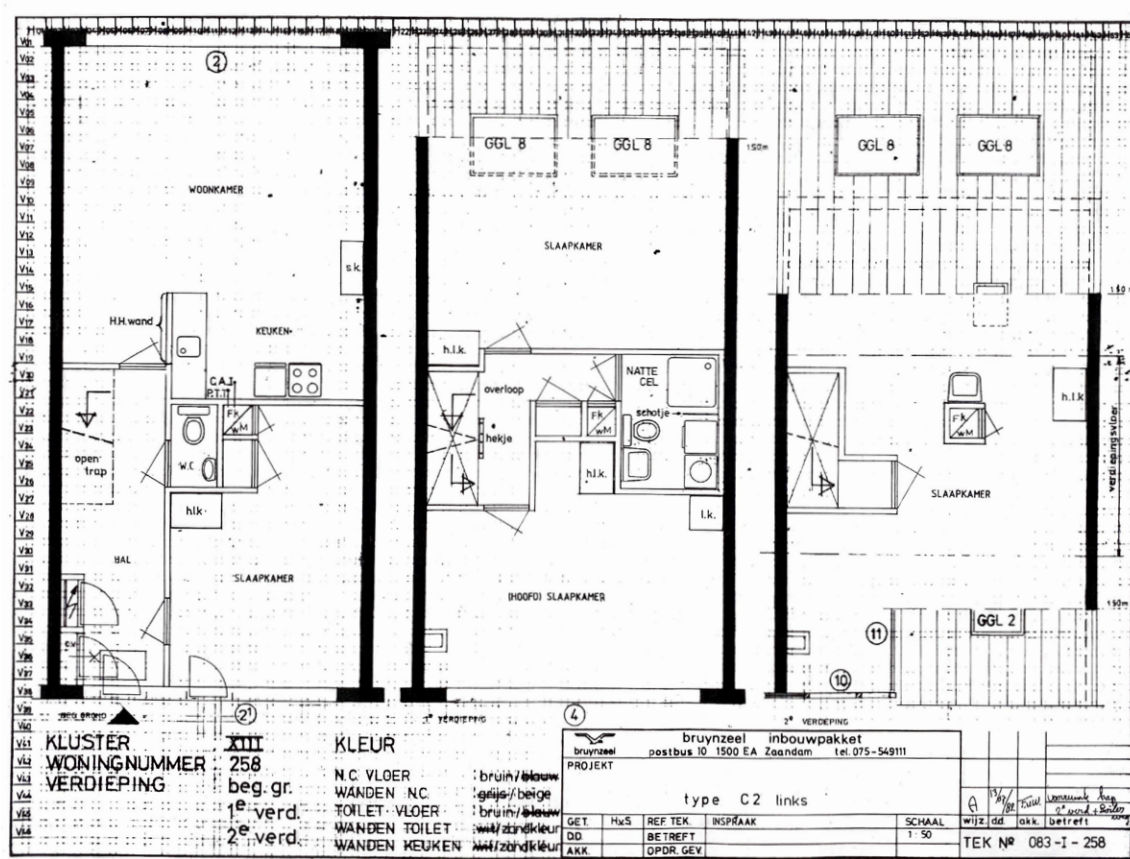


Fig. 4.3: Original infill dwelling plan Household 2. Also indicating choices of colour. From: Collection Het Utrecht Archives, by Bruynzeel, 1982.

