MIXED-USE

IN THE CASE OF FLEXIBLE BUILDINGS

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Foreword

Each design task begins with a thorough analysis and this graduation studio was no different. The only difference was that in this case the subject was not predetermined but could be chosen by each student individually. This meant the research revolved around topics that fascinated us and that lead to conclusions we could use, more or less directly, in our personal designs.

Our research covers a very current trend in architecture that, with many office buildings being unused, is becoming an issue more and more everyday.

The goal we hoped to achieve with this research was to create a lasting set of tools that can be used in architectural design assignments that focus on mixing program for many years to come. Our research helped us in our own designs and we hope it can help others as well.

Urban life is becoming increasingly dynamic. The fast pace of daily activities following eachother up at higher and higher speeds. Sleeping, working, living, recreating, exercising and shopping all have to be done in the span of a single day. Job opportunities in this uncertain economy ask people to move to a different city every year. And once settled, family life changes as people start living together, have families and eventually move out or even separate. These changes occur in a matter of days, months or years.

Housing is still made of brick, concrete, steel and wood. Designed to withstand the forces of nature and in particular gravity without moving, bending or falling apart. Increased individuality has resulted in rigid separations between dwellers and even users within the same building. This structure is meant to last not days, not months, not even years, but decades or centuries. Housing in other words is designed to be static.

To use another term that fits into the contemporary lifestyle, the built architecture and the dynamic program are incompatible. The two possible solutions are relatively simple: change the entire urban lifestyle to become a static process, or change the built environment to become dynamic. Being architects, we will be focussing on the latter.

However simple the concept of dynamic buildings may sound, the execution in practice is everything but simple. What is a dynamic building? Notions of flexibility, adaptability, multifunctionality and interchangability come to mind. But what makes a building flexible? What are the demands of different users and different program?

In order to structure our research and in light of the design project ahead, we decided to focuss on flexibility in relation to mixed-use buildings. By analysing six case studies on several flexibility themes our aim is to find the tools needed to design a building capable of adapting to the ever changing society.

This research will start of with a detailed description of our problem statement and research question. The used terminology is explained in-depth in the next part.
The criteria for the case study selection are given and tested for each the cases. In the following chapter each case study is introduced to give a basic understanding of the projects, the location and the program.
The second main part consists of the analysis, which is built up around five themes. Each theme is analysed using reduced plans, sections or elevations or with a schematic 3D isometric drawing showing the principal elements. With each case study the same analytic drawings are used per theme to allow for a clear comparison.
The case studies are put next to eachother at the end of each theme with a summarising partial conclusion. After all themes have been discussed we end up with a final conclusion in the form of a tools matrix that can be used by architects wanting to design a flexible mixed-use building.

In the appendix we collected the individual products of our research group, consisting of our personal essays and design process.

Thomas de Bos

Fascination
The design location consists mostly of industrial buildings and collective office buildings (bedrijfsverzamelgebouwen). It is very interesting to see these old industrial warehouses being redeveloped and used for other businesses and even housing. These buildings attract young creative pioneers that can revitalise a region that has the potential to become a popular residential area. These pioneers require cheap work and living spaces that can serve different businesses and uses.
The existing urban fabric is made up of mostly large scale warehouses and office buildings with a very industrial character and expression.

Problem statement
Most new building projects are focussed on a specific program for which they are perfectly suitable. However in these economically difficult times we need buildings that can easily adapt to changes in the market in order to prolong their durability.
Also the switch from small industries to housing is a very current issue that architects should be dealing with in new designs.

The paradox that arises is that of creating a flexible building that can adapt to unknown future changes while maintaining an expression that connects it to its surroundings for a long period of time.

Research question
Which characteristics provide a building with the means to change internal configurations of different programtypes over time?

Freek Bronsvoort

Problem statement
Combining living and working gives a lot of planning problems, because the two functions both ask other qualities of a space.
But living and working merge more and more together the last couple of decades.
In addition to that the cycle of building and demolishing buildings is starting to become a big problem as well.
To handle that, developers the unpredictability of the market and the problem of unoccupied offices forced a number of developers and architectural offices to do research into solids without a fixed program.
These trends demand new forms of living/working spaces and buildings which deal with combining functions, and changes of function, in a flexible way. The idea of form follows function can not be regarded as a general starting point for a design, but sustainable buildings capable of combining different functions and accommodating change.

Research question
In what way can flexibility be an instrument to combine living and working in a building?

Geert Durk de Jong

Fascination
The presence of context. History and domination of the industries through the centuries. Atmosphere. Old buildings. Stimulating environments.

Problem statement
The Oosterburgereiland consist of different industrial and working activities. This context had an influential role in the origin of the location and is still present in the older industrial and the new working-type buildings. Changing the function of the Oosterburgereiland can lead to a change of identity. Adding residences can have a effect (positive or negative) on the scale of the urban and also on the area surrounding the location. Adding residences is adding a mix of activities, equals a mix of identities of the working and the living environment. This mix can occur in the scheme of the surrounding but also in the scheme of the building itself. It can shape the space that the different functions will use all together; it can fabricate the identity of the in between. Based on the assumption that the user will change, the Oosterburgereiland should in the future still be used by the working, the recreational and the new residential activities.

Research question
If the combination of working and living lead to a mix of the two function on the same plot and inside the same building scheme. How to manufacture the mix of functions but maintain the identity of the residence, in the mixed scheme of the building and in the environment of the industries?

Common interests
In all of our individual problem statements and research questions the notion of flexibility is touched upon. In order to get to a coherent research as a group we decided to choose flexibility as a guide to analyze different themes that are related to mixed-use buildings.

Problem statement
After our initial research into the subject and possible case studies we found a very strong connection between flexibility and mixed-use buildings. To have a clear hypothesis we decided upon the following problem statement:

A mixed-use building can not function without a substantial degree of flexibility.

With this statement we not only want to suggest a connection between flexibility and mixed-use, but a dependancy. This means the one can not function without the other. By making this statement we stimulate ourselves to investigate the extent of this dependancy. How flexible does a building have to be to be capable of supporting a mixed-use program for an extended period of time?

Unfortunately a clear cut answer to this question can not be given. Flexibility does not have an indexed scale as of yet, so rating each case study as being for example 75% flexible is not an option. Even with detailed definitions of the themes, like the ones we described for our research in the next chapter.

What we need is a way to quantify the 'amount' of flexibility for each of the selected case studies. As a guideline for our analysis we used the themes as described by Bernard Leupen in his book Frame and Generic Space. We then adopted the aspects we thought were the most interesting for our own research and left out the ones that had the least strong connection.

To make a objective comparison between the different case studies possible we analyse each project in the exact same manner using the themes as a basis from which we can determine the flexible characteristics. For a conclusion and the accompanying design tools we need a clear answer to a question that covers both the side of flexibility as well as the side of mixed-use program that is able to change over time.

Research question
After defining the individual parts of our problem statement and studying relevant publications about flexibility we chose the following research question:

Which flexible aspects allow a building to combine housing and work spaces (in changeable configurations)?

This question allows us to answer with a bandwidth of architectural design tools rather than a simple 'yes' or 'no'. By filtering out the tools that do not work and combining the ones that do into a matrix, we hope to end up with a set of design tools that can be put into practice for future design assignments.

Approach

In order to find the flexible aspects in a mixed-use building we decided to use several themes that together cover the entire design. To find the themes that related best to our research question we chose the theory as described by Bernard Leupen in *Frame and generic space* as our starting point.
In his book Leupen defines a system of five layers that together compose a building. Each layer is made up of architectural elements that serve the function of each layer. The layers that Leupen describes are structure, skin, scenery, services and access. These layers are studied using case studies and are put together in a system where one or more layers constitute the frame for a building. Because Leupen focusses on this permanent frame we needed another approach to find the changeable elements inside a layer.

To make sure we completely covered a buildings design we took Leupens five layers and combined them into four themes: structure, routing, services and skin. Because our research focusses primarily on mixed-use buildings we also added another theme, concept & use, to introduce the overall concept and to show the distribution of program inside the building. Our themes structure, routing and skin are based on respectively structure, access and skin in Leupens definition with only minor adjustments. Under services we combine Leupens services and scenery, stating that fixed services determine for a large part the freedom in which compartments can be made.
In this research we organised these themes in the following order: concept & use, structure, routing, services and skin.

Definitions

Because our research partly covers topics that have been studied by many different researchers that each give different definitions for the terminology they use, we decided to include our own list of definitions to avoid any confusion about the meaning of the terms we used.

Flexibility
The ability to adapt to future changes without extensive alterations to the building.

What are 'extensive alterations'?
By extensive alterations we mean that in order to qualify as a flexible building the alterations do not compromise the structural integrity of the building. During the process as much of the remaining program as possible needs to be able to continue its function.

Mixed-use
The use of a building or space for different functions/ program. On a building scale this means a need for different sized and conditioned spaces. On the scale of an inividual space this means the possibility to be adaptable to a different future program.

Adaptability
Adaptability can take place in different forms or under a different name: independent as well as dependent extendability, multifunctionality, variability and polyvalency.

Extendability
Independent extendability means enlarging a space without consequences for surrounding spaces (internal re-arrangement). Dependent extendability means enlarging a space with consequences for surrounding spaces. For example removing walls. These extensions can be in any direction.

Multifunctionality/variability/polyvalency
Leupen, Hertzberger and Priemus all use different words for essentially the same thing. All the above describe the ability for a space to be used for different functions or program without any physical alteration to the space. Primus also includes the possibility of sliding doors or walls to make a space polyvalent. Moving furniture can also be seen in the same context. The fact remains that the physical built space isn't affected.

Mixed-use program
In our analysis we focuss on a specific combination of program within each mixed-use building. This is the combination of housing and work spaces, preferably on the same level.
Housing can be any household ranging from a single resident to an entire family, with the exception of extremely large multi-generation families.
Our definition of work spaces is limited to a range of businesses and occupations. These include (creative) office spaces, studios, art galleries and small workshops.

Case study criteria

In order to qualify for our selection each case study has to meet the criteria for being a flexible building as well as being a mixed-use building on both scales as described in our definitions.

This means that the building not only has to be flexible and used for different functions, but that the spaces used by these functions can be interchangable or extendable for future use.
The functions can be anything as long as there is at least housing program and work space that meets the above mentioned criteria. Below each case study in our selection is subjected to these criteria.

Multifunk
Has been proven to be an adaptable building. Designed initially for 80% work spaces and 20% housing, the building was able to accomodate a complete switch in program to 80% housing with minimal adjustments. Housing and work spaces are interchangable throughout two thirds of the building volume.

Vrijburcht
Developed as a Collective Private Ownership (CPO) project, the building is used for a wide range of housing program and work spaces. The flexibility seems to exist more in the multifunctional adaptability rather than extendability. The focus seems to be on housing typology.

Solid 18
Being a solid typology the flexible aspect is clearly visible. The building is constructed as a framework in which program can be placed freely. Currently serving both housing and work spaces, together with a collective space in the center.

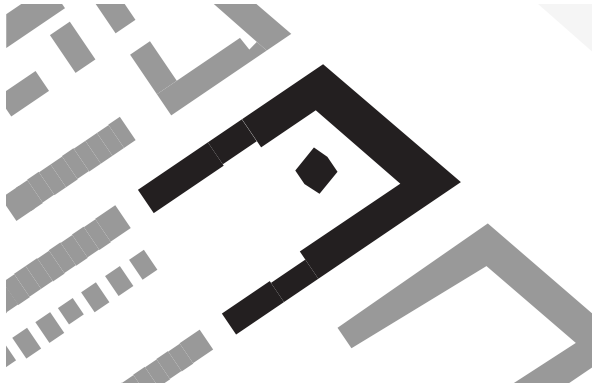
Solid 1 & 2
Built in a context of more traditional shopping street typology, the building exhibits the same characteristics as other solids. The load bearing core and facade offer an open floor plan suitable for housing, work spaces and retail. The ground floor has a higher ceiling height which suggests a difference in program between the ground and upper floors.

Canal house
To broaden our case study selection we decided to include a more historical example as well as a project of a different scale than the other four. The traditional Dutch canal house from the center of Amsterdam meets both these criteria. Because it is a single house this case is the smallest project we will analyse. Canal houses are traditionally intended to be used for dwelling as well as for working.

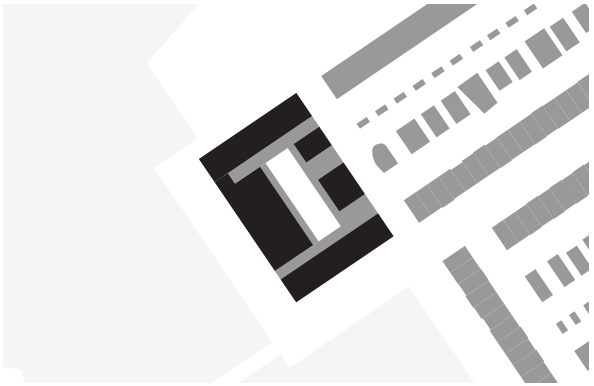
Tetterode
As our sixth case study Tetterode offers a different typology to our research. This complex of buildings was never intended for housing, but has proven to be very suitable for it over recent years. The current mix of program makes it a perfect case study for our analysis.

Case studies

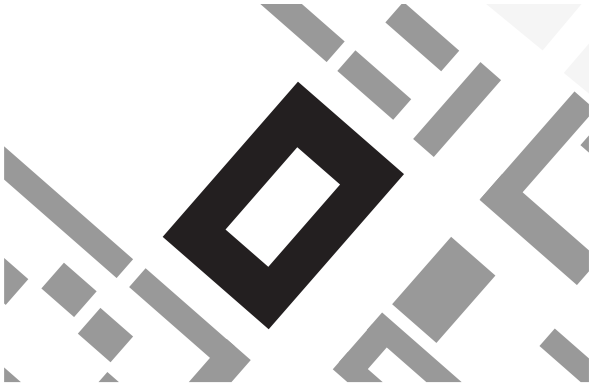
Project:	Multifunk
Architect:	ANA Architecten
Location:	Steigereiland, Amsterdam-Oost
Project year:	2001-2006



Project:	De Vrijburcht
Architect:	CASA Architecten
Location:	Steigereiland, Amsterdam-Oost
Project year:	2007



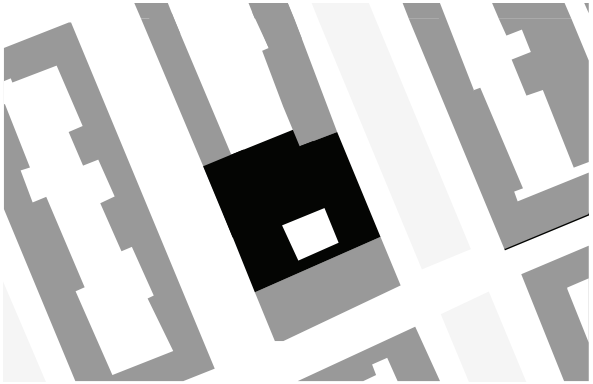
Project:	Solid 18
Architect:	Claus & Kaan
Location:	Haveneiland, Amsterdam-Oost
Project year:	2007



Project:	Solid 1 & 2
Architect:	Baumschlager-Eberle, Lochau
Location:	IJburg, Amsterdam
Project year:	2010

Project:	Canal house
Architect:	Frederic Blancard (1728)
Location:	Heerengracht, Amsterdam
Project year:	1620, 1728

Project:	Tetterode
Architect:	J.W.F. Hartkamp (1902, 1914), B. Merkelbach & Ch. Karsten (1940)
Location:	Da Costakade, Amsterdam
Project year:	1902, 1914, 1940



Project:	Multifunk
Architect:	ANA Architecten (Marcel van der Lubbe, Jannie Vinke)
Location:	Steigereiland, Amsterdam-Oost
Project year:	2001-2006
Client:	Lingotto Vastgoed BV en Ymere ontwikkeling
Program:	Housing (88 private residences, 40 social housing apartments, 28 rental, 20 for sale) Work spaces (3100 m2)

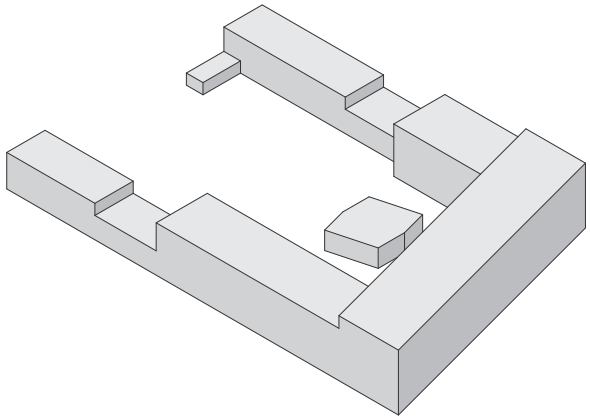



fig. 1

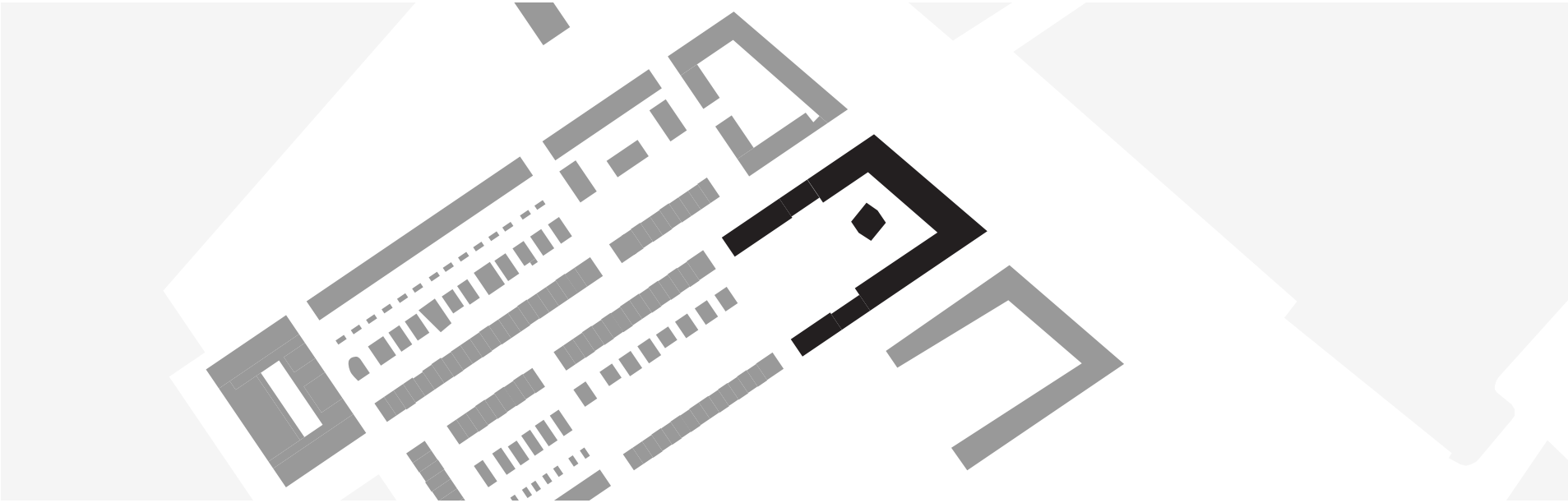



fig. 2


fig. 3

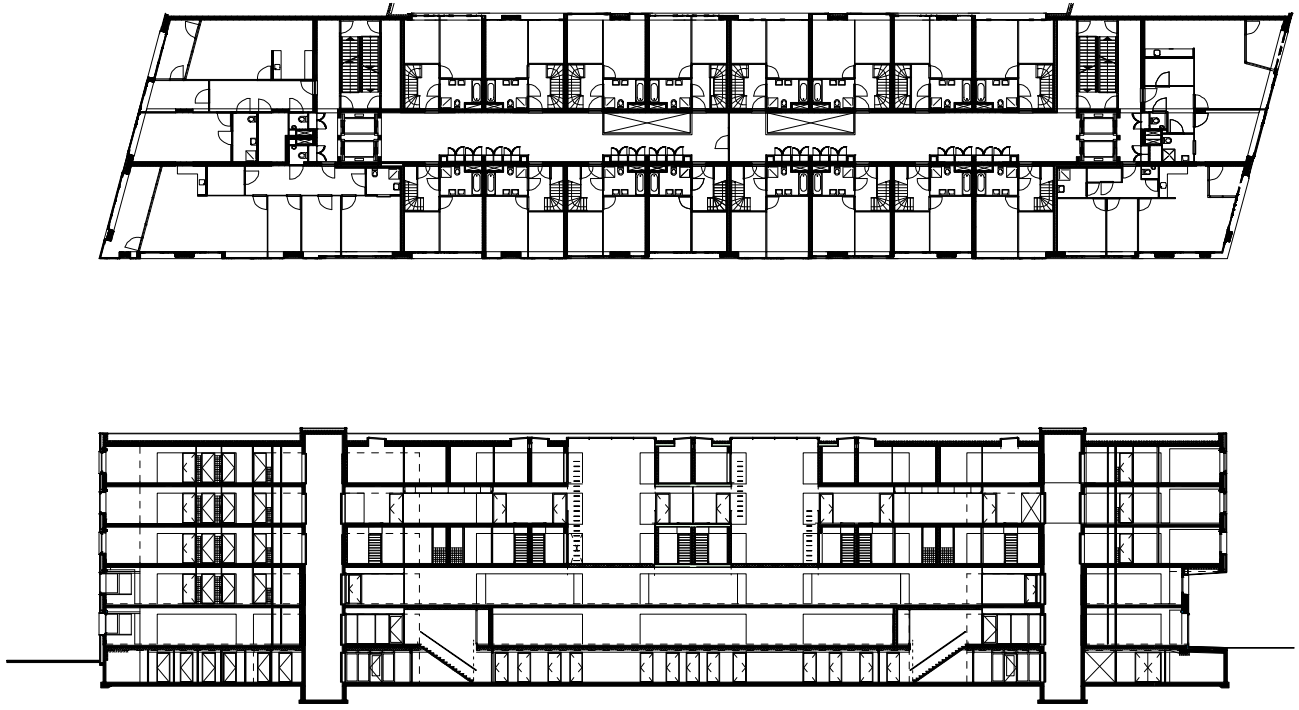

fig. 4

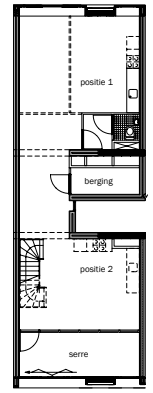

fig. 5

Multifunk is multifunctionality at its best: apartments that can be offices and turned back into apartments. Multifunk applies equally to both functions. ANA Architects analyzed the needs for both: different floor heights, exits, entrances, construction and the difference in installation requirements. The solution lies in the absence of mechanical air-condition. Sunscreens and –blinds combined with natural ventilation through the façade made the deal. The construction is integrated in the façade with columns in the centre of the building. Glass roof parts together with gaps in the floors allow daylight to enter into the heart of the building. (source: Mimoa)

The multifunk building consists in part of small-scale units that lock into the freestanding houses of the Zuid buurt district of IJburg. The portion on Steigerdam is bigger, with a tall ground floor and four upper storeys. The means of access, the zoning of cables and piping, the design of the exteriorspaces and the additional height are all factors that can facilitate the transformation from housing to offices should that be necessary. The tall portion is accessed through porches combined with corridors. With two lifts planned for each porch plus the access 'oversize' of the corridors, parts of the building can be set aside for offices. At the end of the 1990s the planning schedule for the ambitious IJburg programstagnated in the wake of the economic down turn. Many plans on IJburg had to be redeveloped but not Multifunk which is now being built to the original design. Originally 80% of the complex was earmarked for offices. This has been reduced to just 20% with the most minor of modifications. The extra costs necessary to make the building flexible have al ready been repaid by the rapid progress the project is making. (source: Times Based Architecture)

fig. 6
ground floor





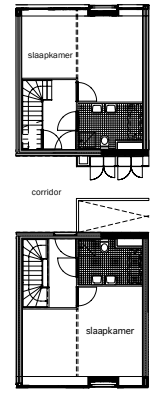


fig. 7 3rd floor plan, longitudinal section and maisonette floor plans

Project:	De Vrijburcht
Architect:	CASA Architecten (Hein de Haan)
Location:	Steigereiland, Amsterdam-Oost
Project year:	2007
Client:	Stichting Vrijburcht (CPO)
Program:	Housing (40 residences, 6 assisted living facilities) Work spaces (12 live/work houses, 4 business spaces) Common facilities (parking, nursery, restaurant, theater, garden, green house, craft room, guest appartment, bicycle storage)