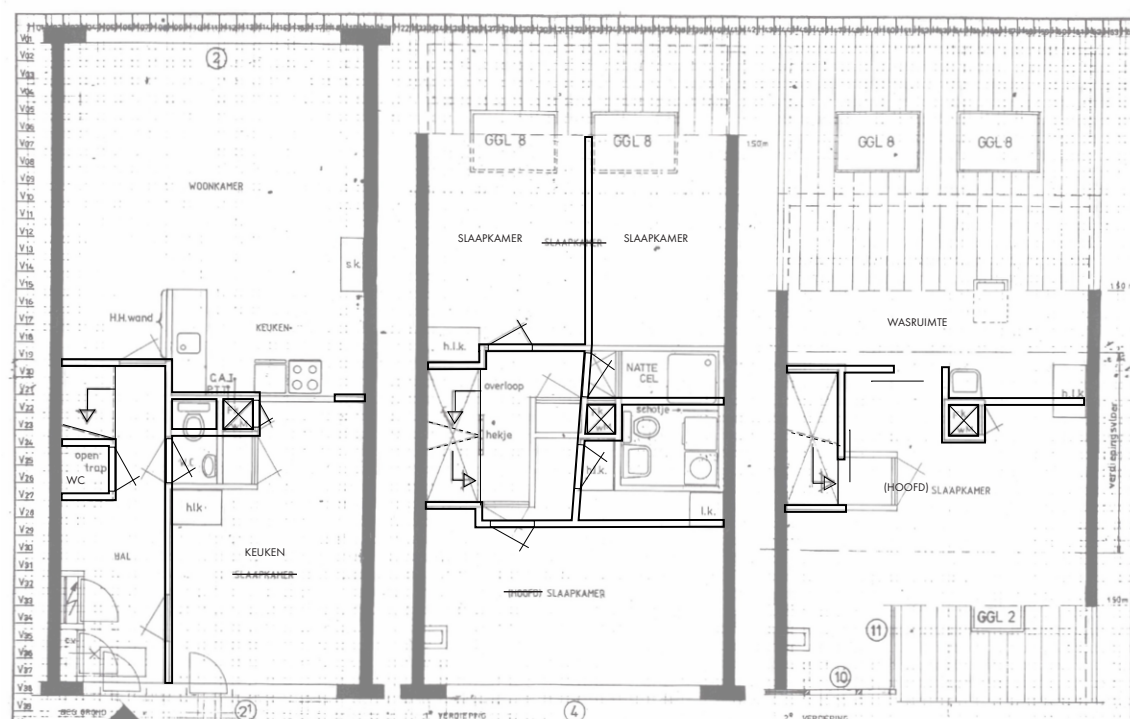


Fig. 4.4: Sketch current dwelling plan Household 2. From: Collection Het Utrecht Archives, by Bruynzeel, 1982. Adapted by the author, 2023.

maintaining privately bought dwellings. Regardless of the degree of former or future infill adaptability, these residents successfully adjusted their homes according to their preferences. The result appears today as high-quality dwellings, where both households re-infilled each of their support parcellation units in different ways. The change of layout in Household 2 is represented in fig. 4.4. Even though the development of these two dwellings exemplifies that the quality and adaptability of the infill package itself were not well enough developed at that time, it still shows that the collective support structure functions as a solid base structure to fill in varied dwellings, even with conventional interior building products. In some way, this still argues for Lunetten's adaptable qualities, even though more in the flexibility of the support structure, rather than the adaptability of the physical infill.

A somewhat exception in the process of adapting the dwellings according to the new homeowner's preferences is the treatment of the façades. As also belonging to the dwelling infill, one can in the facade elevations detect infill adjustments. In relation to the changing internal partitioning, some adjustments have been done to the composition of the façades in Household 1 and 2. Both in terms of changed door placement and enlarged window surfaces, but also quite evident changes in the colour pallet of the façades. The change of colour and composition serves at times as a conspicuous visual symbol of the changing ownership and the gained freedom of the dwelling owners. Where the still rental social hous-

ing mainly has kept the original colour palette, while many of the now privately owned households have adapted their façade colour composition more freely.

As a combined consequence of the restrictions on carry out changes in rental homes, the trend of social housing sale to the private market, and the underdeveloped technical and aesthetical quality of infill systems at the time, the state of the infills in Lunetten is today overall divided into two main categories. One is the intact and unchanged infills located in the three-quarter of the project kept as social housing units. While the other category is the anticipated completely removed internal infills and partly adapted external infills, belonging to the remaining one-quarter of private owner-occupied units. In both cases, there are no firm indications of actually adjusted internal infill packages, despite the adaptable intentions present in constructing the experimental infills of Lunetten.

Fig. 4.6: Facade variation between rental dwellings and owner occupied homes. Sint Gotthard, Lunetten. By the author, 2023.



5. A Durable Concept?

The Development of the Infill Concept.

To complement the investigation on how the physical infill developed in the case of Lunetten, this chapter will look further into how rather the concept of Open Building on the infill level has developed over time. To reduce the scope, and have a relevant reference for comparison, the Open Building projects of Frans Van der Werf are chosen as a base to discuss this development. The primary source of reference in this section is an interview conducted with Van der Werf (personal communication, March 2, 2023) as part of the research for this thesis. After zooming into the specific developments in the work of Van der Werf as one individual line of practice, a brief change of perspective will finish up the chapter by touching upon the broader current status of Open Building, and what relevance this design method provides today.