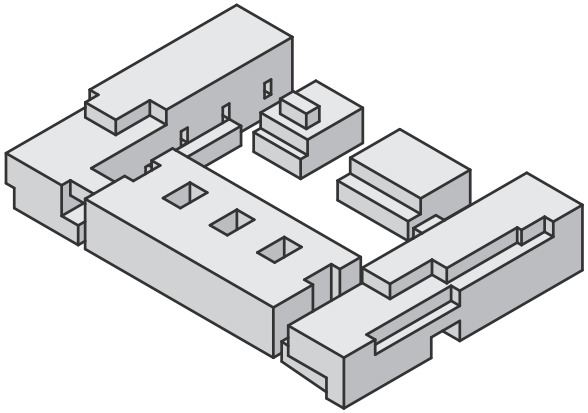


fig. 8

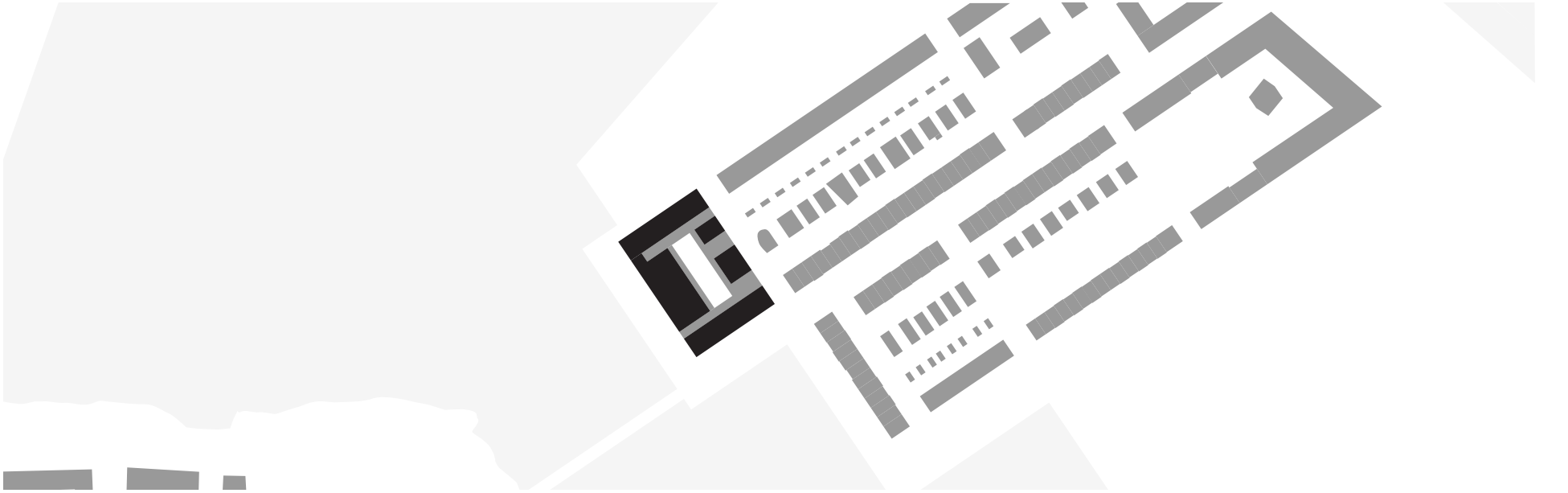


fig. 9


fig. 10

fig. 11

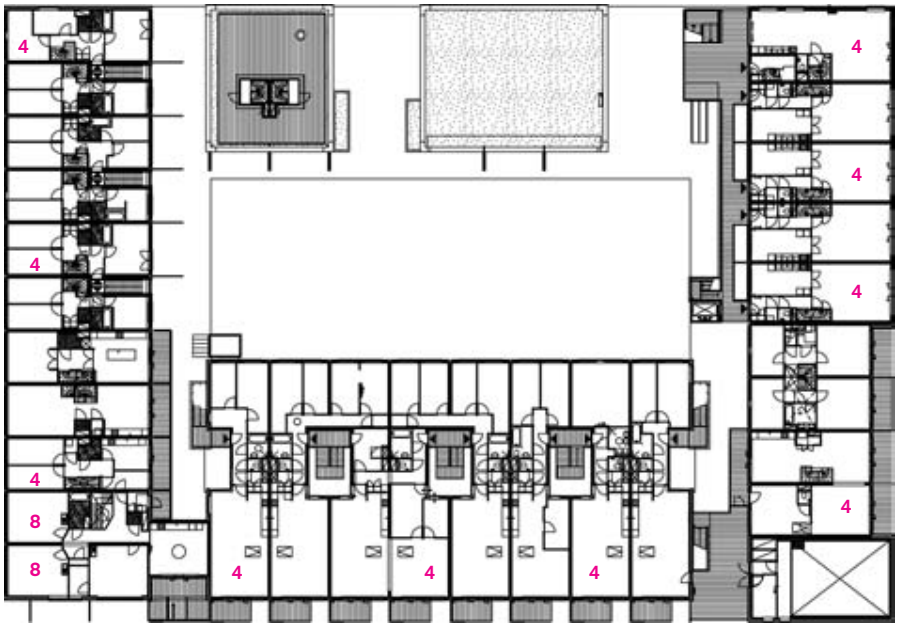
The concept is client-oriented development: citizens with more influence on the design of their house and on the program and form of what happens directly around their home (urban space, working, and facilities).
Vrijburcht totals around eighty residents, in fifty-two apartments, plus sixteen business, a theater, restaurant, common house for mentally handicapped youth, children's day care center, guestrooms, greenhouse, common garden, workshop, and harbor.

Vrijburcht is a result of identifying and understanding typology of development. Different types of development provoke different degrees of resident-influence on the program and design of their houses, working spaces, and facilities. (Collective Clientship (do it yourself development on a common site))

The critical number of unites (40-50 houses) and a high density make it possible to develop common facilities. Collective Clientship functions very well in areas that are centrally orientated in the city. In these locations, shared facilities make the most practical sense. Families can easily organize their daily lifestyles within this existing network which encourages community interaction, integration, and health. In this way a very social and sustainable neighborhood will grow effortlessly.

Another interesting feature is the inclusion of a business space within the home.

fig. 12 ground, 1st and 2nd floor plans



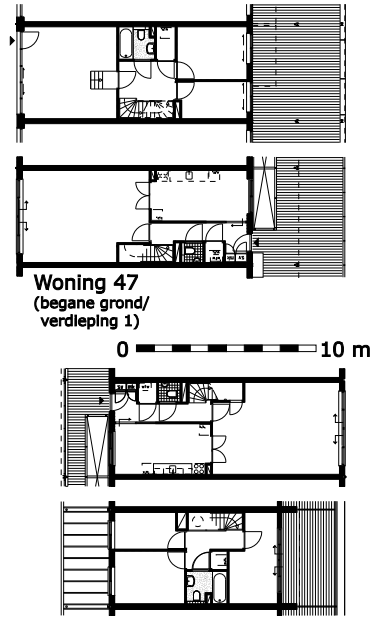


fig. 14 dwelling plans

Project:	Solid 18
Architect:	Claus & Kaan (Jaap Graber)
Location:	Haveneiland West, Amsterdamdam-Oost
Project year:	2007
Client:	De Principaal
Program:	Housing (84 residences) Work spaces (5.160 m2) Common facilities (parking, gym, roof garden)

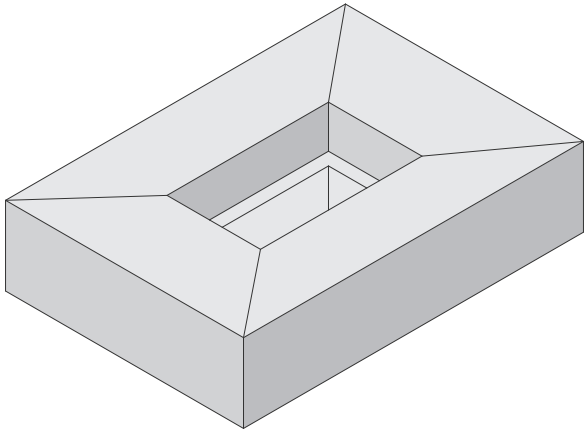



fig. 15


fig. 16


fig. 17


fig. 18

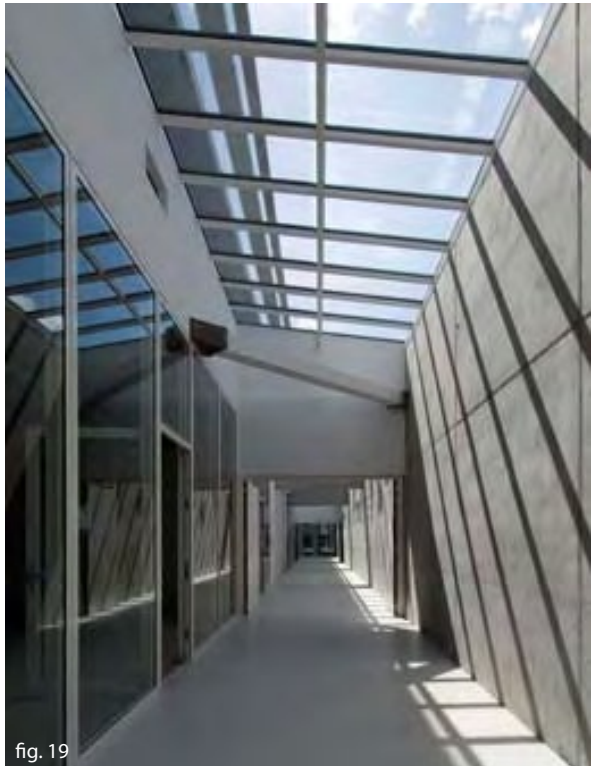


fig. 19

Solid 18 offers a variety of uses, such as relaxation, working and living. The building houses a total of approximately 5,160 m^2 of office space, retail space and commercial space, which is divided over the ground floor and first floor. The units are available for partial lease from 62 m^2 upwards, and due to the combinations that can be made, every possible surface area can be realised. The enormous windows provide a spacious and light atmosphere in all the units. The Ed Pelsterpark, which is located adjacent to the building, provides a lovely green surrounding. 84 apartments are located on the top floors of the complex.

A distinctive feature of the complex is the gymnasium, which is situated on the ground floor, in the middle of the building. This three storey high space can be devided into three separate halls for sports and recreation.

The roof of the gymnasium is covered with vegetation, as a 'view-garden' for the dwellers.


fig. 20

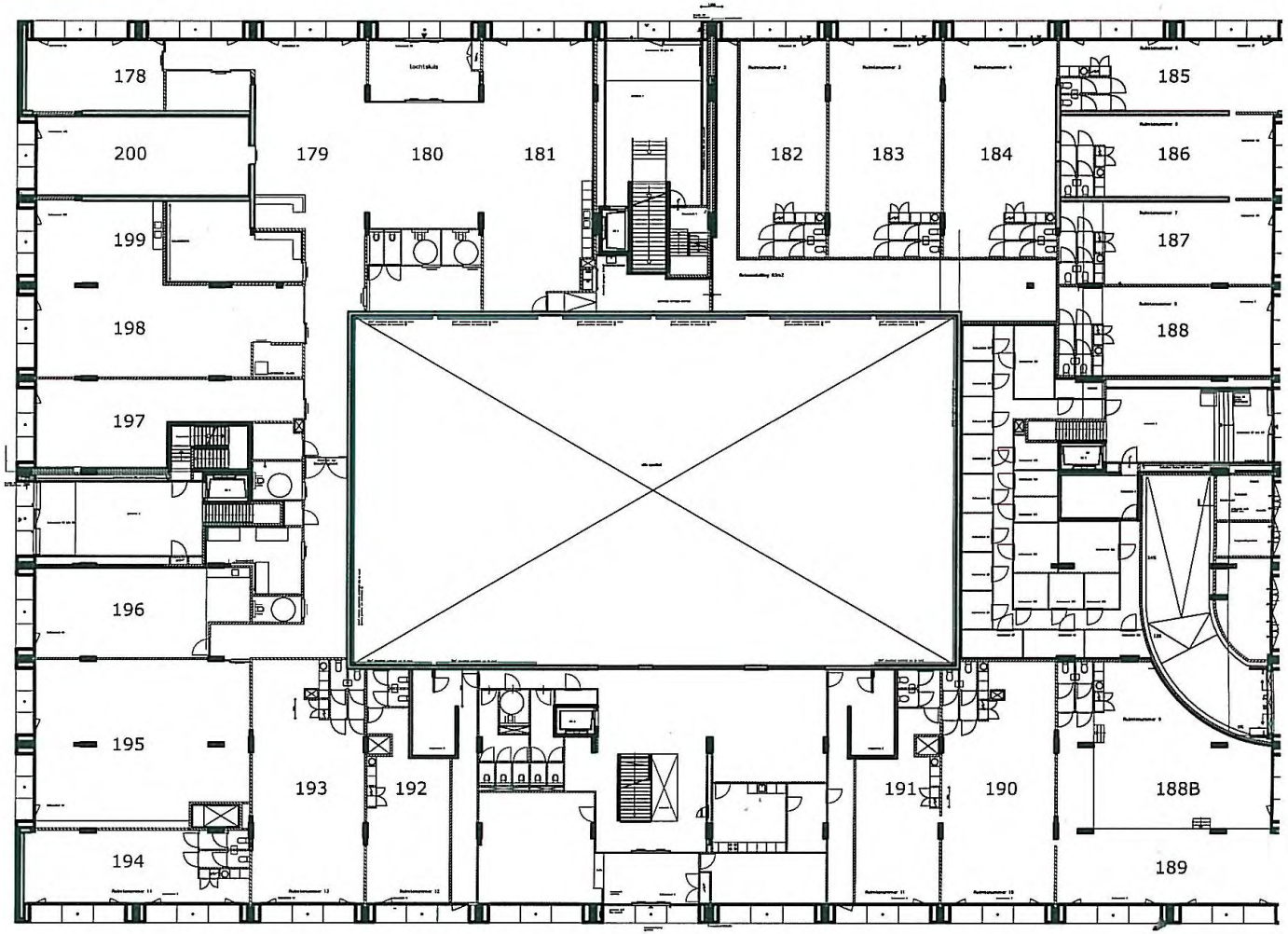


fig. 21 ground floor plan

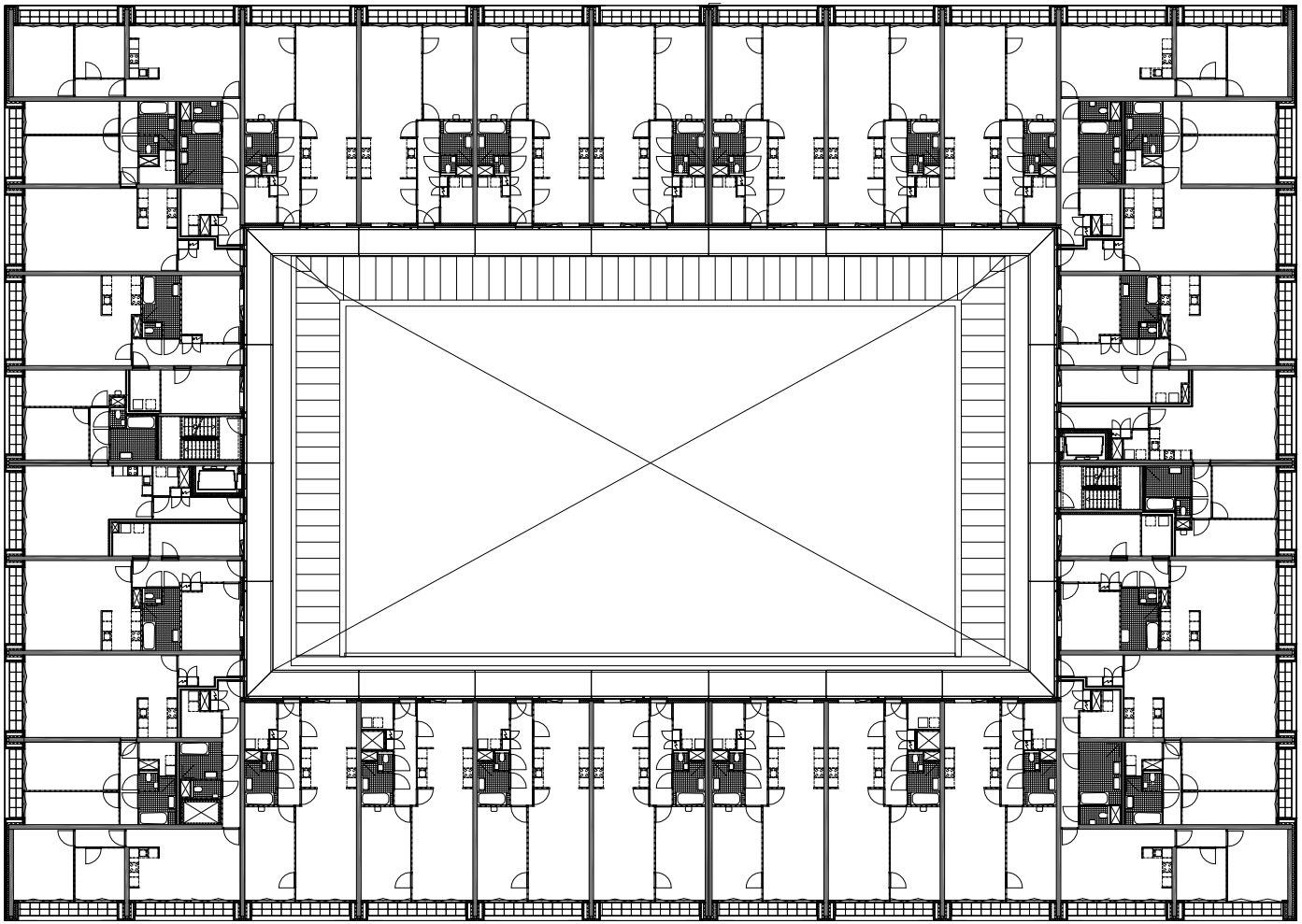


fig. 22 2nd through 4th floor plans

Project:	Solid 1 & 2
Architect:	Baumschlager-Eberle, Lochau (Dietmar Eberle en Stefan Beck) (Inbo Bouwkunde; Piet van der Ploeg, Elmer Bronkhorst, Martijn van Harn)
Location:	IJburg, Amsterdam
Project year:	2010
Client:	Stadgenoot Housing Association
Program:	Housing (free layout) Work space (30.000 m2 m^2) Common facilities (meeting room)

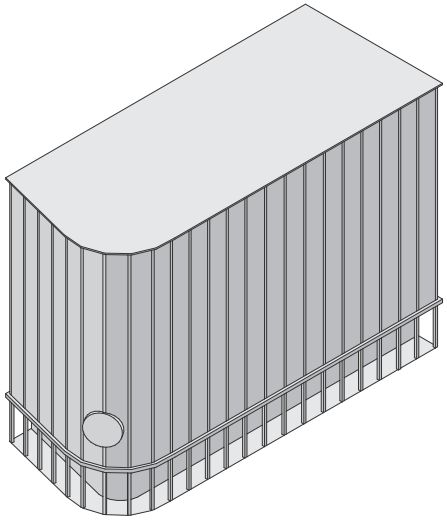


fig. 23


fig. 24


fig. 25


fig. 26


fig. 27

IJburg is one of Amsterdam's big new urban neighbourhoods extending over seven artificial islands with accommodation planned for 45,000 people. In autumn 2007 work began on the Solid(s), a perimeter block development consisting of 7 buildings located at the entrance to Haveneiland. This scheme combines a very high building density – the specified floor area ratio of 6.4 is comparable to that for high-rise neighbourhoods in Asia – with a ground plan allowing for flexibility of use. The appearance of the ensemble is reminiscent of traditional urban business premises with colonnades, punctuated façades, balconies and imposing stone facing. By contrast, the interior of the buildings is almost radically minimalist with a view to permitting the maximum leeway in the use and division of the space.

The structural framework is designed for longevity, whereas the technical infrastructure is variable and readily adaptable to valid standards. The building itself, as a 'shell' devoid of any specific function, and merely provides a framework that every tenant can fill as needs dictate. The loft-like units up to 20 metres deep can be used as offices or as hotel space, medical or legal practices, social amenities, studios or apartments. This leaves scope for individual design and easy adjustment to changing requirements such as urban diversity and sustainability of use.

The term 'Solids' is intended to reflect the durability of the buildings as well as their functionality. That it also encompasses high-quality architecture is apparent from the impressive façades and the elegant foyers as well the careful selection and details of the materials. (source: Baumschlager-Eberle)

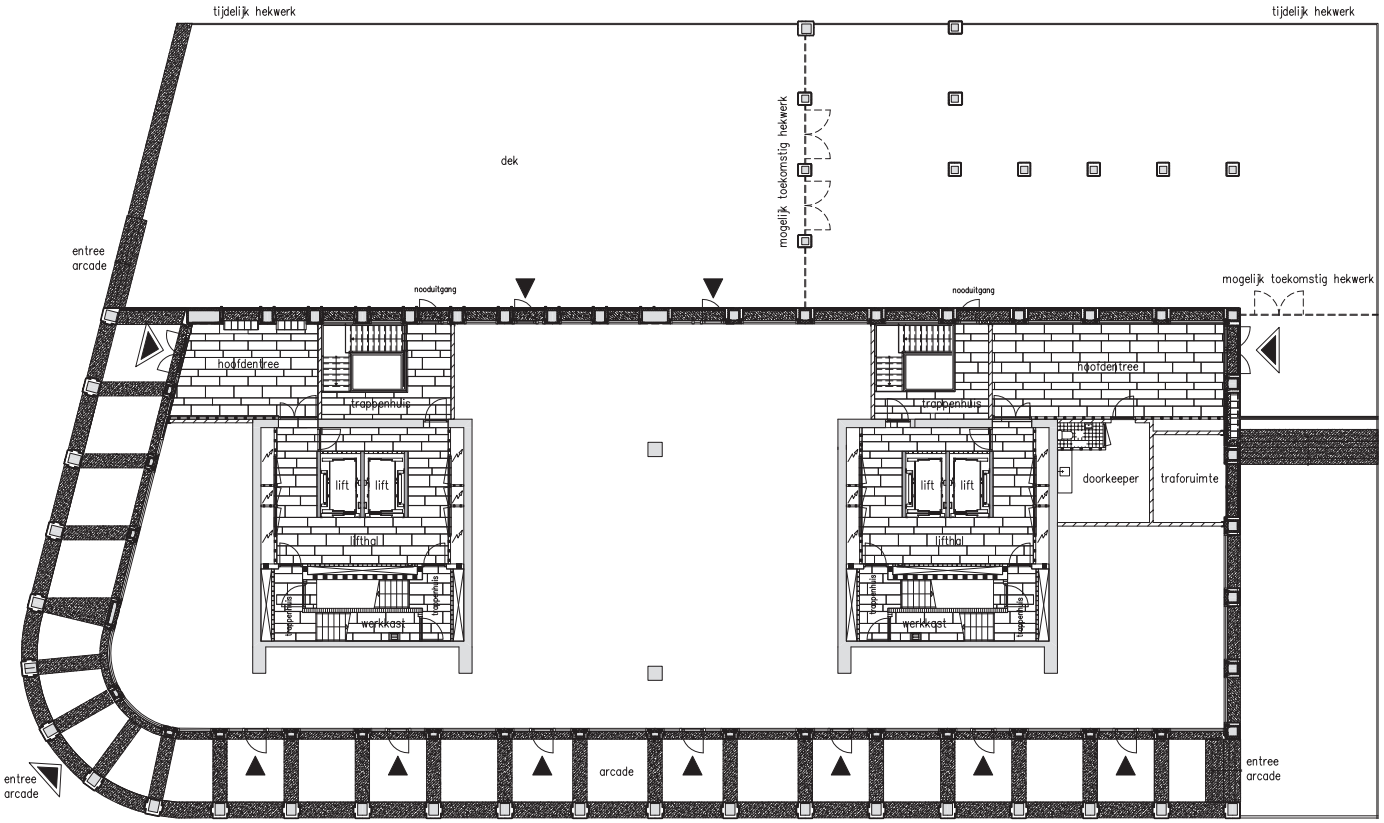


fig. 28 ground floor plan

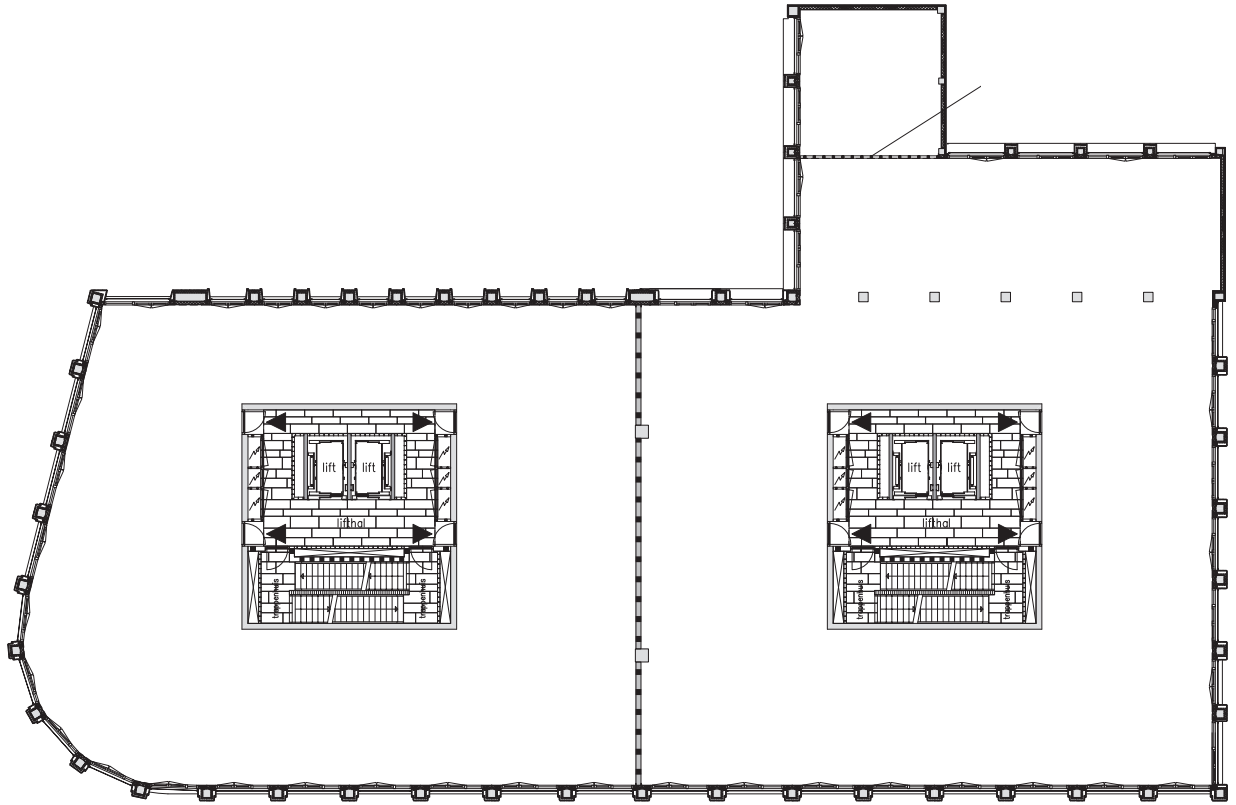


fig. 29 1st through 8th floor plans

Project:	Herengracht 284
Architect:	Frederic Blancard (1728)
Location:	Herengracht 284, Amsterdam
Project year:	1620, 1728
Clients:	Leonora Hakens (1620), D., M. en H. Rutgers (1728)
Program:	Housing Work space

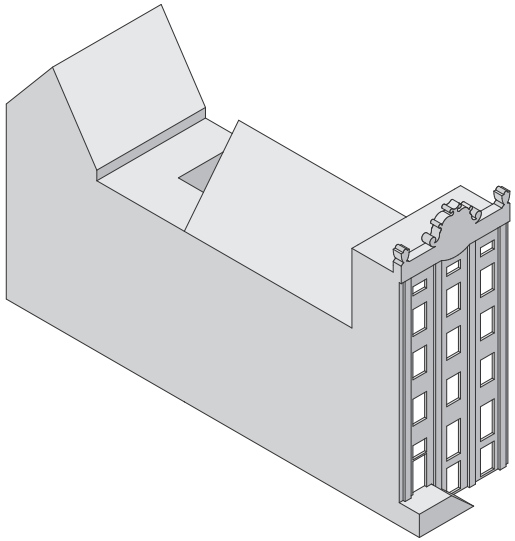


fig. 30

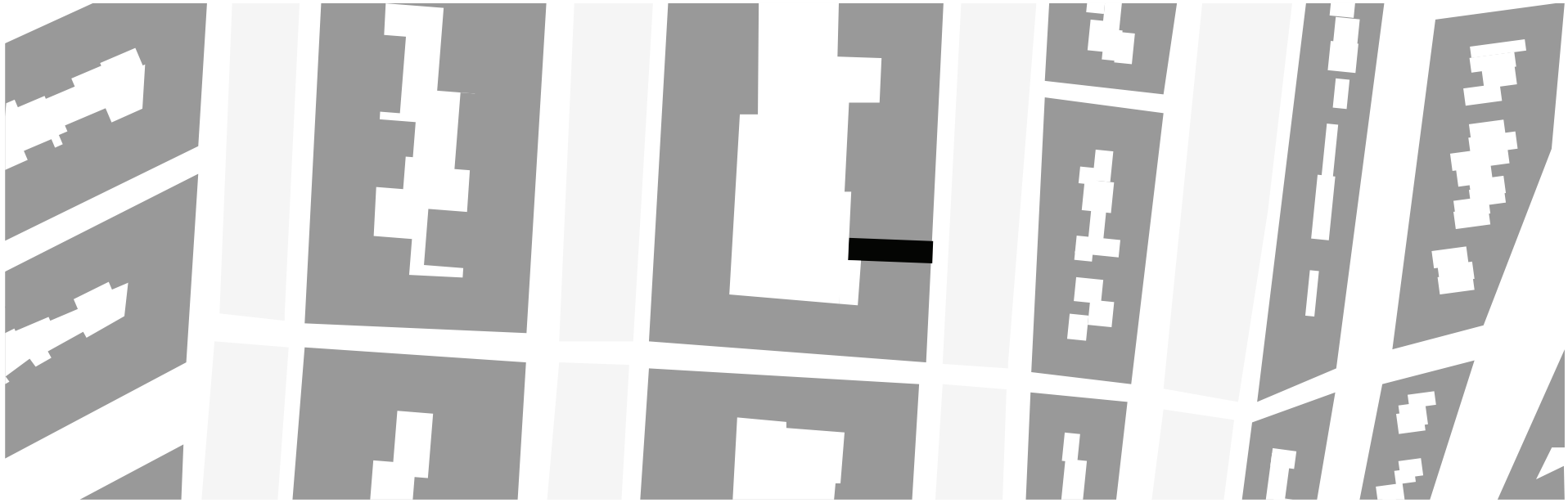



fig. 31


fig. 32


fig. 33


fig. 34

The land on which the residence is built was bought in 1614 bij Hans van Wely. After his death, his widow Leonora Hakens had two identical houses built on the plot in 1620. The original architect of these houses is unknown.

In 1728 the left house came into posession of David Rutgers and his sisters and they hired Frederic Blancard to rebuild the house. Blancard transformed the simple dwelling into a Louis XIV-style mansion with a large back-house, an inner courtyard and a monumental staircase. Much of the building stems from this period.

A smaller renovation in 1781 was done in Louis XVI-style, commissioned by its new owner Arnoldus Johannes van Brienen. The building still holds his name to this date.

The mansion has many original interior features and because of its standard layout it is seen as one of the best examples of 18th century canal houses in Amsterdam.

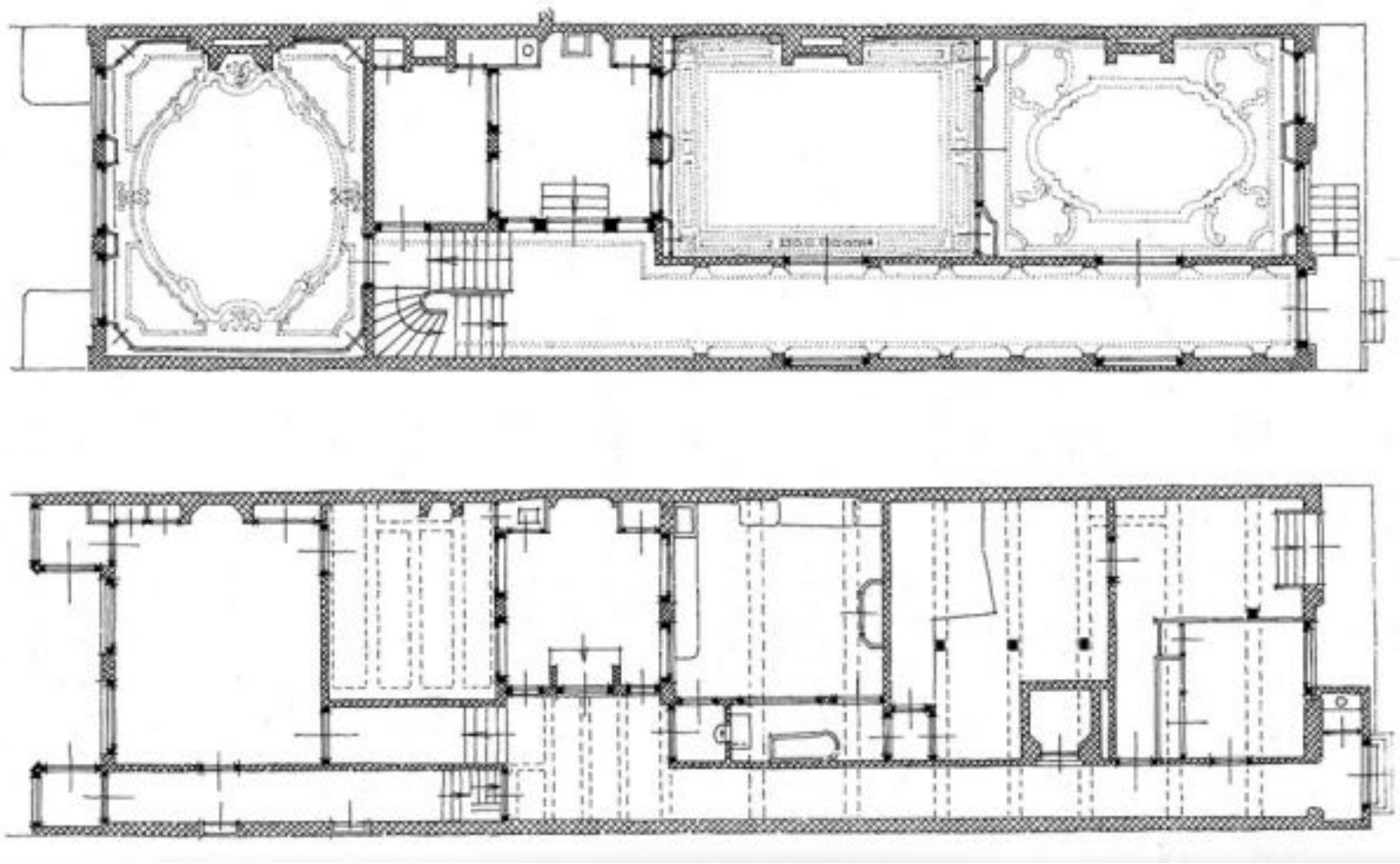


fig. 35 ground and basement floor plans

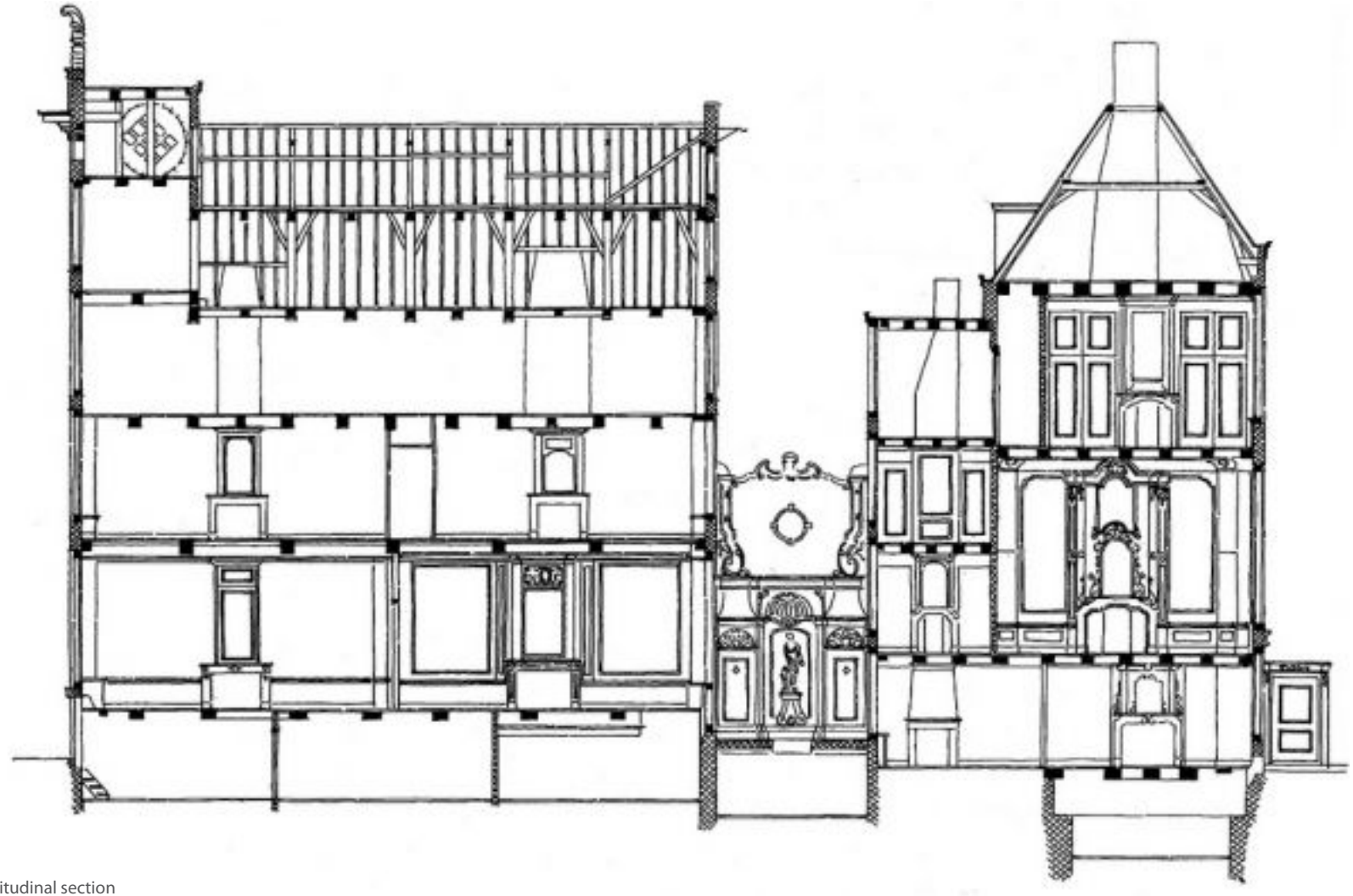


fig. 36 longitudinal section

Project:	Tetterode complex
Architect:	J.W.F. Hartkamp (1902, 1914) B. Merkelbach & Ch. Karsten (1940)
Location:	Bilderdijkstraat 157a-165 & Da Costakade 152-164, Amsterdam
Project year:	1902, 1914, 1940
Client:	N. Tetterode
Program:	Housing Work spaces Common facilities (courtyard)

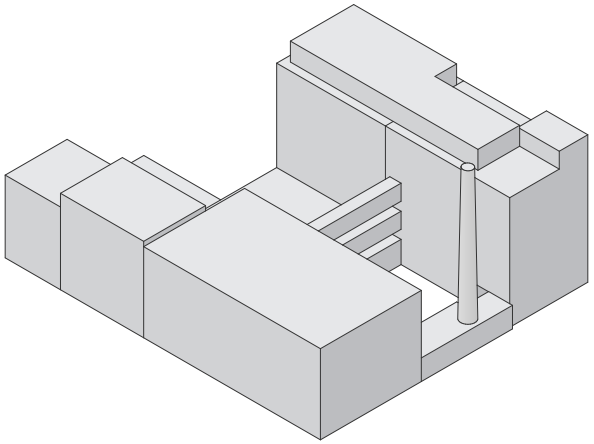



fig. 37

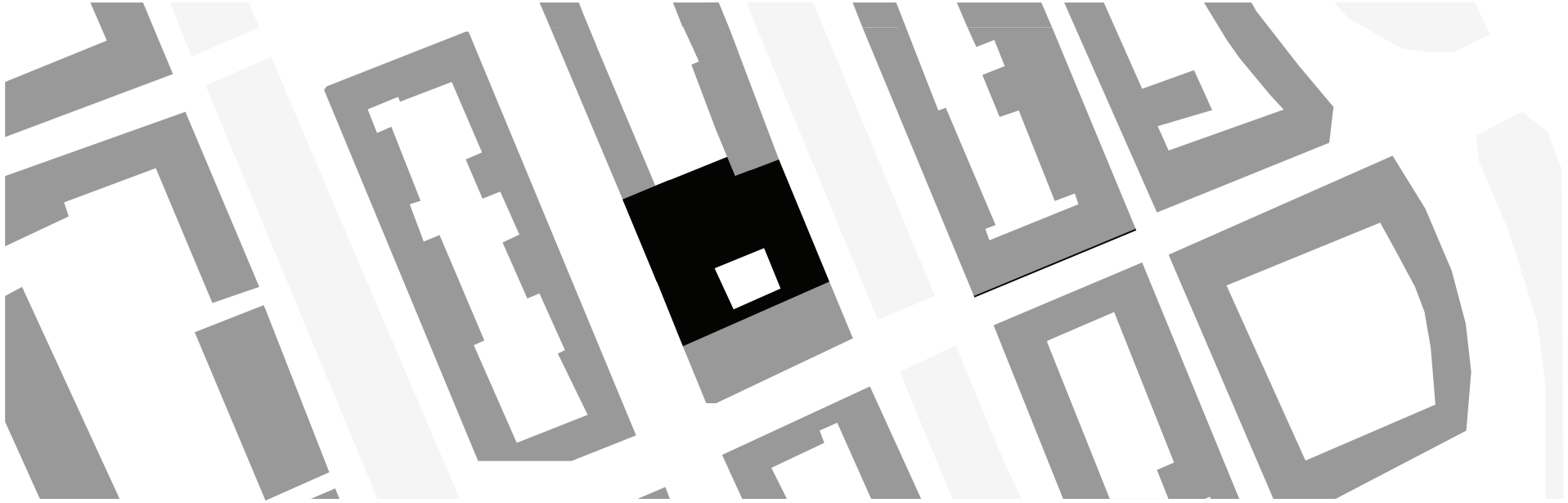



fig. 38


fig. 39


fig. 40


fig. 41

The Tetterode building complex has evolved to its current state between 1902 and 1950. In 1902 the type foundry of N. Tetterode moved into a Jugendstil-style building on the Bilderdijkstraat, designed by J.W.F. Hartkamp. The same architect built an extension on the Da Costakade in 1914 in the style of the Delftse School.
Between 1940 and 1950 a third extension was built, on the Da Costakade, designed by Merkelbach and Karsten. This building is one of the few remaining examples of the so-called Nieuwe Bouwen in Amsterdam.

In 1981 the building was sold to the Bataafsche Aannemingsmaatschappij (BAM), who intended to demolish the building to make space for a new complex. BAM withdrew itself after the building was squatted later in 1981 and they sold the building to PGGM.

After a visit by Frank Bijdendijk the arrangement was made to rent out the complex to the squatters in exchange for the renovation of the interior spaces. The facade was renovated by the housing corporation of Frank Bijdendijk, Het Oosten.

The Tetterode complex is now a much sought after place for housing and work space for young artists and businesses.