5.1 Practicing Open Building

Ever since graduating from TU Delft in 1965 with the award-winning project 'Housing the Linear City', Van der Werf has been developing and practising the ideas behind Open Building. As some sort of a coincidence, Van der Werf was in his graduation design touching upon the same support principles that the SAR was researching and developing in the sixties. Connected through Professor John Habraken himself, Van der Werf was offered a job at the research office to further work with the principles for this design method. After

practising in Paris for a few years after graduating, Van der Werf came back to the Netherlands to accept the job offer at the SAR. After working with developing the urban tissue methodology of SAR73 for a few years, he left the research office in 1974 to rather devote himself to the design practice.

During his career Van der Werf designed and realised six residential Open Buildings. The support-infill journey started with the already mentioned Molenvliet experiment in 1978, followed by a steady Open Building production throughout the eighties and nineties, with Lunetten (1983), Keyenburg (1985), Berkenkamp (1988) and Pelgremhof (2001), ending with his last realised Meanderhof in 2008. Van der Werf is now retired and does no longer officially practice as an architect. However, he did in 2018 publish the design study 'Transformation of Slums into Urban Districts by 'Open Building' (Van der Werf, 2023a). In addition to that, Van der Werf has also in his retirement days kept disseminating the ideas of Open Building, through holding lectures, and arranging workshops and excursions. Even though Van der Werf now consider himself more or less done with practising, it's no doubt that he throughout his career has been instrumental in the development and implementation of tissue-support-infill principles in the Netherlands.

Fig. 5.1: Van der Werf's six realised Open Building projects. From *Projects*
<http://www.vdwerf.nl/projects.html>



In this development, Van der Werf clearly explains that designing with Open Building has more than anything been a continuous process of learning, where he has not been afraid of making mistakes. The developments have of course been many and versatile, but certain themes seem to have kept developing throughout Van der Werf's projects. The most impactful being: defining the scope and necessary complexity of the infill, working towards adjusting the legal framework and building standards, and the developments in technical quality and infill coordination. The following section will now further discuss these main developments, and exemplify of how they appear in his projects.

5.2 Reducing Complexity

As a first experiment, Molenvliet (1978), provided an initial reference for further development of Open Building implementation. The film Molenvliet (1984) shows how this first implementation was in general viewed as a great success. They managed to create great variation within a simple support structure through the process of user participation, with seemingly all very satisfied residents. On the other side, the film production also touches upon how the complexity of the experiment was a challenge that left its mark on the project. Primarily in the way that some of the traditional work of the architect, such as the detail design, was neglected in favour of managing the participation process and handling the following great variation and complexity in the project (Van de Noort, 1984). In the process of improvement from there on out, Van der Werf views Lunetten as a big step forward, where they got the opportunity to correct some of the first challenges in the Open Building implementation. One of the bigger changes done was indeed the reduction of complexity, where limiting the number of different dwelling types within the support structure was a crucial point. Molenvliet operated with 67 different dwelling types, while this in Lunetten was reduced to 15 types (Van der Werf, 2023a).

Asking Van der Werf how he today sees the general development of the physical infill concept, he answers that simplifying the system and the scope of the infill has indeed been important. Through evaluating what actually needs to be flexible and adjustable, an important progress has been to change the heating and lighting from part of the infill to part

of the support (personal communication, March 2, 2023). In Lunetten these elements were still part of the adaptable infill in questionable configurations of piping and wiring ducts along the walls, to the already mentioned dissatisfaction of some of its residents. This issue was tried resolved in the later projects, with among other things the transition to floor heating and the realisation that only certain zones in the dwelling required heating. Then the heating system could be permanently integrated into the support system, and function appropriately regardless of room partitioning. This was for example implemented in Pelgromhof (2001), with defined sections for adjustable floor heating along the facades, in addition to a central zone for drain and floor heating in connection to the shaft (Van der Werf, 2023a). This development serves as an example of how a more intelligent configuration of the permanent support structure could provide increased flexibility and freedom, by reducing and simplifying the scope of the adaptable infill.