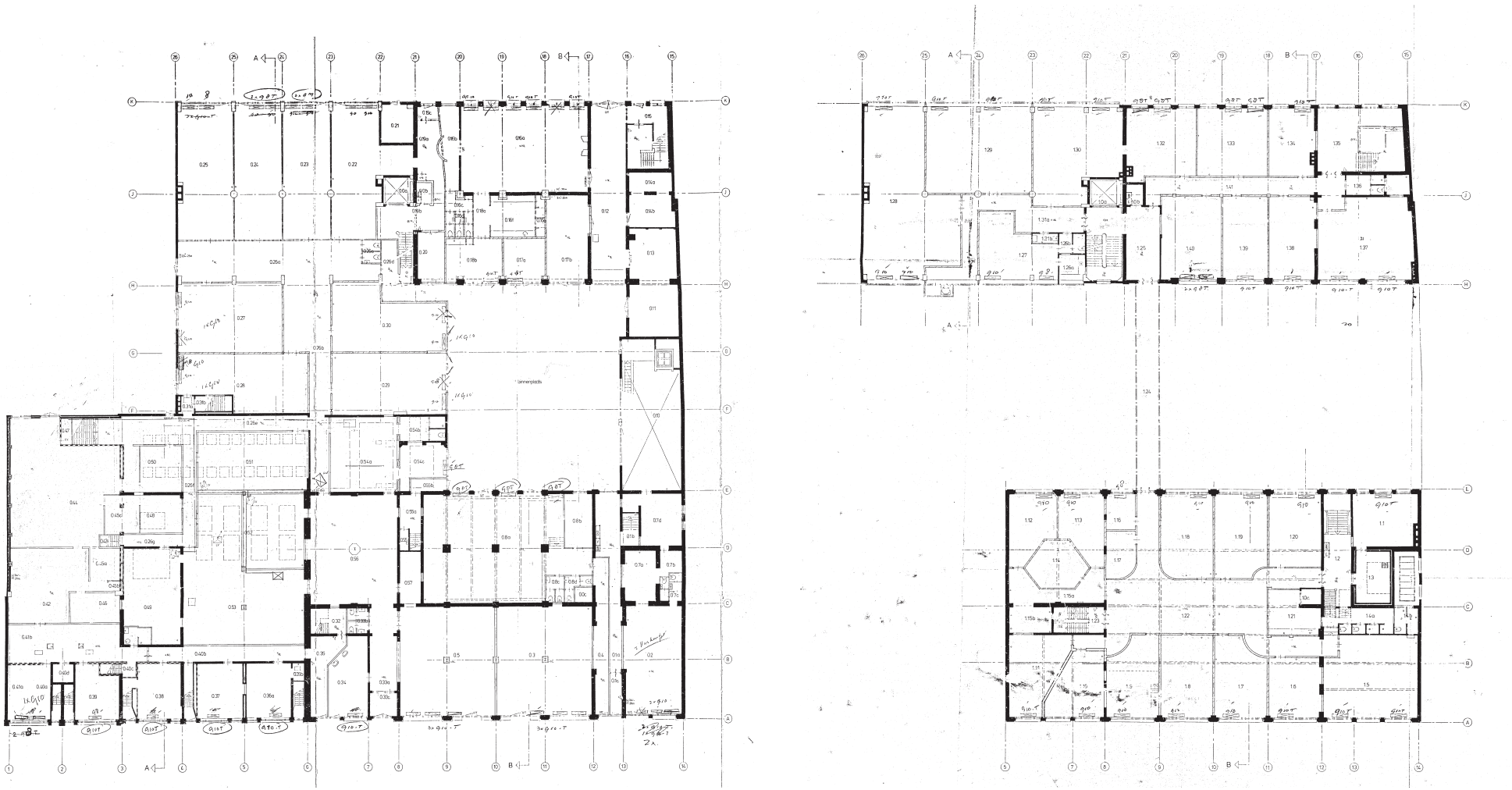


fig. 42 ground and 1st floor plans

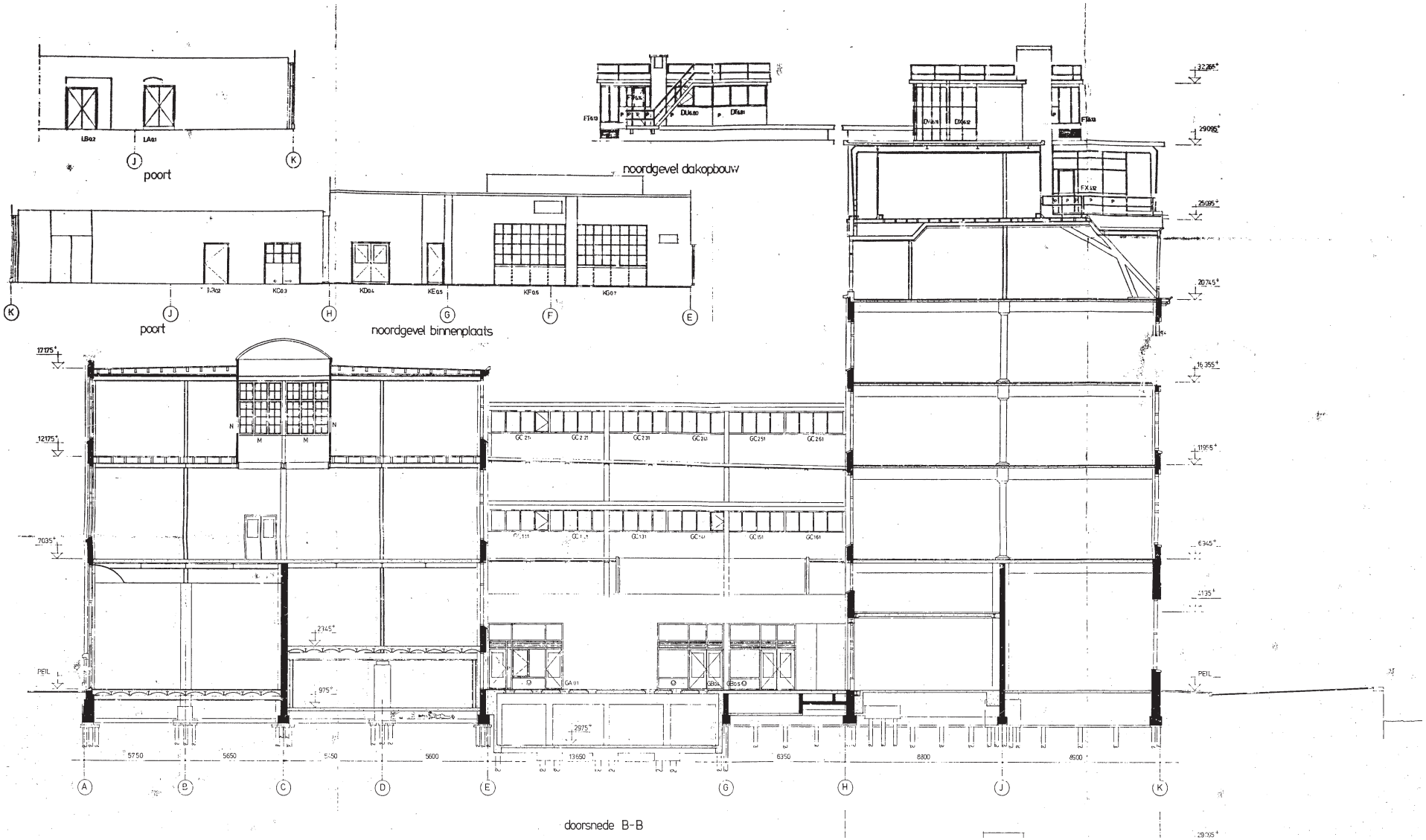


fig. 43 cross section

Analysis

Designing a building always starts with a concept. From this concept the architect starts to design and work out the concept into a real building.
The structure, routing, services and facade all have to do with the concept of the architect, so that is why we first introduce you to the concept and vision that the architect had with the building.

Having a concept, and designing a building to this concept is one thing. However, eventually the building is often used completely different.
This has a big influence on the way the services and routing are being used, and therefore is crucial to analyse.
Because this research is about mixed use, all the buildings have, or are able to have, a diverse program. In this chapter you can see the different ways architects divide functions. Vertically, horizontally or mixed on all levels.

Multifunk - Concept

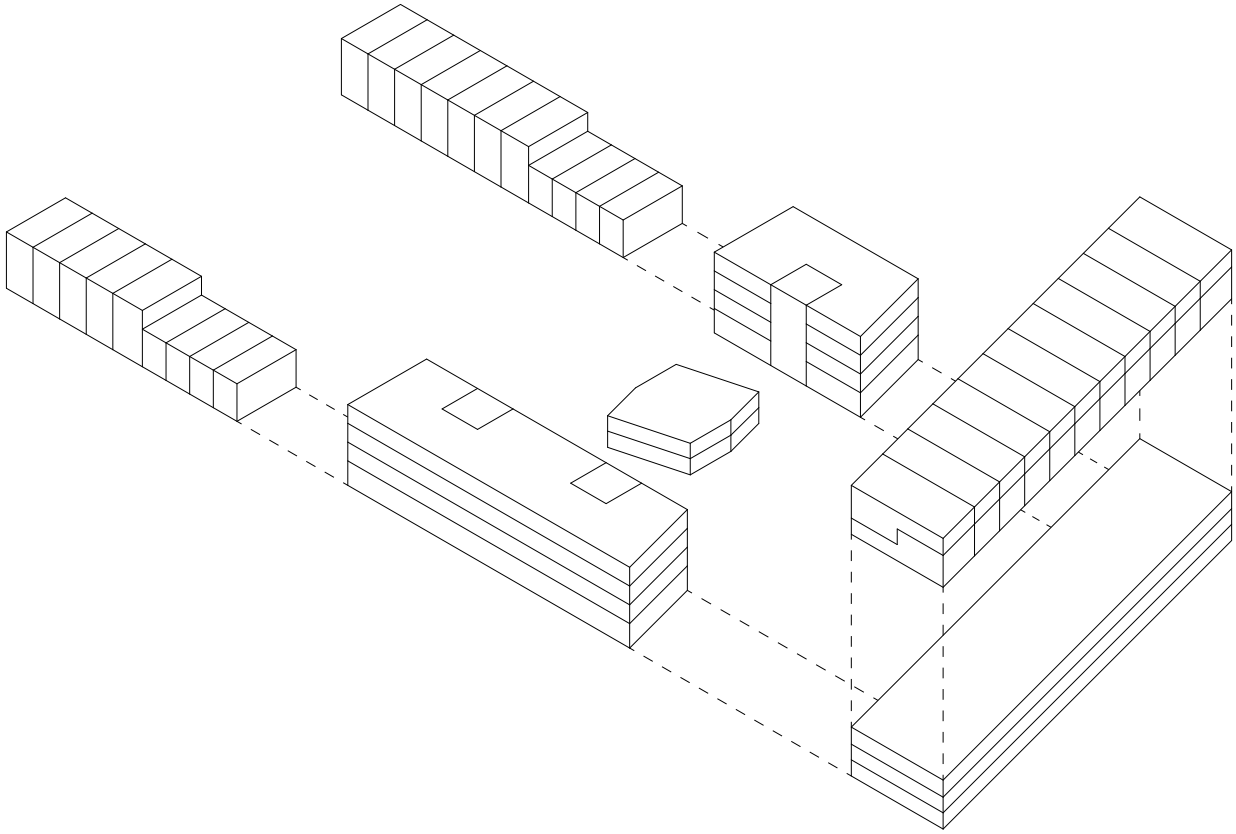
Multifunk is a housing and work space complex in the shape of a slightly skewed U. The Multifunk building is made up of several parts that each have a distinct character.

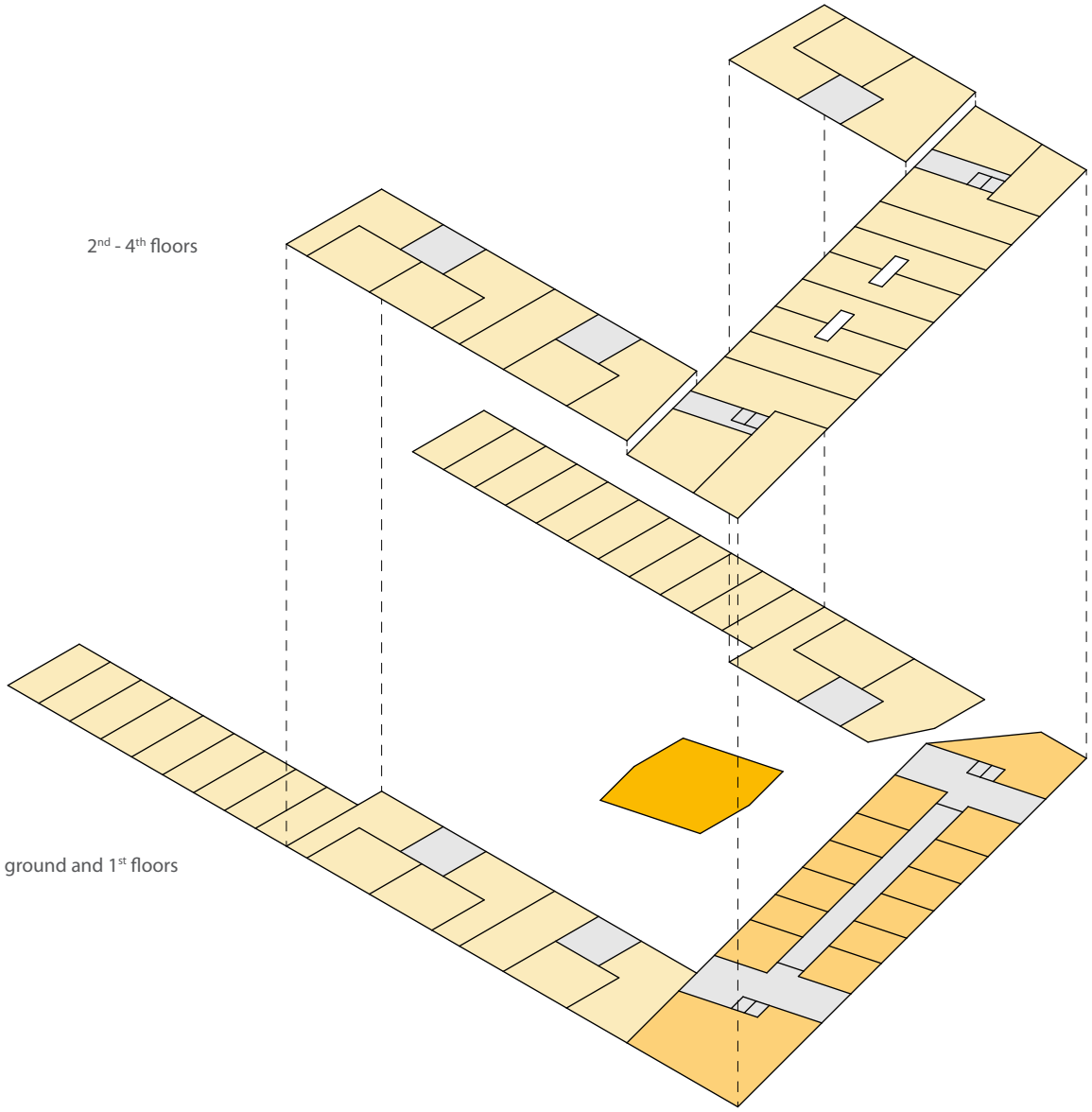
The two 'ends' on the left are the most conventional part of the building with standard row-housing typology. There are two and three storey dwellings.

The two middle parts, one small and one larger, were designed as flexible floor plan wings around a portico access core. During the building phase these parts were transformed into housing wings with three or four dwellings around each core.

In the middle of the courtyard a small pavillion is built that houses a daycare center for children. Between the two 'ends' there are plots for private ownership housing.

The main part of Multifunk is situated on the 'front'. This large wing is designed to be as flexible as possible with large open floor plans to accomodate both housing and work spaces.
During the building phase the decision was made to convert this wing to be half housing and half commercial space. The bottom three floors were reserved for businesses and the top three floors were filled with maisonettes. These dwellings are accessible through a corridor on the middle of the three floors.





Multifunk - Program

The multifunk building has a very diverse program. The building is designed to house dwellings and work spaces. At the end of the 1990s the planning schedule for the ambitious IJburg programma stagnated because of the economic downturn.
Many plans on IJburg had to be redevelopped, but not Multifunk. This building is built exactly to its orginal design. Originally 80 percent of the complex was marked for offices. But with the economical downturn the demand on offices was reduced. Because the multifunk building was designed to house workspaces, as well as dwellings this was not a problem for the building.
The amount of work spaces has been reduced to 20 percent with the most minor modifications. The extra costs necessary to make the building flexible have already been repaid by the rapid progress the project is making.

circulation
livingspace
workspace
extra program

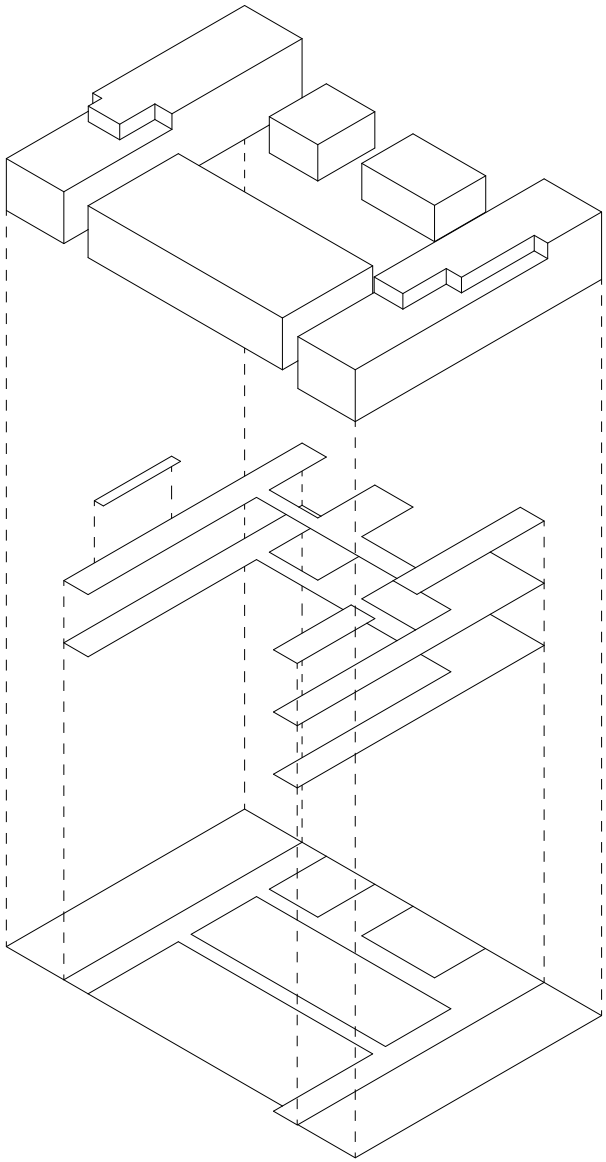
Vrijburcht - Concept

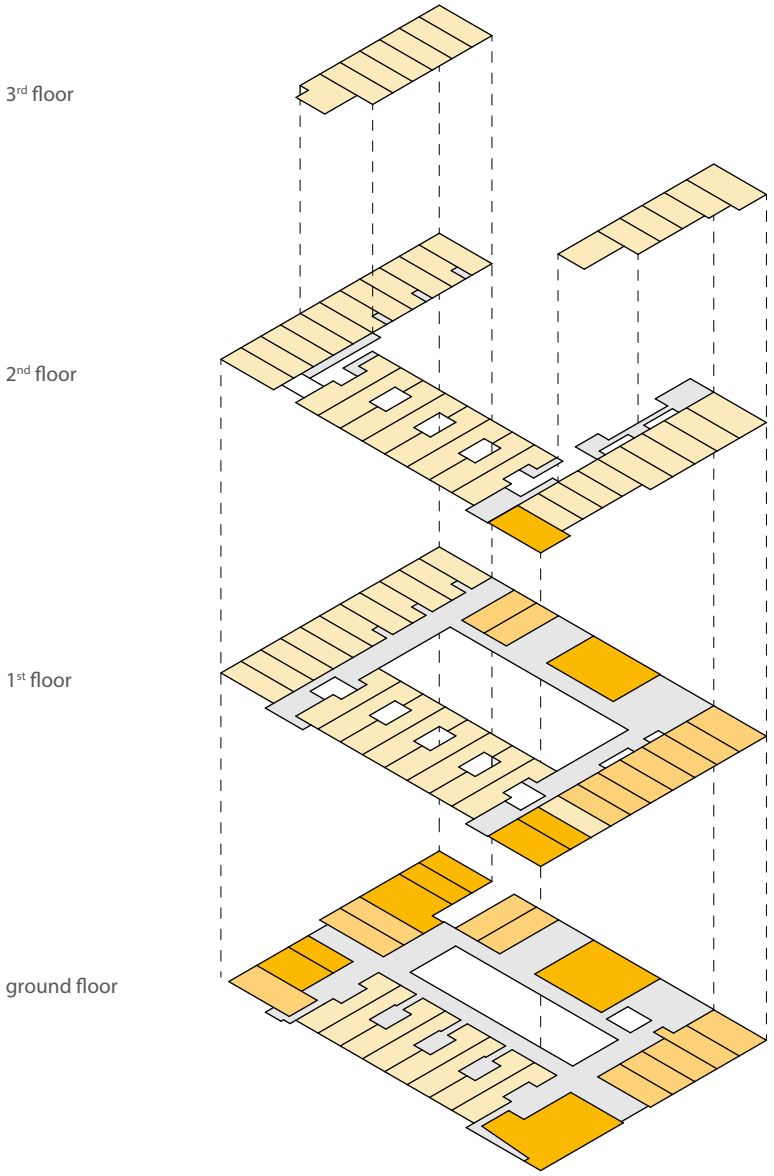
The Vrijburcht building most closely resembles a typical Dutch closed housing block. The separate building elements form a closed rectangle surrounding an inner courtyard that is a collective space for the dwellers.

An important aspect of the building is its routing system. Different access types are connected by a gallery that surrounds the courtyard on three sides. The other houses are accessed by a portico. The three levels can be reached by elevator or stairs and all have a view on the courtyard.

The housing blocks themselves are comprised of a multitude of different types of dwelling typologies: standard row-housing, atelier-dwellings and live/work dwellings in several configurations.

These dwellings are alternated with commercial space such as a daycare center and a cafe/theater.





Vrijburcht - Program

Vrijburcht is a cooperative housing project, in the Steigereiland area of IJburg in Amsterdam. The building includes a café, a theater, a childcare center, live-work dwellings, row housing, maisonettes, apartments and a group home.

This diversity in program is visible mainly on the ground floor. Here most of the different typologies are located and occupy either one or two levels. Separate functions are not linked together but are placed side by side along the perimeter of the block. On the upper floors this system is repeated with a couple different housing typologies.

The program inside the complex is chosen by the dwellers themselves and because of this the building acts like a community that is not accessible for outsiders.

circulation
livingspace
workspace
extra program

Solid 18 - Concept

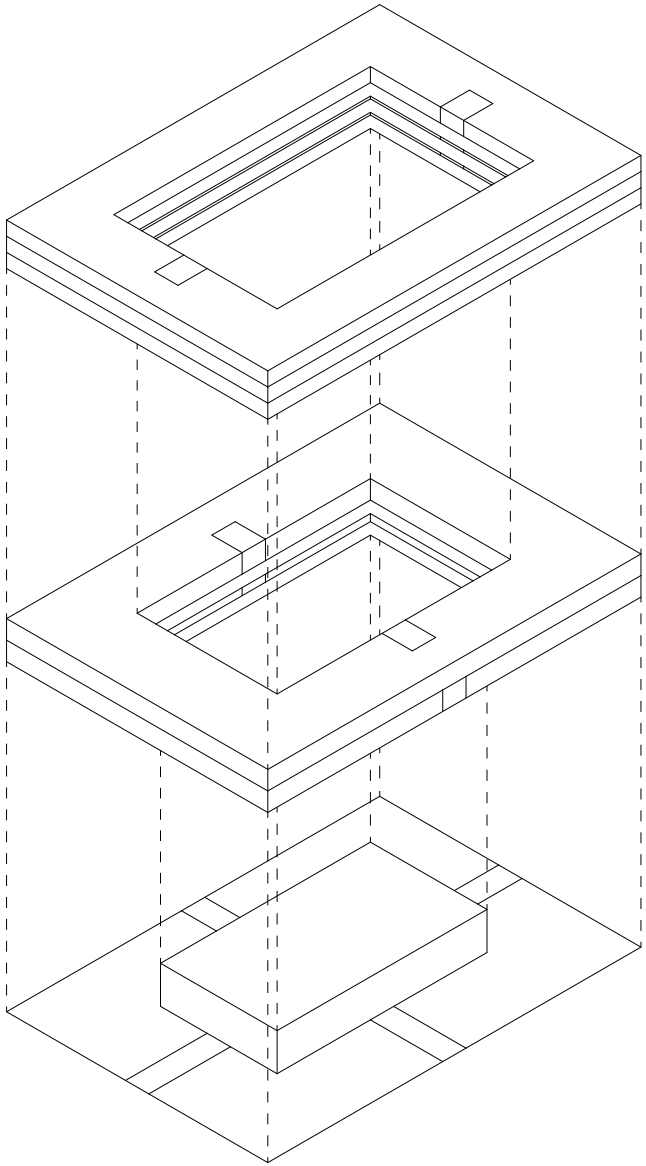
The concept from which Solid 18 was initially designed is that of the 'solid', a uniform building with open floor plans that can be used by any number of different functions over time.

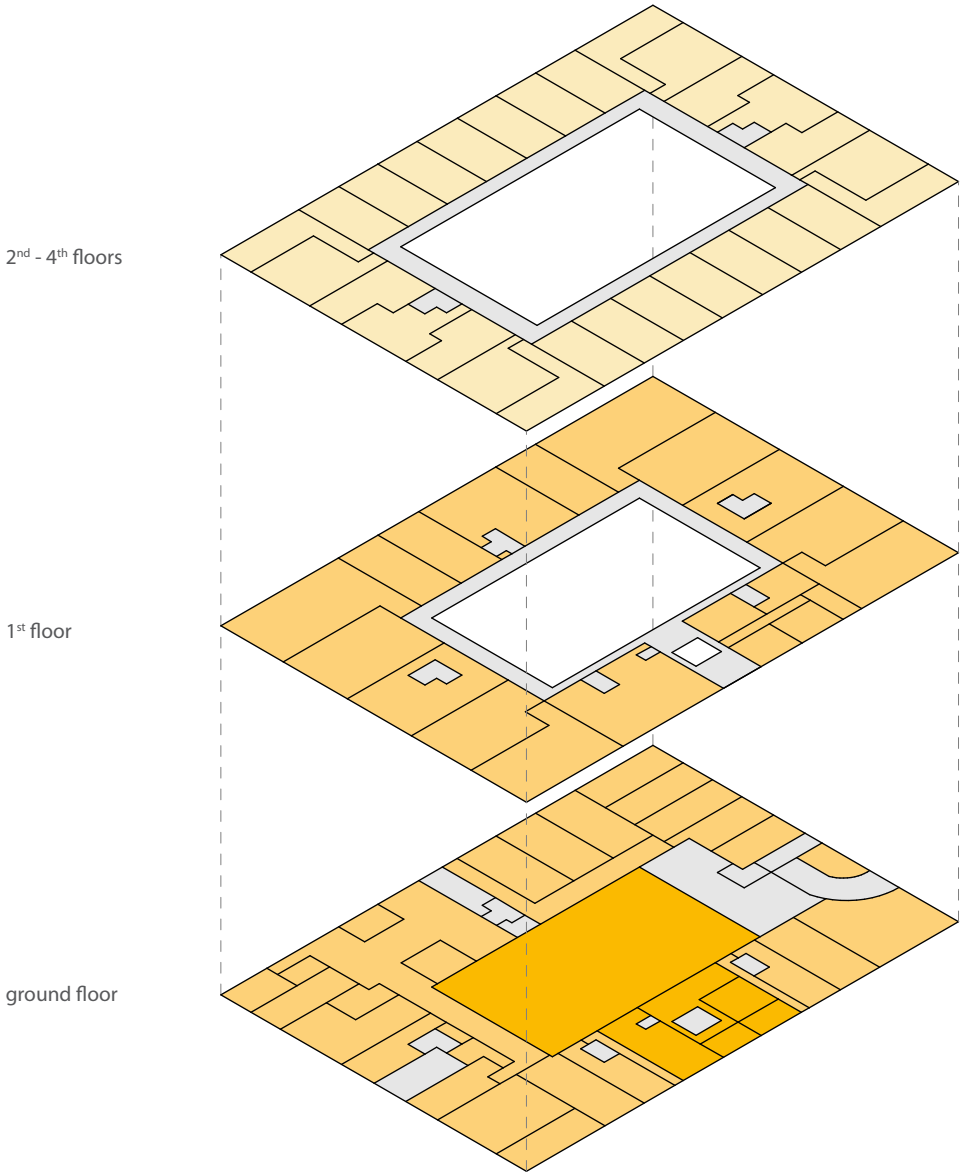
In the case of Solid 18, part of this concept was abandoned during the design phase and it was decided that a more traditional separation between housing and work spaces would be implemented.

The main public function in this project is the gymnasium. Starting in the basement it goes up three levels. The entrance lies on the side of the Ed Pelsterpark.

The bottom two floors are used for commercial space and offices. On the ground floor the accesses are at streetlevel and on the first floor there is a gallery on the inside.

The upper three floors consist of housing. Accessed by an elevator that opens to an outdoor gallery that runs around the courtyard.





Solid 18 - Program

The functional program in Solid 18 can be devided into three parts. The most noticeable is the gymnasium in the middle of the complex that starts in the basement and goes up to the second floor. The access to the gymnasium is public and is situated at the park side of the building.

The remaining space on the ground floor together with the first floor form another programmatic cluster. This space is used for a number of different smaller commercial functions and businesses. Not all businesses have the same dimensions but many of the spaces on the first floor have similar sizes.

The third part consists of the housing program that is located on the top three floors. The dwellings are single level apartments of roughly the same size. All three dwelling floors have nearly exactly the same floor plan.

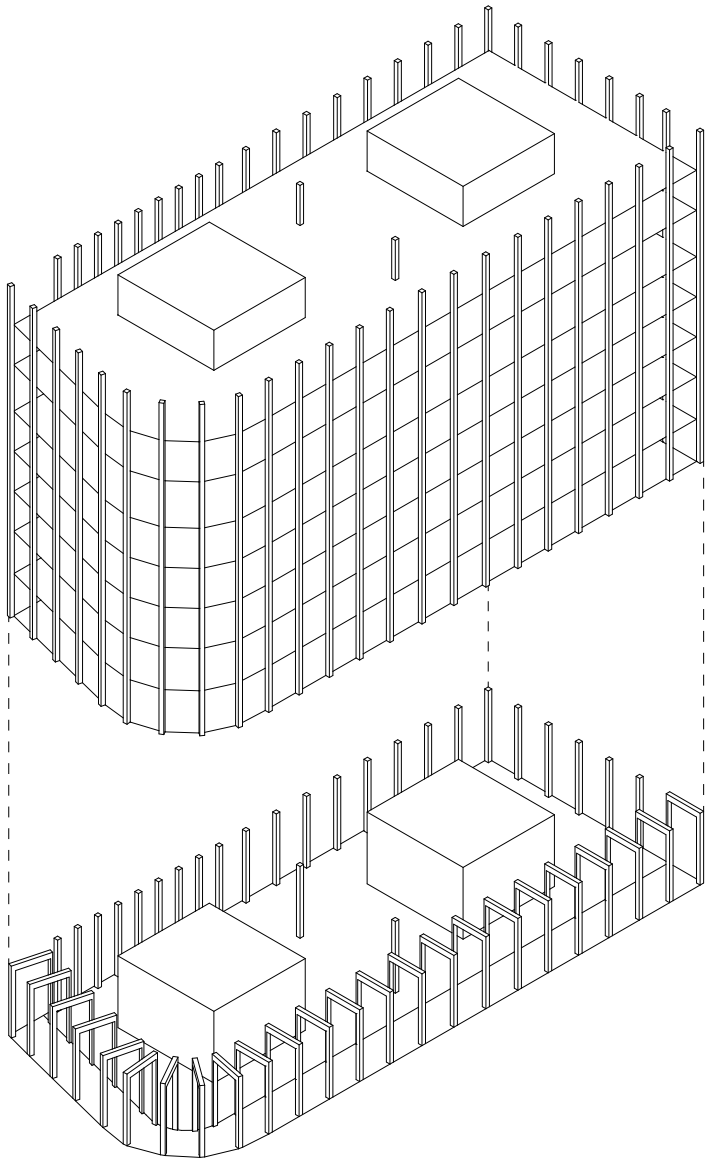
circulation
livingspace
workspace
extra program

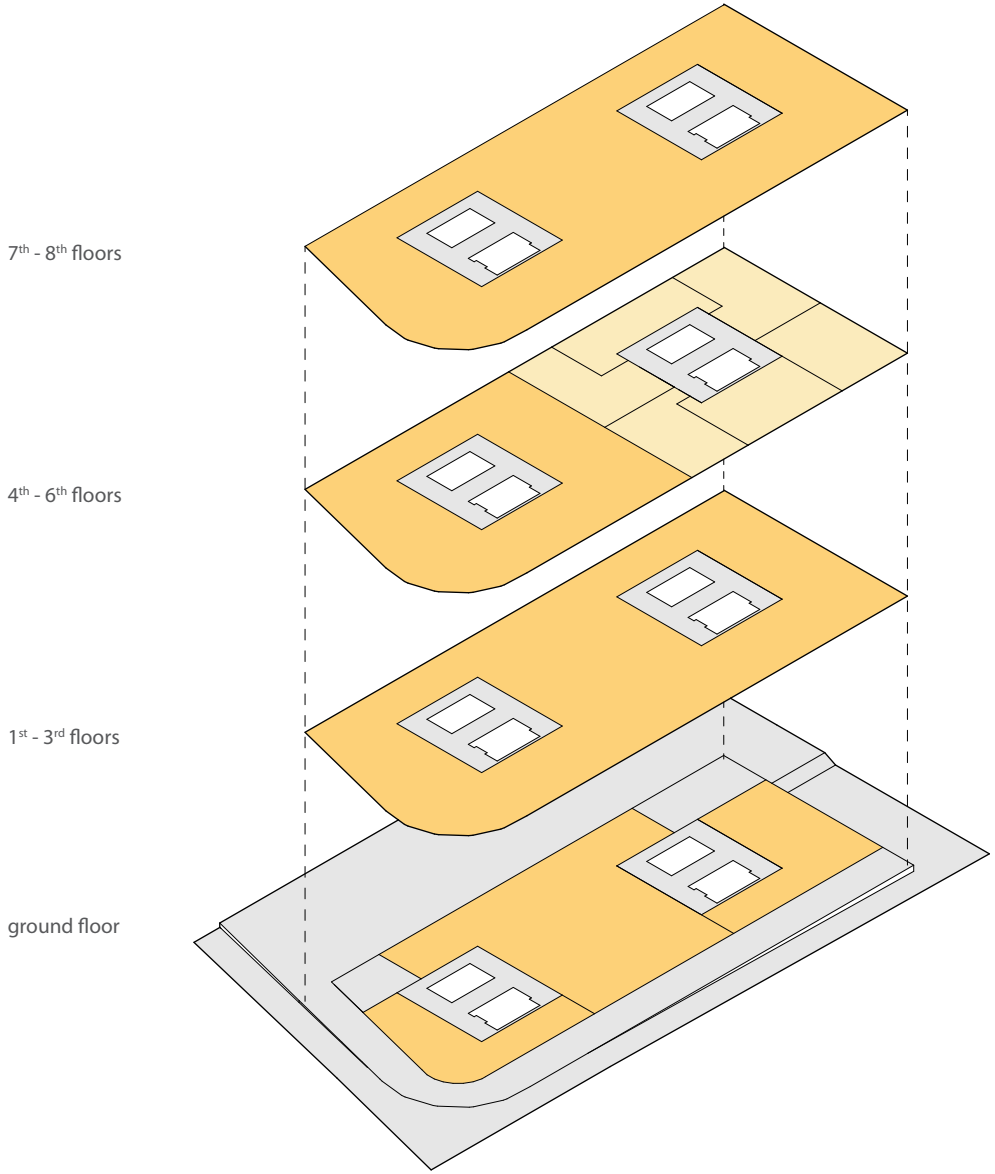
Solid 1 & 2 - Concept

In the case of Solid 1 & 2 the concept of the solid was implemented from start to finish. Open floor plans, central service cores and large floor heights provide a flexible building that can be used for many different functions.

Like most solids the ground floor is treated specially. Extra high ceilings and a collonade to connect the building to future developments around it.
All other floors are identical apart from small variations in height,

Much of the solid concept is not visible in the actual building but is a specific set of rules and guidelines that make it possible to exploit a building without a functional program.





Solid 1 & 2 - Program

The functional program in Solid 1 & 2 is mixed throughout the entire building, apart from several spaces that are still for rent.

On the ground floor there are two different commercial functions occupying the left and right wings. The middle part, along with the entire first, second and third floor, has not been rented out yet.

The fourth, fifth and sixth floors are devided in two halves, of which the right half is used for housing. This part is split into six apartments of similar size and is rented out as social housing.

The top two floors are rented out to a single company.

The programmatic distribution of Solid 1 & 2 shows that the building is very well suited for different types of functions on each level.

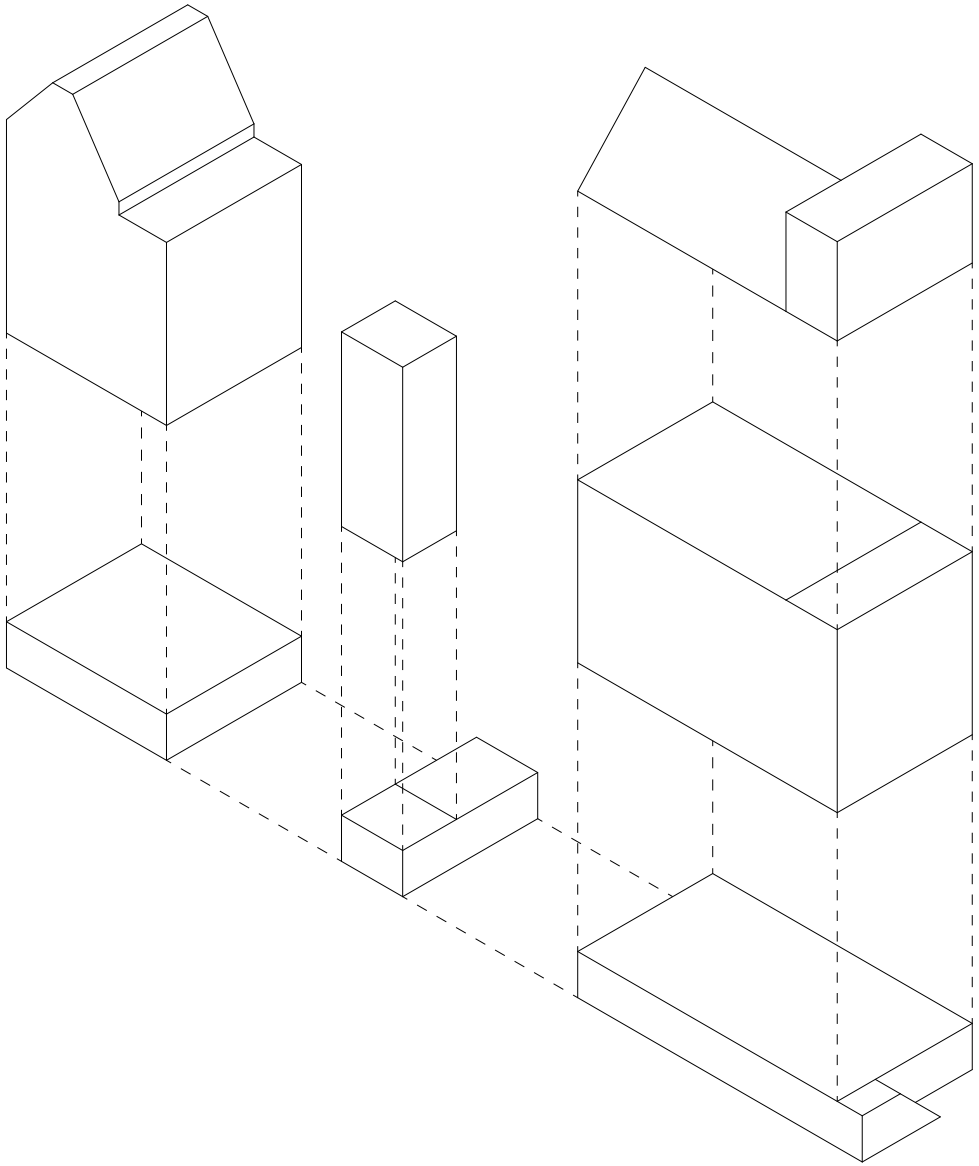
circulation
livingspace
workspace
extra program

Canal House - Concept

Although the mansion has been rebuilt the core concept remains the same as the original house. This concept was used for nearly all traditional canal houses built in Amsterdam and other cities throughout the Netherlands.

There is a high and representative facade on the side of the street and the canal, with stairs that lead to the front door. Goods could be hoisted up into the attic with a crane that extended out of the top of the facade, or stored in the basement.

Behind the front house there is a monumental staircase that gives access to all the different levels. The back house was situated on the other side of the staircase and was oriented more towars the garden.
At the back of the garden there is still the garden pavillion.



Canal House - Program

Because the house was made for dwelling as well as trading there is a clear separation of spaces. The basement and attic were meant for storage, household staff and cooking. The floors in between were used for living and receiving guests.

The backroom features a large, heavily decorated room that looks out over the garden and below a garden-room that was on the same level as the garden itself.

The organization of the program is rather straightforward and is placed on one side of the hallway.

circulation
livingspace
workspace
extra program

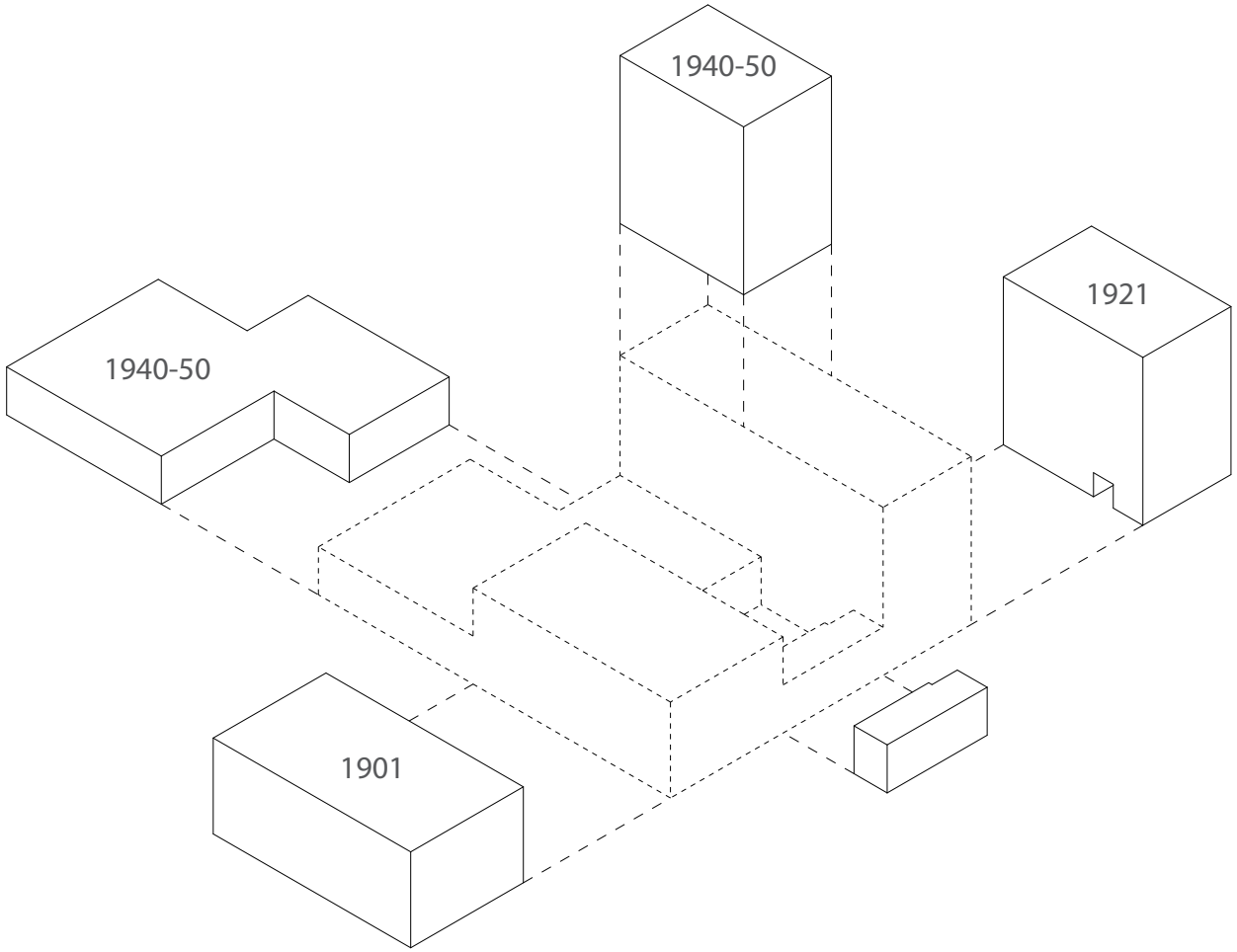
Tetterode - Concept

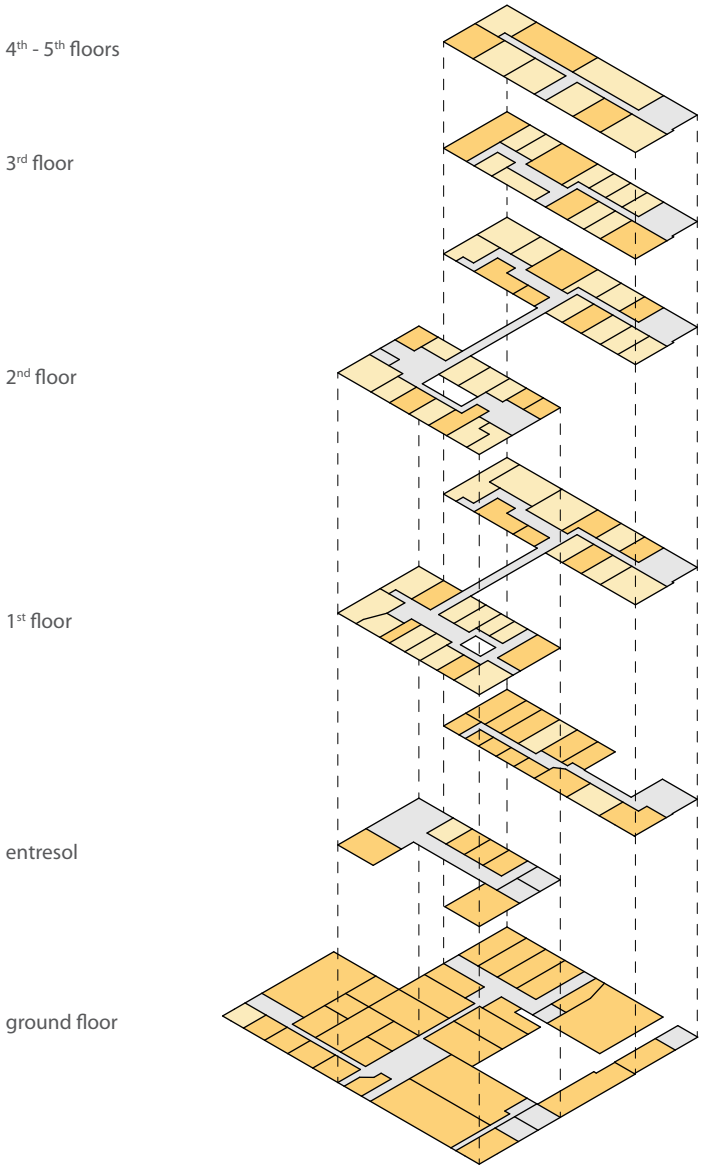
The Tetterode complex is built on behalf of a 'lettergieterij' (type foundry) and consists of three main buildings, a chimney and infill spaces, and is built between 1900 and 1950. The complex has two fronts that are accessible from two different streets, each one on a side of the typical grid of the Amsterdam canal houses.

The first building was constructed in 1901 on the Bilderdijkstraat and was extended and renovated in 1906, 1912 and 1914. In 1921 a former milkfactory on the Da Costakade dating from 1898 was taken over for the type foundry. The last extension took place from 1940 to 1951 when a second building on the Da Costakade was built as well as a single storey connection on ground level.

The industrial firm N. Tetterode used the buildings until 1980. After losing its original function and several renewal plans in the beginning of the 1980's, the neighbourhood and squatter movement protested against demolishing the complex. The housing association 'Het Oosten', the squatters and the municipality agreed to make the Tetterode complex into a place for work and living.

The three buildings are combined and connected by the inner courtyard on ground level, and two connecting walkways on the upper levels. The three main volumes are combined into a single complex for work and living with a corridor routing system.





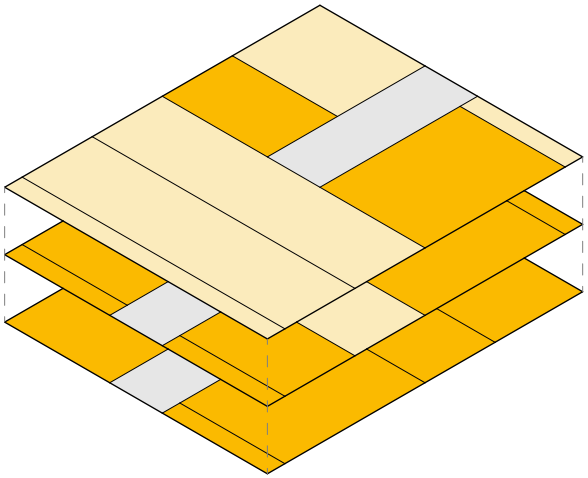
Tetterode - Program

The programmatic infill of the Tetterode complex is very diverse. Dwelling units, work spaces, shops, artists studio's and cultural functions are situated in a single building.