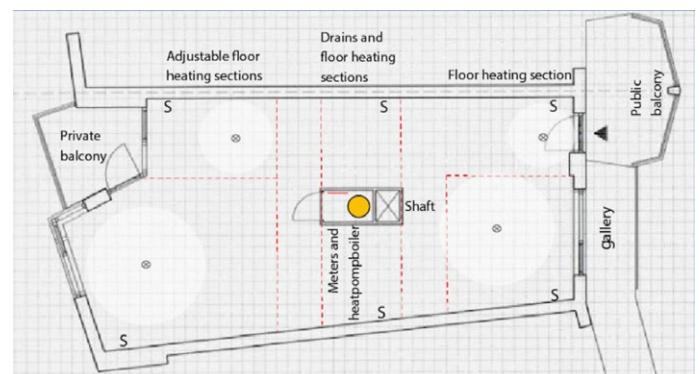


Fig. 5.2: Zones for floor heating and wet functions. From *Pelgromhof*, by Frans van der Werf.
<http://www.vdwerf.nl/pelgromhof.html>

5.3 Changing Legislations

Another important development in the infill practice was the change in norms and legislation motivated by Van der Werf's Open Building experiments. In the infill design of Lunetten, it was used a 30cm design grid from the SAR65, subdivided into 10cm and 20 cm bands. Here the partitions and load-bearing walls ended in the 10cm bands, while all piping lay in the remaining free 20cm band. These applied principles have later been translated into a formalized norm for modular coordination, called NEN281983 (Van der Werf, 2017).

A more fundamental change in legislation was executed in connection to the development of the following Keyenburg project (1985), that in fact enabled and simplified the further free infill practice in the Netherlands. Up until then the practice of free infill was only made possible through the exceptions from the building regulations provided by Schut's Experimental Housing Program. Van der Werf (personal communication, March 2, 2023) vividly explains that he with the Keyenburg project went to Schut's commission for the third time, to get the project granted experimental because the building regulations still didn't allow for the free infill practice. This even though the experiments of the housing program were supposed to be implementable into regular housing construction practice, to allow for greater variation to the anticipated need for mass housing towards the turn of the millennial. Almost reluctantly, the commission granted also the Keyenburg project experimental, with the message that this would be the last project of this kind to be nominated. To Van der Werf's great joy, this wore to be the case, because shortly after the rules were in fact changed to allow for the resident participatory free infill. From then on Open Building projects became according to Van der Werf a lot easier to conduct. After the change in regulations, the only thing necessary to get a building permit for the free infills was to provide a reference layout that showed that the housing regulations were possible to achieve (personal communication, March 2, 2023).

5.4 Technical Developments

Over time, the technical aspect of the infill developed on two separate levels. One being the improvement of the physical quality of the separate infill products, while the other being the change in the technical coordination and compilation of these elements.

For example, the issues of raised bathroom floors experienced in Lunetten and Keyenburg were tried tackled in a better way in Berkenkamp (1988), with rather introducing a sanitary plinth along the wet room walls (Van der Werf, 2023a). The later development of the already mentioned heating- and wet zones also eliminated this issue. In addition, the issue of lack of isolation ability in the partition walls was improved over time, and being disturbed by noise three rooms down the hall is no longer an infill issue (personal communication, March 2, 2023).

Van der Werf also points out that even though the separate infill elements have undergone great technical improvements since the start of the infill journey in 1978, the delivery and coordination of these elements are still an issue. Cause while Lunetten got its infill system delivered by Bruynzeel as one unified supplier, such an option is no longer available in the Netherlands today. Van der Werf points out that Lunetten's infill supplier had great potential to further develop the complete supply of infill systems, but unfortunately, Bruynzeel dissolved as a infill supplier after, or in fact during, the challenging work on Lunetten.

After that, a similar complete infill supplier has not been accessible, resulting in the later infills instead being managed by the project contractor that chooses products from different suppliers. The physical infill system as a complete and coherent system has in that sense not developed much in the Netherlands after Lunetten.



Fig. 5.3: Bruynzeel inbouwpakket delivered on site in Lunetten. From: *Lunetten 4D*, by Frans van der Werf, 2017. <http://thematicdesign.org/wp-content/uploads/2017/06/Lunetten%20for%20Thematicdesign.org%20-6-17%20main%20text75.pdf>

5.5 A Human Practice

Even though the infill structures have had technical challenges, and still seem to suffer from issues of technical coordination, Van der Werf makes it clear that this is not where his concerns for the infill development lie. He sees it as an unfortunate misconception that practising infill is about solving technical problems. The technicalities are in his view always a solvable affair, while the real issue at hand is how to deal with the human aspects of the infill. For Van der Werf the passion and essence of working with Open Building are about the human interaction in the user participation, and being able to give residents that otherwise would not get the chance, the opportunity and freedom to design their own dwellings.

In that way, despite the technical issues, Van der Werf sees the Open Building development over the years as generally successful (personal communication, March 2, 2023). Even though he reflects upon that his projects partly have had a loss of diversity and human scale over time due to a shift from intuition to rationality led design, he steadily stands by that the Open Building concept is the perfect tool for giving the user individual freedom to shape their private living environment (Van der Werf, 2023a).