The majority of work spaces and commercial program is located on the ground floor and entresol around the central inner courtyard.
The upper floors consist of a combination of primarily dwelling units and some work spaces. However, many of the dwelling units also have a workshop space and can be considered mixed-use by themselves.

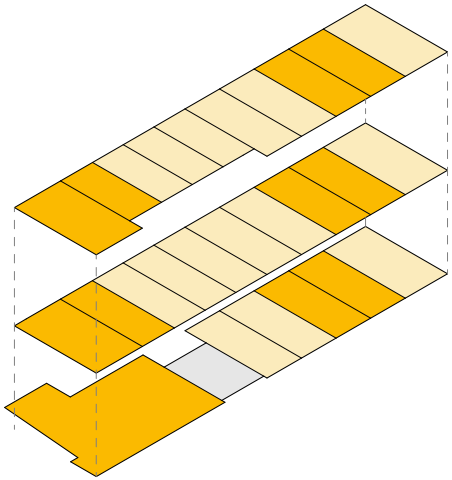
The programmatic scheme on the left is an interpretation of the distribution of functions on the upper floors.

circulation
livingspace
workspace
extra program



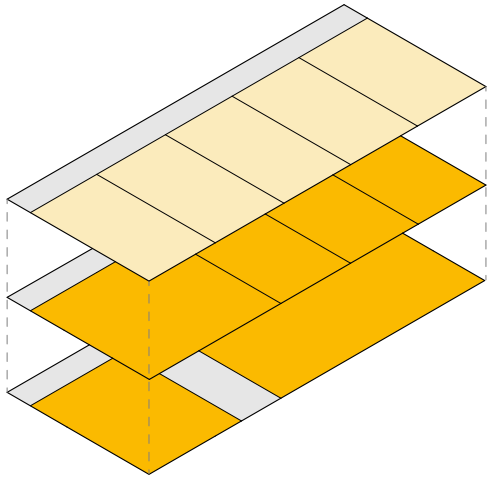
Summary scheme Multifunk

Although the current organization is rather conventional, the fact that a big change in program could be made without drastically changing the design, shows the conceptual strength of the programmatic concept. Different functions with different dimensions within the same building and possibly on the same floor.
The building of Multifunk allows for a wide range of functions and organizations.



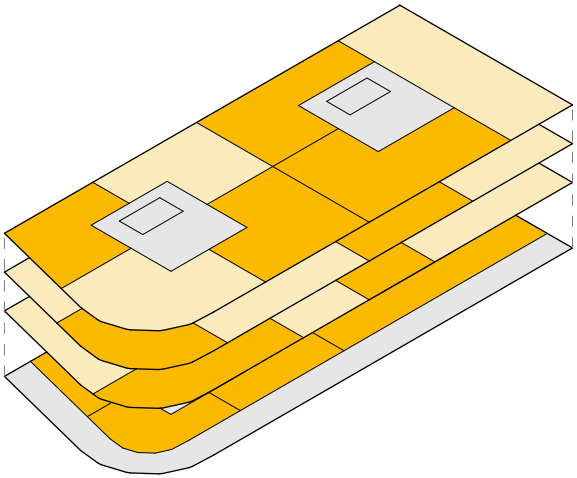
Summary scheme Vrijburcht

The Vrijburcht is a very diverse building in that it houses a large number of different dwelling typologies and users.
Despite this mix of program and typology, the organization of the program is pretty straightforward. The differentation of program is made horizontally and the organization is mainly based on standard housing typology.



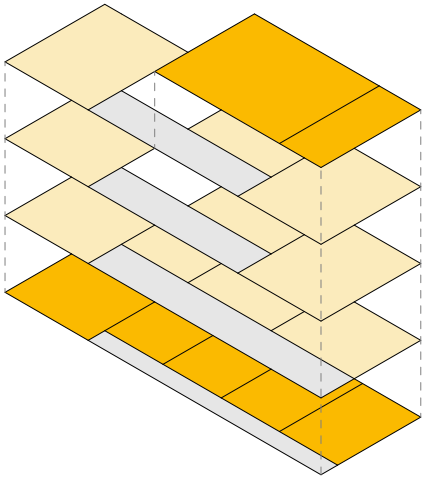
Summary scheme Solid 18

Because the concept of the solid was partly abandoned in the case of Solid 18, the programmatic conclusion is twofold.
The bottom two floors still have the open floor plans that allow for a wide range of functions to be accommodated. Solid 18 houses several different sized businesses on these floors.
On the top floors where the concept was changed it is visible that the organization is typical of that of a closed housing block with an inner gallery. The three floors are nearly identical and are all made up of housing.



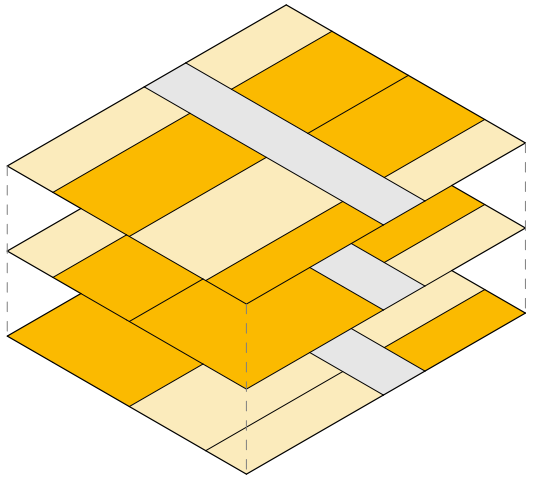
Summary scheme Solid 1 & 2

Solid 1 & 2 are the only solids so far that completely stuck to their concept from start to finish. Although the ground floor is slightly different, all floors have the same layout with two service cores and large open floor plans.
This results in an organization where the program is mixed throughout the building. Commercial space is alternated with (social) housing on different floors. The organization can also easily change because of this layout.



Summary scheme Canal house

The traditional example of mixed-use can be seen in the canal houses. Designed for the trade of goods brought in by boats the building is devided in three parts, both vertically and horizontally.
The work spaces are situated in the basement and attic, with the living floors in between. The basement was mainly for the household staff and the attic was used for storage of goods.
Because of the large floor heights the main living floor in the original house is now often used as the main commercial space for businesses. Even in such a small building different organizations are apparently possible.



Summary scheme Tetterode

The programmatic infill of Tetterode is a combination of work spaces en dwelling units. This mix occurs both vertically between floors as well as horizontally on the same floor.
Most of the commercial program is located on the ground floor and most of the upper floors consists of dwelling units.

The structure of a building determines the grid of a building, and is therefore very important to make a building flexible. In Holland and Europe the Building Decree has a tight hold on the reins, so the standards leave little room for the “flexible approach”.
We are obligated to determine a building’s purpose beforehand, and many requirementes are hitched to that purpose. The next thing needed is a period of reference, a lifespan. This is usually very short, 15 years, or long, about 50 years or longer. Alltogether this hardly gives a framework to propagate flexible buildings.

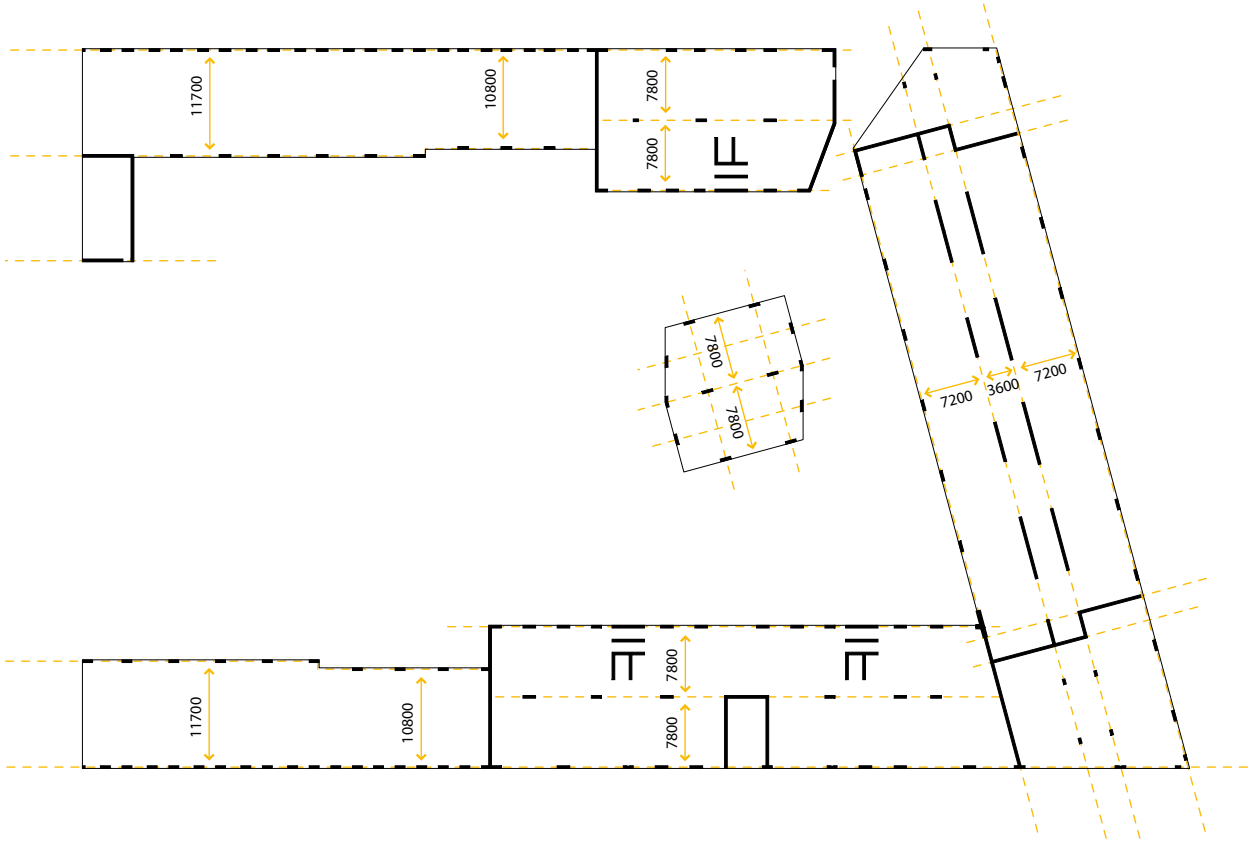
In this part we want to investigate how architects managed to create flexible buildings while stucture normaly is a very rigid element, with almost no flexibility. Are there buildings whose structure allows for a varying volume and variable functions? And which characteristics of this stucture make it adjustable and flexible?

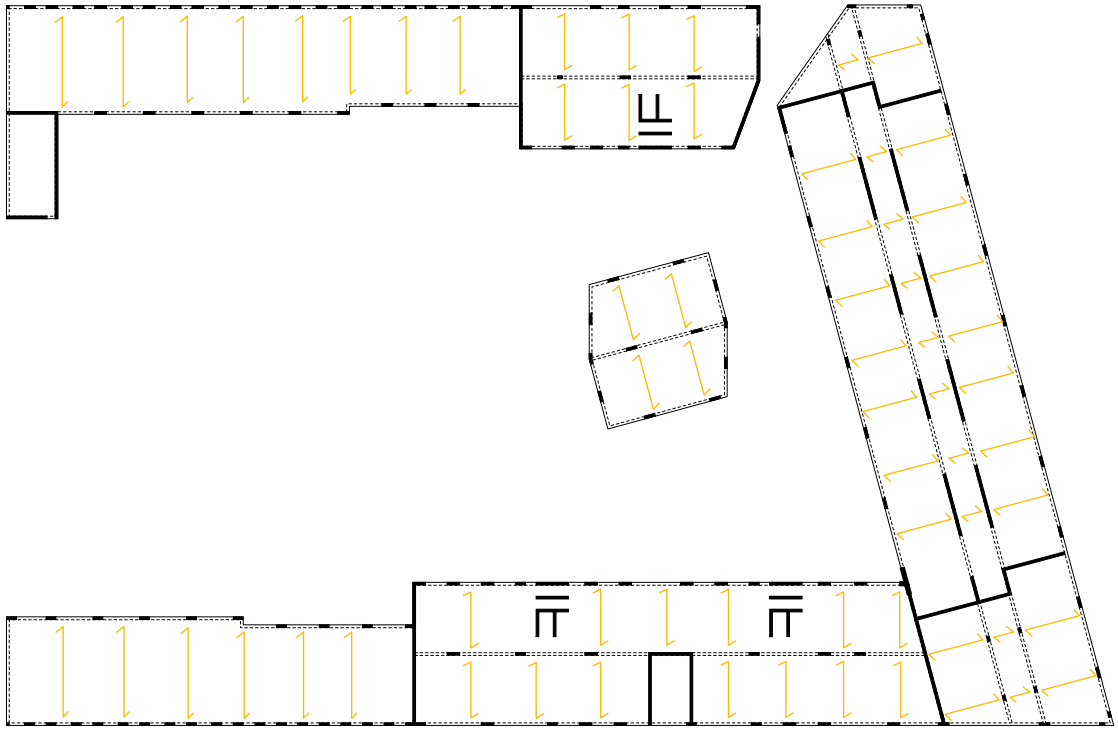
Multifunk

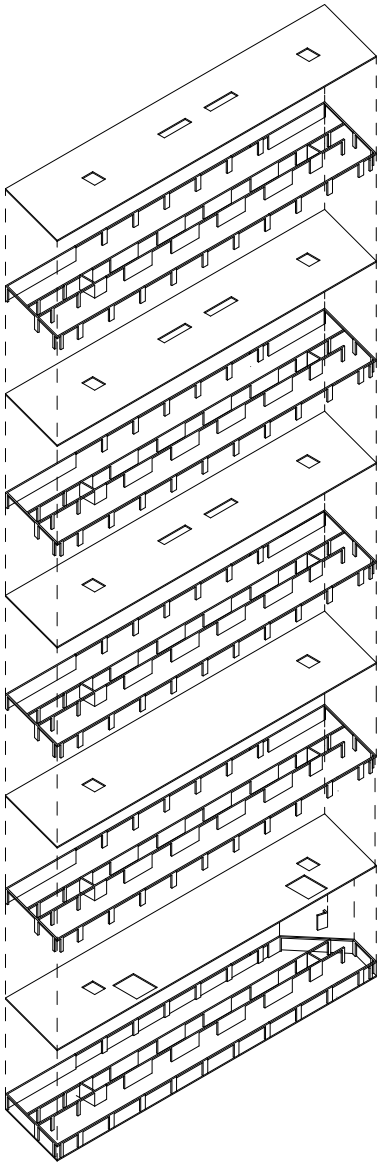
The building consists of six basic volumes: two wings that contain exclusively housing, two higher and deeper wings for housing and work spaces, one even higher wing as the front of the building also for mixed program, and a separate volume in the center.

To create a building that is as flexible as possible the architect chose to use a couple of solid elements.
The load bearing construction is provided by the facade. This facade has a structural grid of slab columns that run parallel to the facade.
In the three higher wings there is an additional row of slabs in the middel, because the span here was becoming to big.
In the portico building a single row of slabs is added, and in the corridor building, they needed a double row of slabs, because of the span of 18 meters.

In between these internal constuctive elements, a corridor could be realised on every floor.
The ground floor has a bigger height than the upper floor plans to be able to house commercial functions. The floor heights of the upper floors is three meters, higher than the 2,60 that is requiered according to the building regulations. This bigger floor hight gives the upper floors the possibility to adapt to different functions as well.







grid

direction of span

load bearing wall

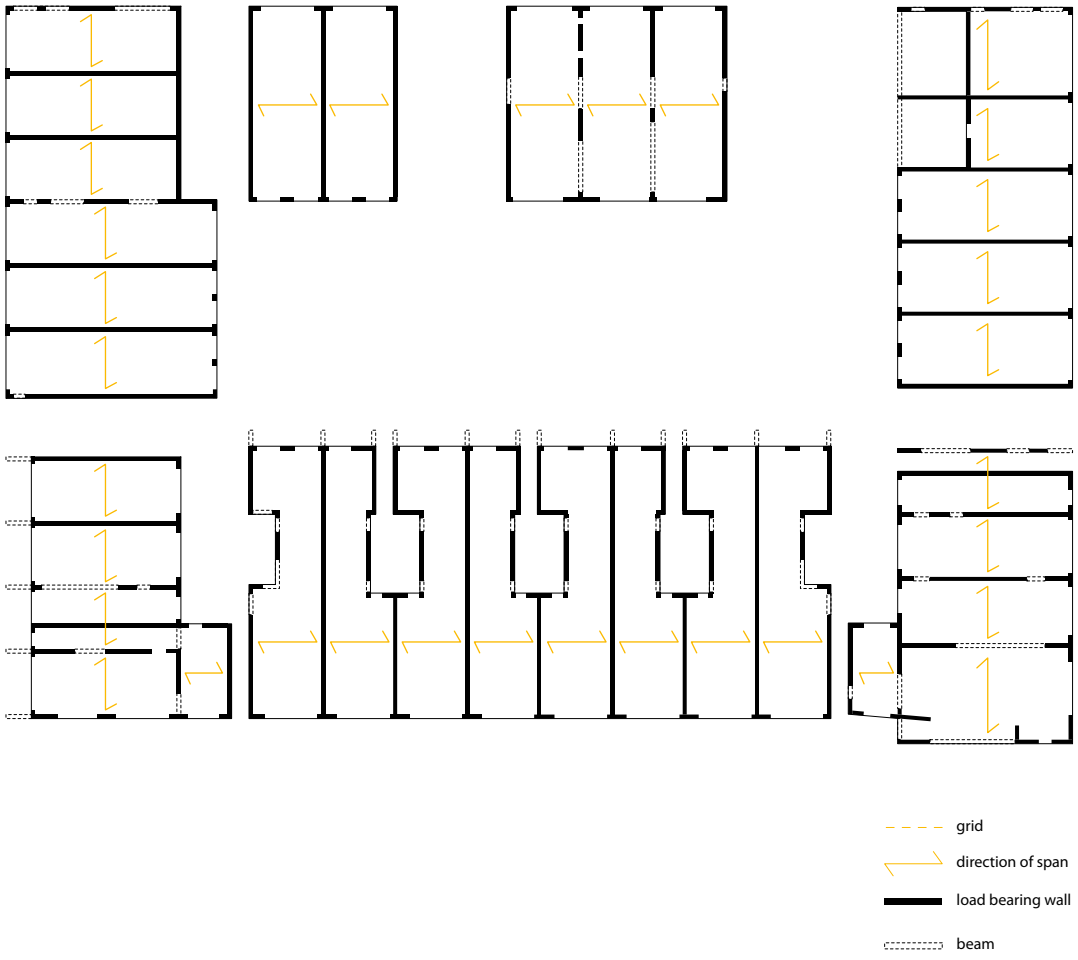
beam

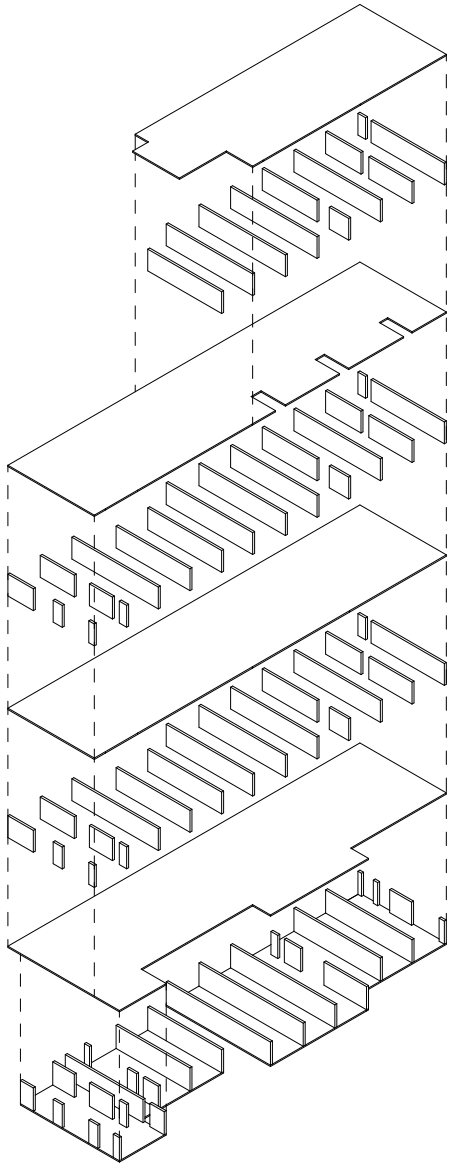
Vrijburcht

The building is set up as a collective private ownership. This indicates that the building is designed according to the individual demands that the dwellers and business owners had.
The building also accomodates houses and work spaces as well as a diner, theater and a day care center. All these functions have other standard grid dimensions, and in the case of vrijburcht the architects clearly let the housing grid be leading in the stucture.

The grid system in this building allows the dwellers to change the interior of their dwelling as they want. But more importantly, by giving the day care center and theater the same grid system as the dwellings these parts of the design are always flexible enough to accomodate housing in the future.

The grid dimensions that are used are 4800 milimeter and 5400 milimeter. Both conventional grid sizes. The day care center is built up of three times the 5400 grid, so in time it could be changed to house dwellings.


grid
direction of span
load bearing wall
beam

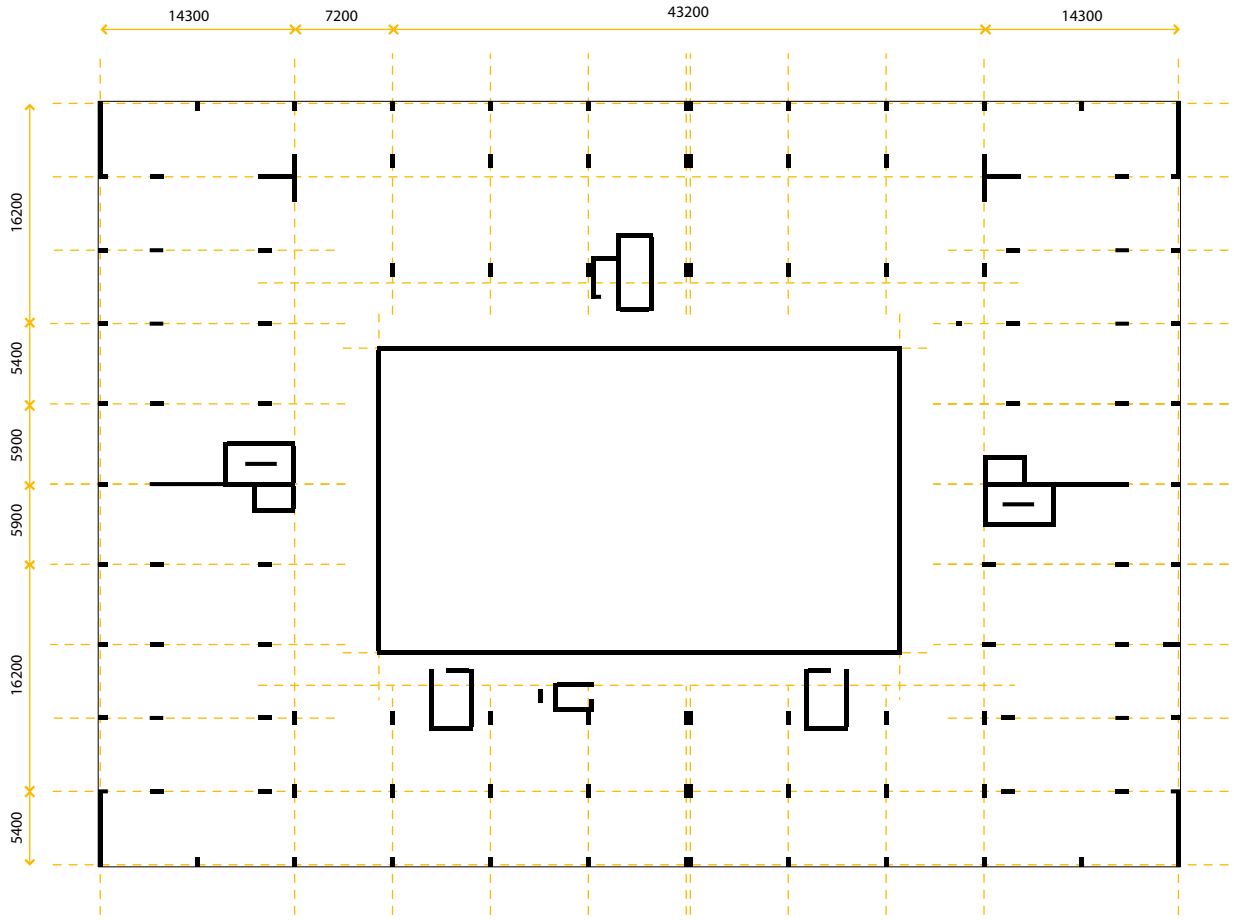


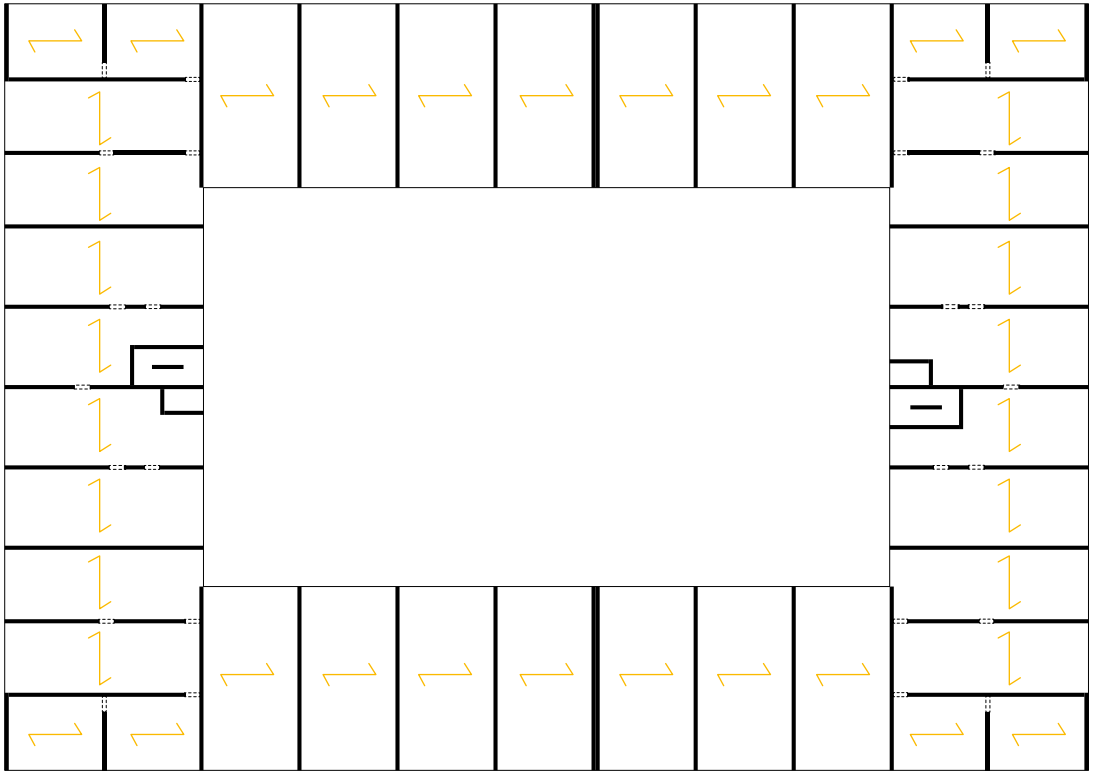
Solid 18

The solid has two completely different stuctural systems. The ground floor and the first floor have an open column system. The floors above use load bearing walls.

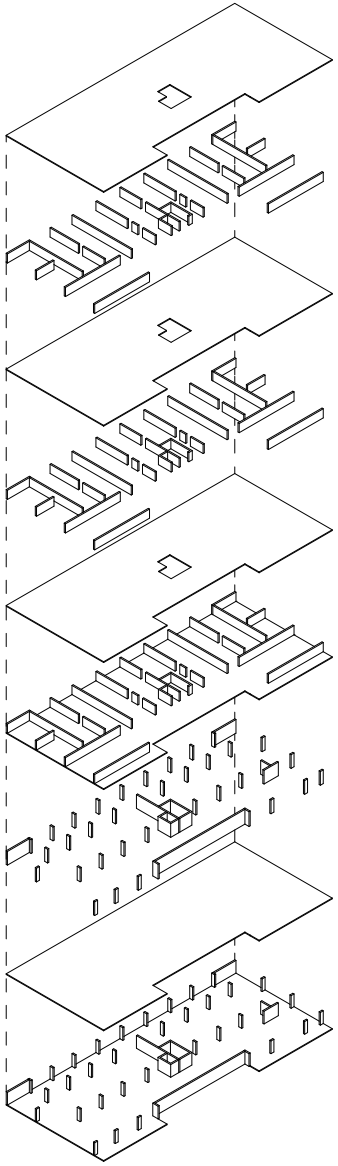
The column system on the ground and first floors gives these floors a very flexible layout. The sizes of the retail and office spaces that are located on the ground floor, can be changed completely over time. The only big fixed structural elements are the cores that house the stairs and elevators.

The dwellings are situated on the second, thirth and fourth floors. The structural layout of these floors is completely different than the layout on the first two floors. The structure is provided by concrete walls that are placed perpendicular to the facade.
This gives a clear dwelling grid to these floors, but in this grid there is the possiblility to link more units together to create a bigger dwelling.



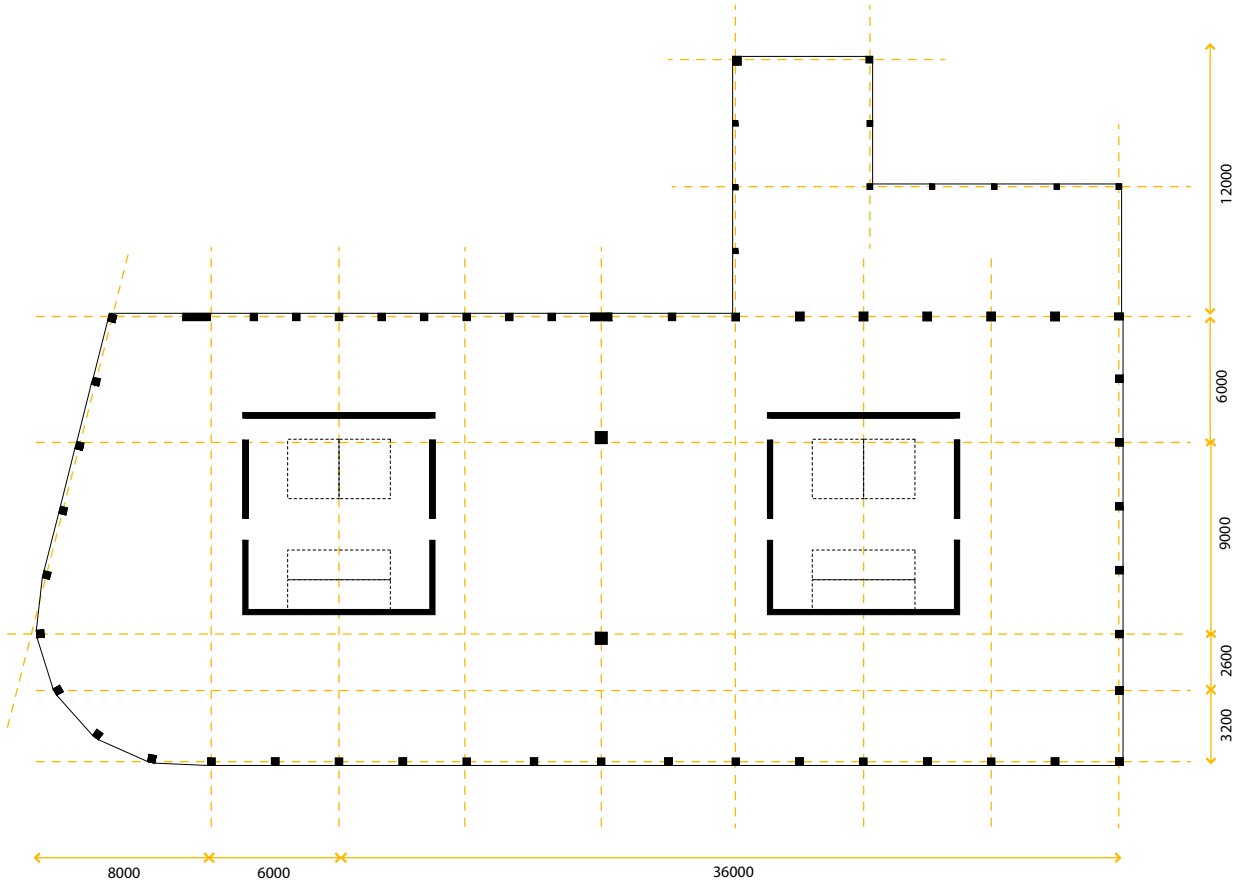


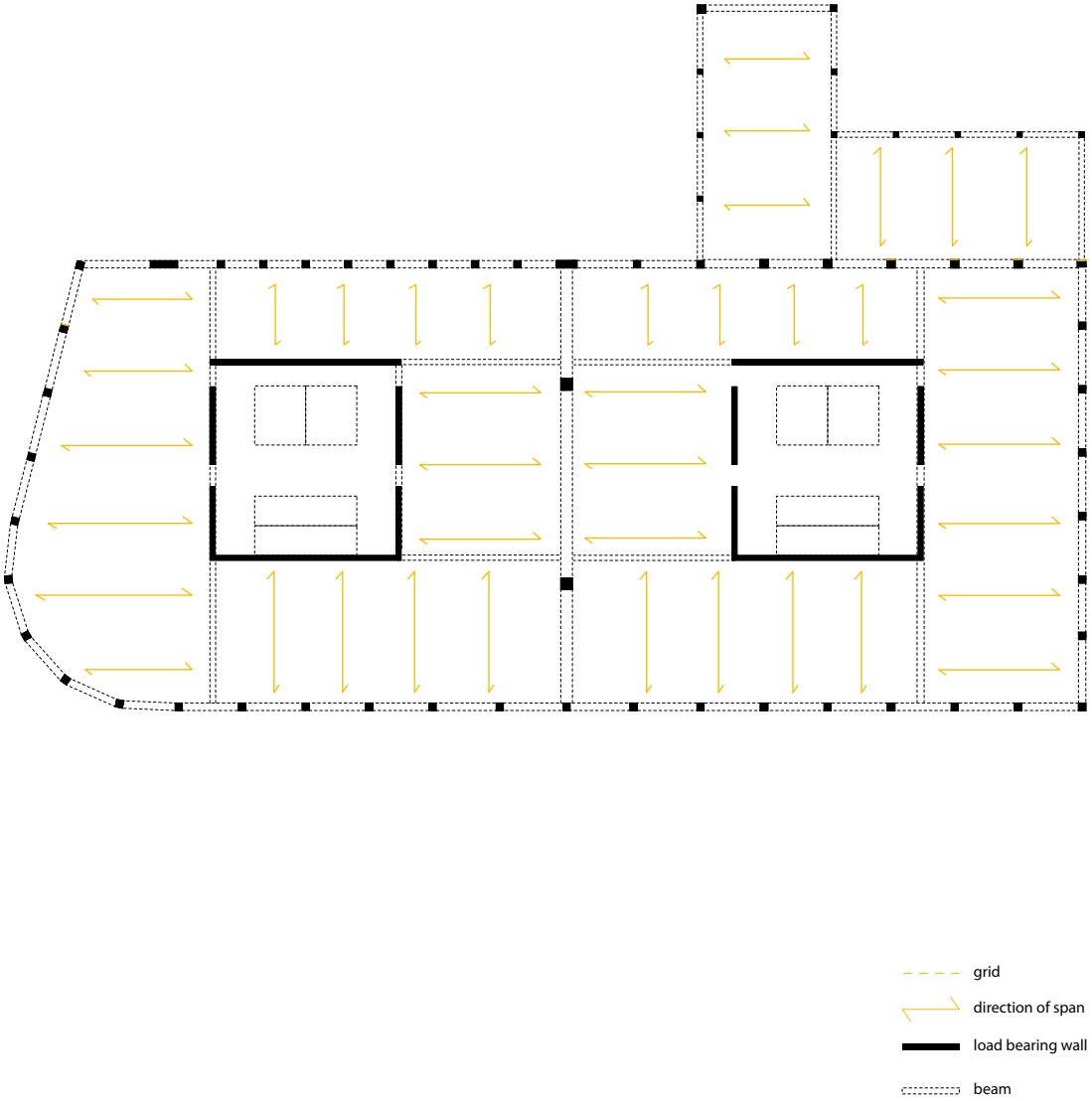
grid
direction of span
load bearing wall
beam

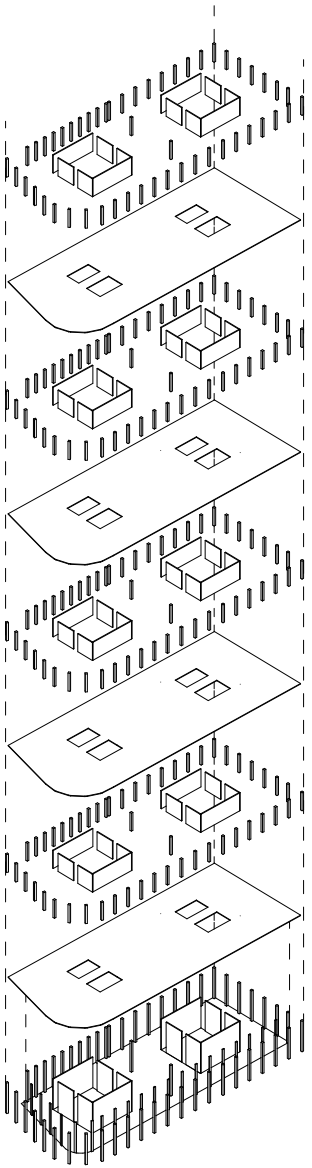


Solid 1 & 2

The load bearing stucture of Solid 1 & 2 consists of a colomn stucture with a fixed core, in which the vertical traffic is organised.
The columns are placed in the facade, which gives the building a load bearing facade. This allows the architect to create a completly open floorspace in between te load bearing facade and the core.
This gives the interior of the building its flexibility, and allows the dweller to design the dwelling in any way he or she wants.
The ground floor is higher than the upper floors, which gives it the possiblility to house commercial functions.
The height of the upper floors is also higher that the minimal heights according to the regulations. This gives the building a bigger flexibility in change of functions.




grid
direction of span
load bearing wall
beam

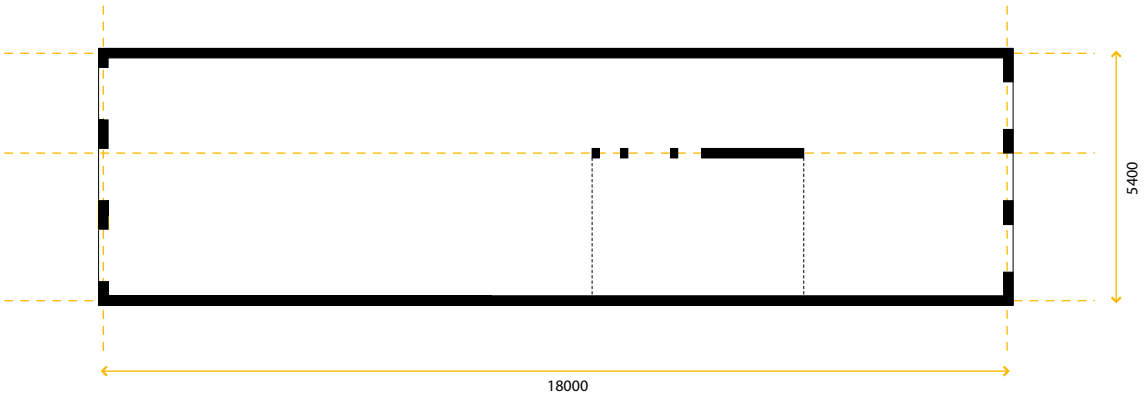


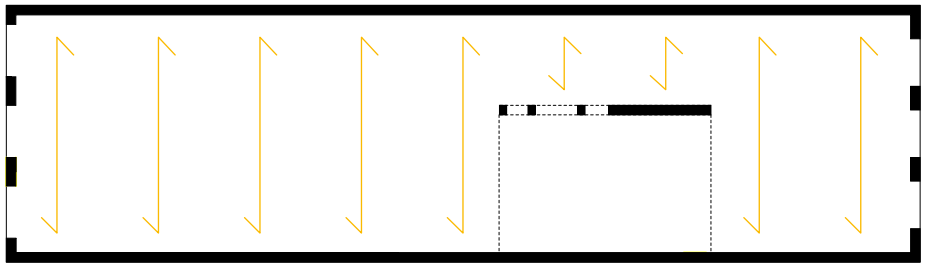
Canal house

The Amsterdam canal house is a type of dwelling with a high accommodation capacity. This means that the building has a high potential to accept changes in program.
The load bearing structure plays a big role in this capacity. The building is able to keep accepting changes of functions because of the oversized load bearing structure and floor areas.
In the 17th century, they were large dwelling houses with reception areas and rooms for the domestic staff. In the 20th century these were converted into offices and recently many were converted again into apartment buildings.

In the images on the right you can see that the building serves as a frame as load bearing structure, in which flexible partition walls can be placed.
This reduces the risk of premature demolition if the demand for other programs and spatial needs should arise.

Canal houses have a load bearing structure that consists of brick walls and wooden beams that carry the floors.
The span is always between five and seven meters, in this example the span is 5,40 meter.
When these dwellings were built in the 17th century the main construction material was wood and the maximum load bearing ability was obtained at about seven meters.