Fig. 5.4: Frans van der Werf during infill design with residents for Molenvliet. From *Molenvliet*, by Jacques Van de Noort, 1984 https://www.youtube.com/watch?v=2b_O7lAoKW4&t=92&s

5.6 Open Building Today

Even with Van der Werf as an unarguably important implementer of the support-infill principles, the development and practice of Open Building are by no means limited to the scope of his work. Open Build-

ing has developed into an internationally widespread concept, which in the last decades has gained increased relevance with the continuously increasing focus on the required sustainability in the construction industry.

As Kendall and Teicher (2002) state, the principles of residential Open Building was already two decades ago rapidly developing throughout the world (p.9). Even under a variety of names, such as Open Building, Support/Infill, Skeleton Housing, Supports and Detachables, Houses that Grow etc, the principles of Open Building are still being developed and practised in both Europe, Asia and North America (p.8). Along with the Netherlands, Japan has also been an incubator in the initial development of the movement, and has today come a long way in developing sophisticated solutions for infill systems.

Among several organisations and institutions that promote and practice the principles of Open Building, is the already-mentioned OpenBuilding.co. They are a group of Dutch architects, engineers and developers that through the methods of Open Building, are dedicated to extending the lifespan of buildings through reducing their ecological footprint and creating healthy communities. Including central Dutch architectural practices, and well-known recent projects such as Silodam, Fenix 1 and Patch22, OpenBuilding.co is actively working on both practising and researching Open Building developments (OpenBuilding.co, 2023c). As part of the research practice, they did in 2019 launch the Open Building Academy, in collaboration with Hogeschool van Amsterdam and the Delft University of Technology. In 2020 the academy took a new online direction initiated by John Habraken himself, with a digitally available workshop and lecture series called Open Building NOW! (OpenBuilding.co, 2023b).

As a nearby example, this Dutch initiative serves as a confirmation that the concept of Open Building is still today well-conditioned, and together with a growing international community, it attempts to tackle the challenges ahead for our society and built environment.

6. Conclusion

The specific temporal contexts of the seventies left a characteristic and experimental mark on residential architecture in the Netherlands. In this decade experimental ideas, such as the SAR's design methods of support and infill were developed and implemented, laying a solid foundation for the later development of the Open Building movement. Lunetten remains a particular example of Dutch seventies architecture and an important project in the first attempts at the implementation of these new experimental ideas. To contribute to the research on experimental housing and investigate its results and effects, this thesis has aimed to answer how durable the experimental adaptability in Lunetten is, by looking closer at the structure and the concept of the infill.

The investigations of chapter 4 show that the infill structure of Lunetten has had an interesting two-folded development since its completion 50 years ago. Exemplified through closer investigations of two households, the research finds that rental restrictions combined with the sale of social housing, have resulted in a currently divided housing stock in Lunetten. An estimate of about three-quarters of the dwellings have remained in the ownership of the housing association as rental houses, and are assumed to have the original infill more or less unchanged and intact. The remaining quarter of the project is on the contrary sold to the private market and has in all likelihood removed most of the internal infill structure, and replaced it with conventional solutions. The façade infill is though partly adjusted, and especially the changes in façade colour showcase the change in ownership and contribute to a visual experimental presence in the neighbourhood of Lunetten. The following conclusion is that apart from external adaptations, the internal infill of Lunetten has not managed to adapt in the way it was intended. Nevertheless, the great variation in possible dwelling plans, both then and now, shows that the support structure indeed is flexible for change, even if it's not through adaptation of the original infills.

The following section in chapter 5 investigated how the infill concept has developed over time in the work of Frans Van der Werf. The results find that the quality and adaptability have improved over time, both by reducing the scope and the complexity of the

infill and through technical developments of the infill elements. A lack of complete infill suppliers in the Netherlands has though resulted in that the coherence and physical adjustability of the infill has still not reached its full potential.

Despite the technical difficulties, both Lunetten and later implementations of Open Building show that designing with infill as a separate design layer remains a valuable design approach. Both as a method to provide freedom and variation in housing, but also as a way to ensure a more sustainable building industry, by expanding the lifespan of buildings through adaptability. The today colourful façades of Lunetten, indicate how the separate layers of design have the potential to work independently over time, and serve as a visual reminder of how the experiments of the past can contribute to tackle the issues of the present.



Fig. 6.1: Experimental façades. Sint Gotthard, Lunetten. By the author, 2023.

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