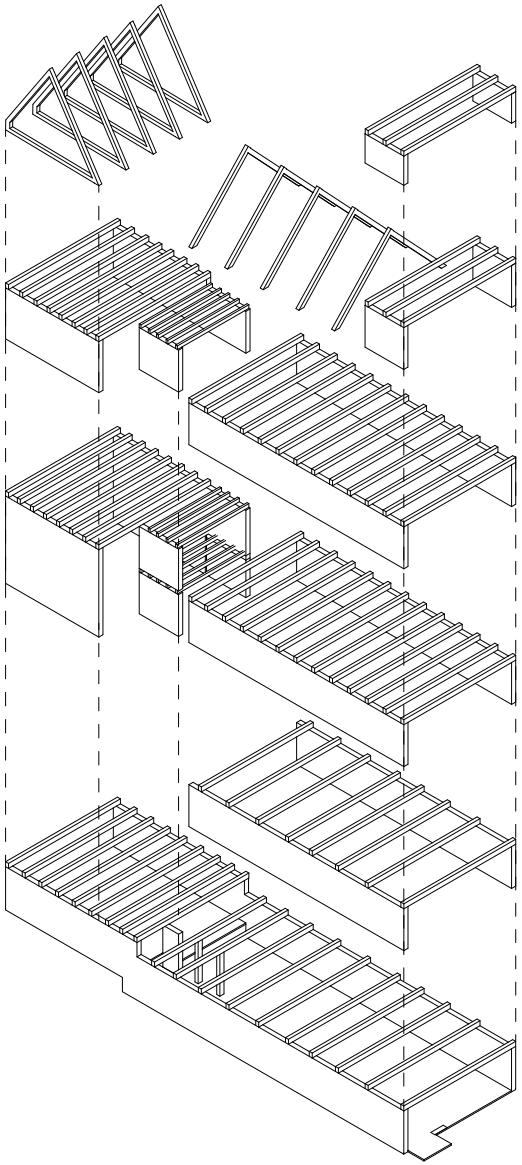


grid

direction of span

load bearing wall

beam

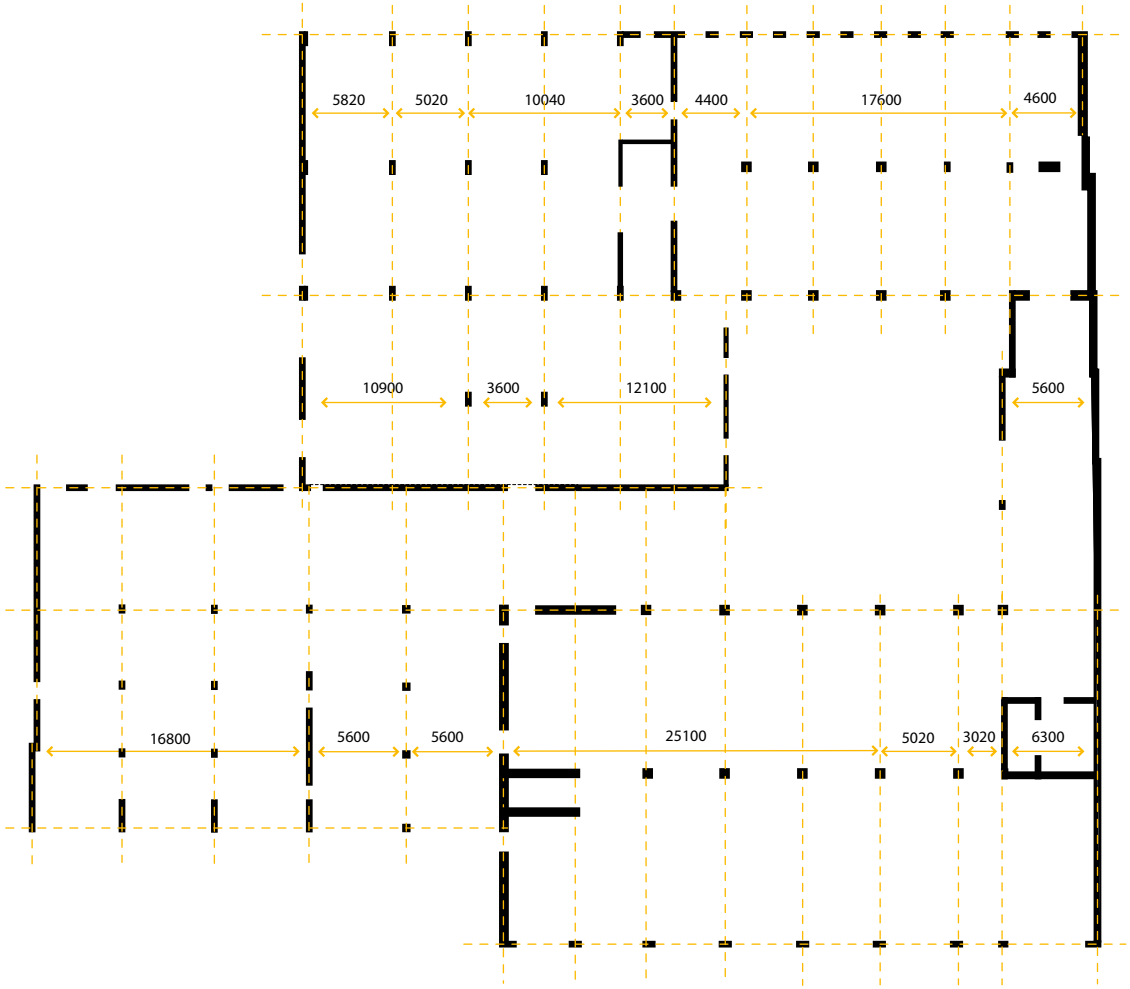


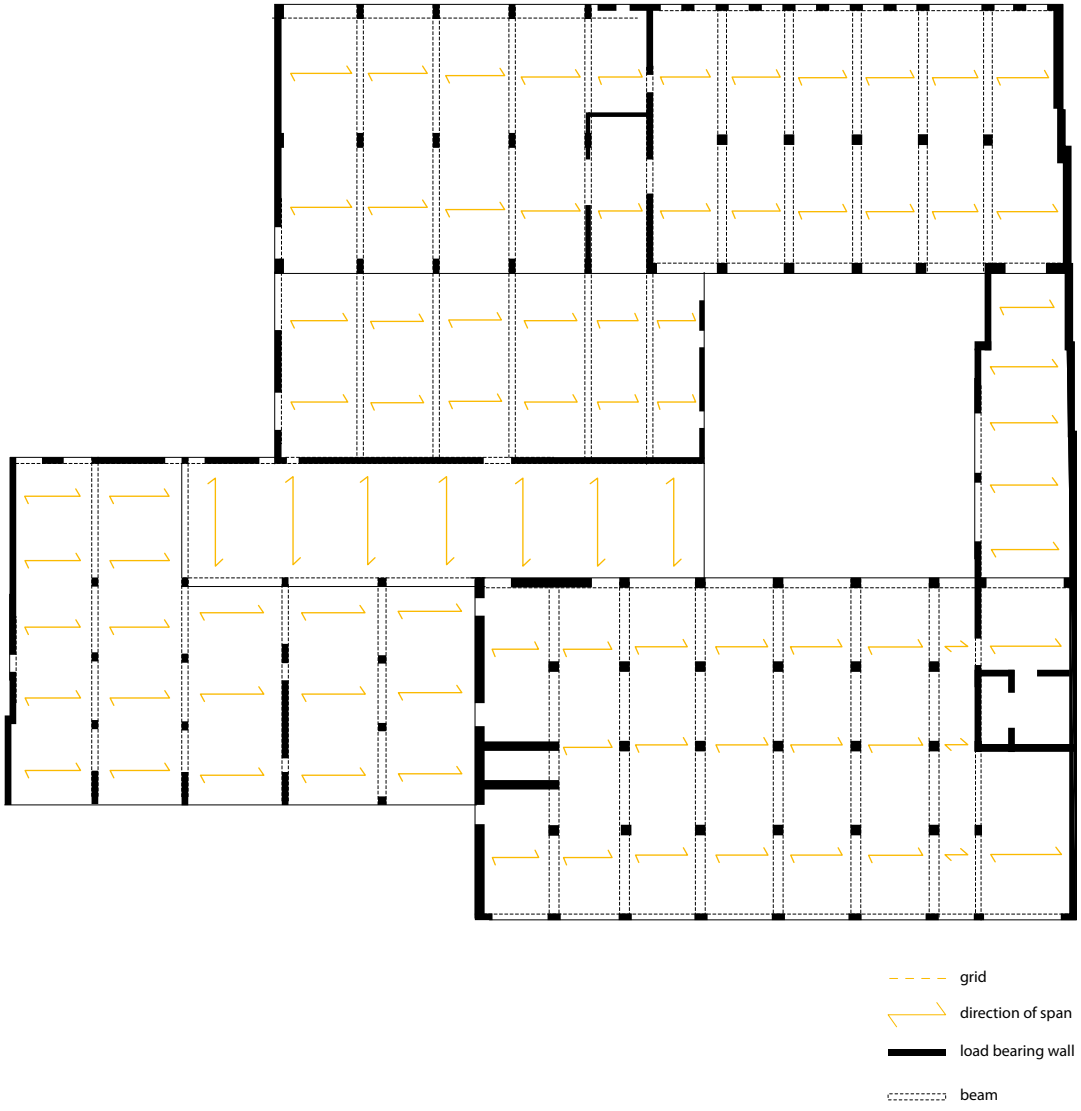
Tetterode

The structural system of Tetterode consists mainly of large open floor plans supported by a grid of columns. Because the building was used as a factory with large machines and equipment the spans and floor heights needed to be very large.

The two main buildings both have a system of columns in the facade and a single row of columns inbetween. The beams have spans of 4400 mm in the shortest direction and up to 8900 from column to facade. The facade columns are covered in brick, except for the newer building on the Da Costakade.

Four main structural cores and several structural walls provide the stability as well as the vertical transport for the building complex.




grid
direction of span
load bearing wall
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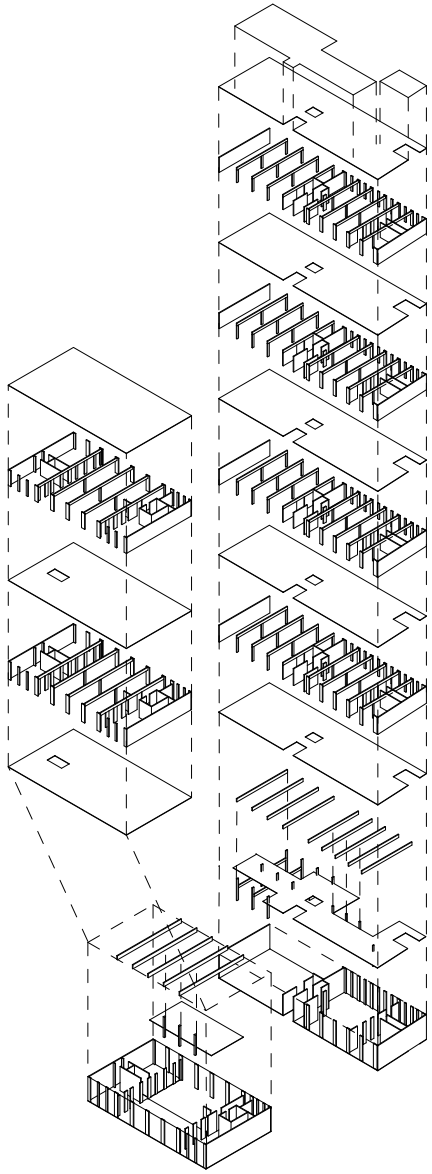
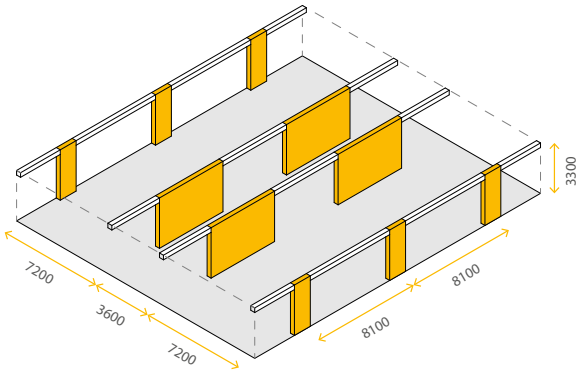
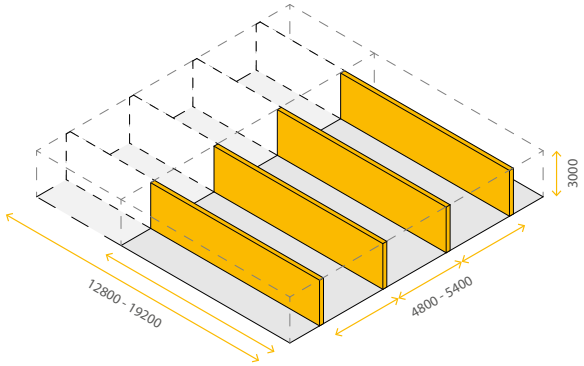




Summary scheme Multifunk

The important thing about Multifunk is the way the load bearing structure is designed. Compared to the other schemes on this page the construction is rotated 90 degrees and runs along the facades as well as in the middle of the building. It is also one of few buildings that has structural elements in the facade.
The larger slabs that run along the center of the building provide stability.
Floors span from facade to facade, supported by beams that run along the lines of the main construction elements.

Because of this structural organisation Multifunk is able to provide a very flexible open floor plan with the possibility of a function taking up the entire length of the wing of the building.
Walls perpendicular to the facade can be added at random, depending on the clients demands.
The large storey heights are suitable for dwellings as well as work spaces that require a lowered ceiling.

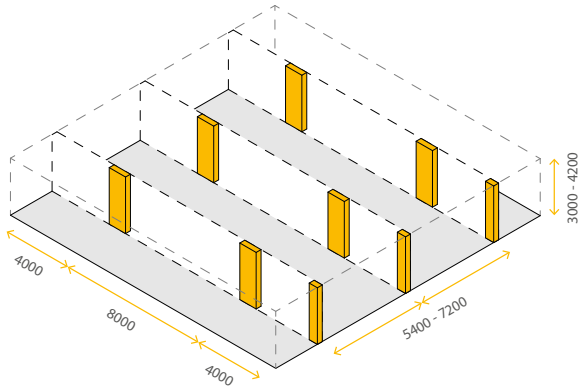


Summary scheme Vrijburcht

What becomes clear when looking at the structural schemes is the system of load bearing slabs perpendicular to the facade. Although the dimensions differ on each side of the building, the system remains the same.
Floors span from slab to slab over a length of 4800 to 5400 mm.

The structural system of Vrijburcht is clearly designed with housing as primary objective. The load bearing elements as well as the dimensions of the spans are typical for Dutch dwellings.

Work spaces in the building are also subjected to the same structural grid. The structural slabs are reduced to slab-columns to allow for a larger floor area for work program, but are still placed in the same grid.
The transformation to a 100% housing building should be relatively easy because of this.

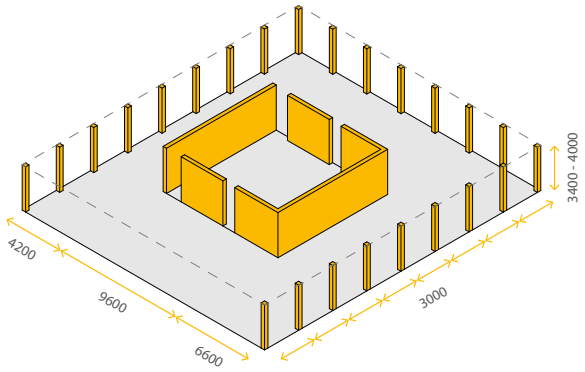


Summary scheme Solid 18

At first glance the structural system of Solid 18 looks similar to that of Vrijburcht, using structural slab-columns and walls perpendicular to the facades.
However there is a difference between the ground and first floors compared to the upper floors.

The ground floor and first floor are layed out with a grid of slab-columns which leaves an open floor plan in between. From the second floor up the slab-columns change into structural walls that run from the outer facade to the inner facade.

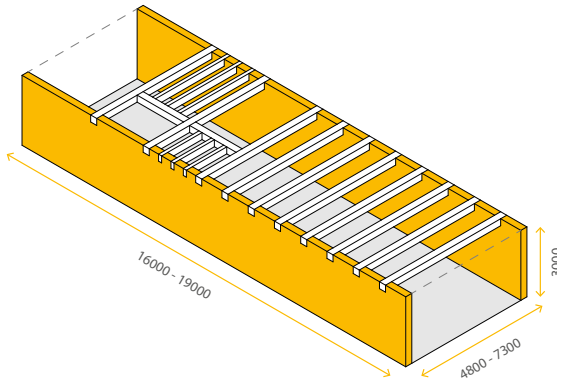
This system suggests a specific difference in program between the first two layers and the upper three: work spaces below and housing on top. Because of this system the upper floors can not be transformed into work spaces as easily as is the case on the lower floors. Regular floor heights on the upper floors also prohibit a wider range of functions.



Summary scheme Solid 1 & 2

The structural scheme of Solid 1 & 2 shows the essence of a solid-type building. A single core with a large open floor plan around it. This layout is possible because the loadbearing construction is situted in the facade and the core. The space in between can be filled in according to the demand.

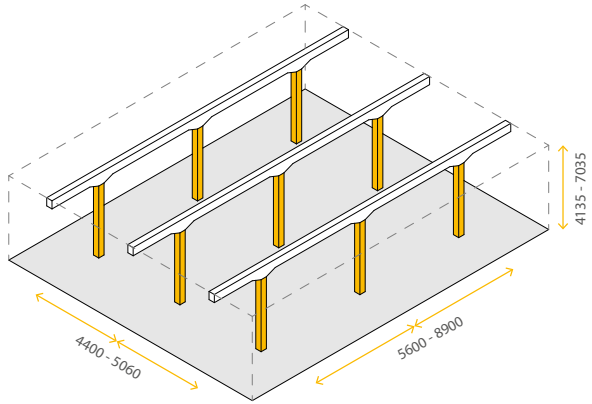
The construction elements are over-dimensioned to allow for extensions and future changes in legislation. The floor heigths are based on the requirements for work spaces and can accommodate a large range of functions.



Summary scheme Canal house

Unlike the other case studies the canal house's construction is not based on specific demands or aimed at different functions, but is a result of period-specific restrictions. The spans that could be reached with wooden beams were limited at the time of construction and this meant most houses had the maximum accepted width. This ranged from around five to eventually seven meters.
Because of the limited width the houses were often stretched deep into the available plot to get the desired amount of floor space.
The heigth of the ceilings however could be chosen more at will and are therefor often higher than strictly necessary.

The high ceilings allow for work spaces to be placed in traditional canal houses.



Summary scheme Tetterode

Because of its history as a factory building the structural system of the Tetterode complex is overdimensioned for many, if not all, of the current users.
The system of columns and beams in a grid with large spans and high floors allows for a wide variety of possible functions to be placed inside. The high ceilings make it possible to add entresols and create extra living space in the dwelling units. They are also ideal for commercial spaces and artists that work with large objects.

When a building deals with different functions, or must be able to deal with different functions in the future, the routing is a very important design factor.
We normaly design a routing in a building by looking at the function of it, and seeing how these people want to enter, for example, their dwelling. But other functions have other needs, especially when it comes to the routing.
Do you combine the routings of different functions, which gives the office workers the possibility to come very close to the dwellings? Or do you separate both functions, which gives the building places that are abandoned by night, because the workers are at home.
The second question is, how can you make a building adjustable through time, and how can the routing accomodate that change. What different ways of accessing a building are there, and which ones are the most suitable to accomodate different functions?

Multifunk

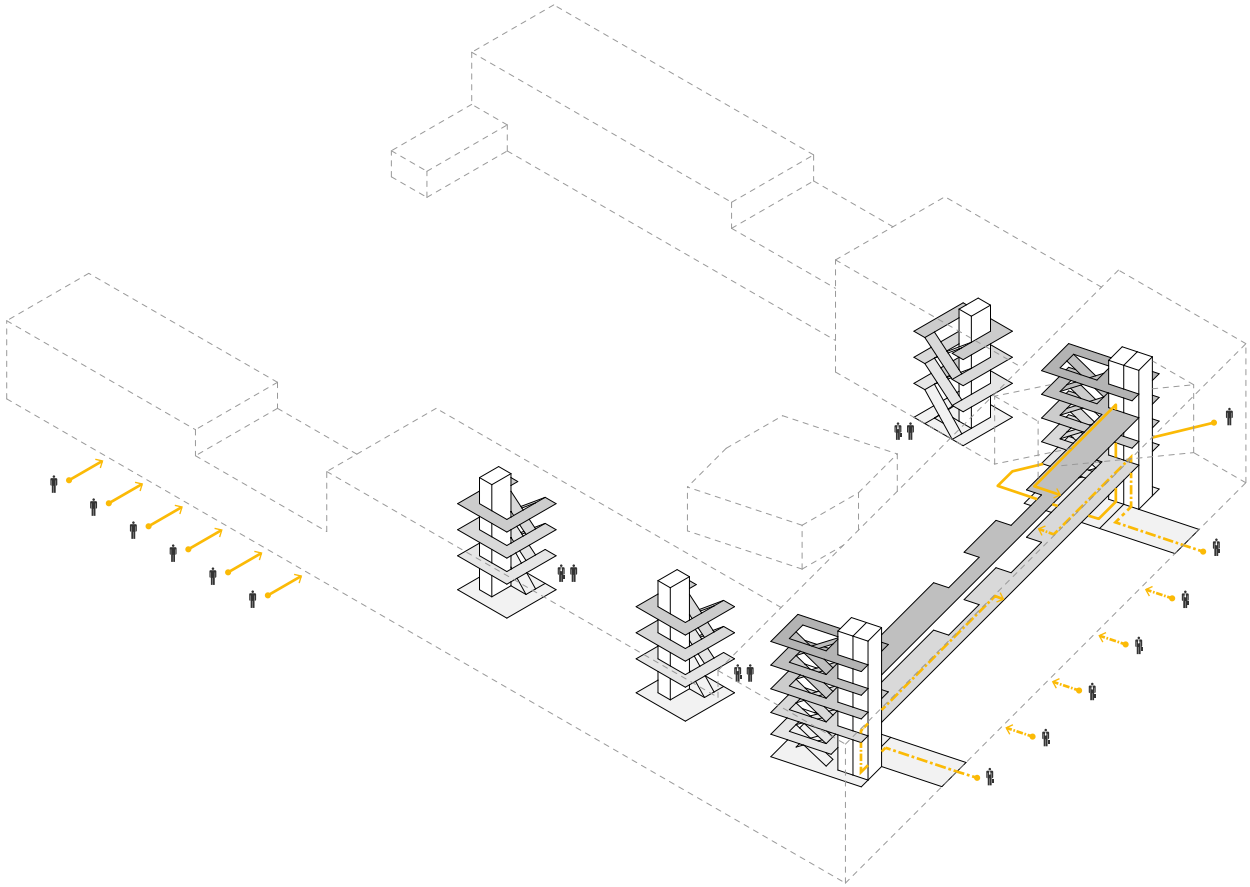
The building has three different types of accesses.
The houses that are built at the two edges of the building have an individual access from the street. These houses are flexible in the way the internal organisation is organised, but in program they will stay houses.

The second type of access is the portico access. These buildings are both four floors high, and both have a central portico with an elevator and a double staircase. A big void provides light into this collective traffic space. Every portico is able to change its function completely or partly.

The corridor building is the most flexible part of the building. This part is the front of the building, and it is five floors high. The dwellings in this building are accessable from the court, at the back of the building. The workspaces have their entrance at the side of the street. By separating the traffic flow of these two functions both functions are able to function on their own.

The corridor building has corridors that give access to the different live or work units. These corridors are accessible by two portico's that both have two different elevators: one for the dwellings and one for the workspaces.

In different places in the corridors are spaces left open where in the future stairs can be placed.
This makes sure that the building can be split horizontally and vertically in many different ways.



routing werken

routing wonen

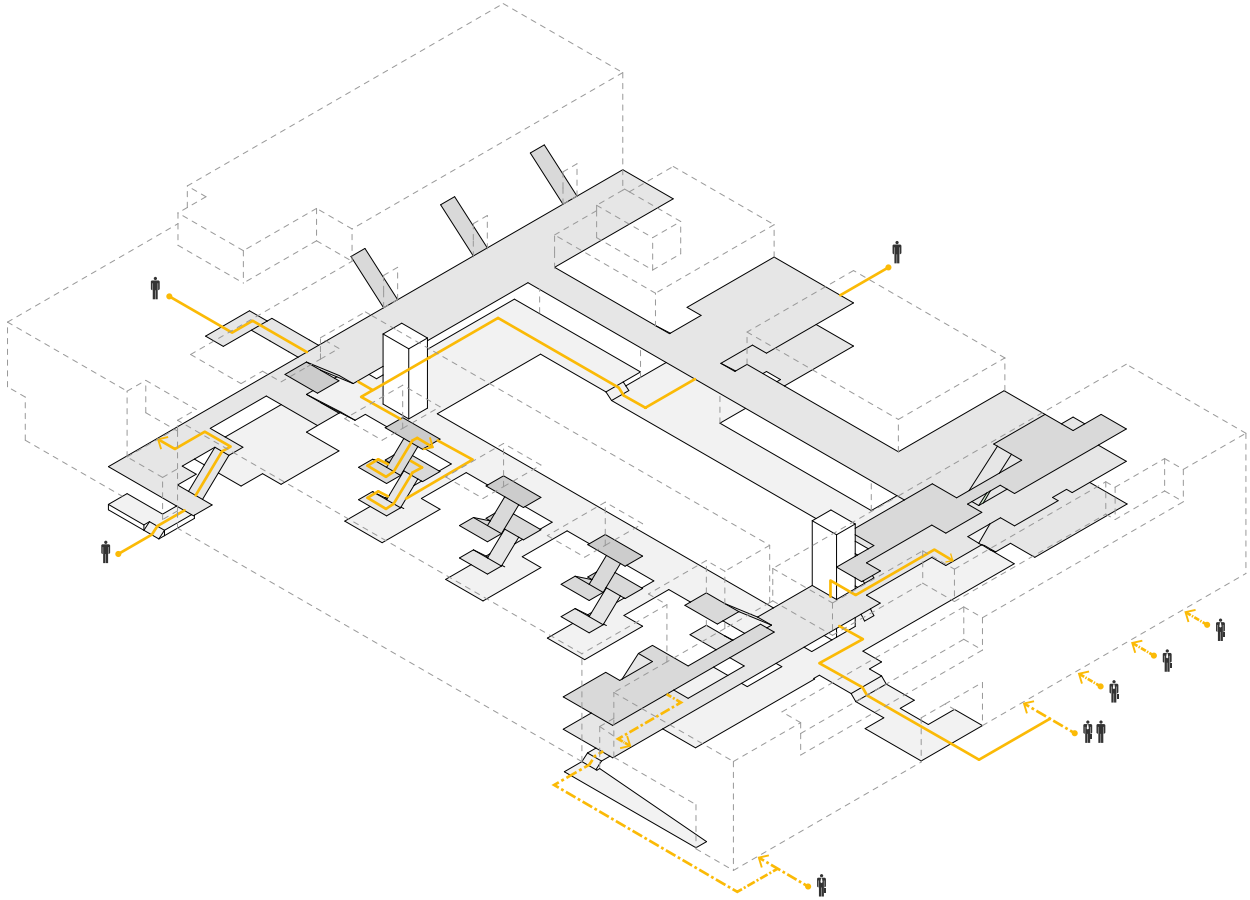
These four schemes show the different routing principles in the buildings. The routing to the dwelling is separated from the routing to the work spaces.
What becomes clear when you look at the schemes is that dwellers enter the building at the back of the building, and the work spaces are accessible from the front of the building.
The two functions both enter the same portico, that runs from facade to facade, but the two routes do not cross each other.
In the center of the portico a clear separation is made, by a glass wall. This wall contains a door, but this is only accessible by the dwellers.. This separates the two routings, because the people that go to their work space will not be able to enter the elevator that goes to the living spaces.

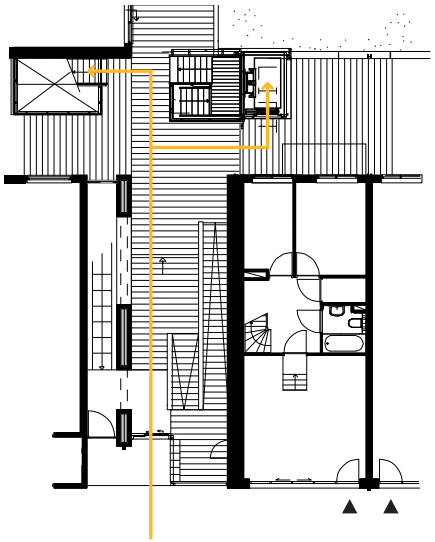
On the upper floors the layout can be changed completly. And with this change, the floors where the elevator stops for example, can be changed as well.
So the right elevator, the elevator that accesses the working spaces will only stop on the floors that are used as work floors. And for the dwelling elevator it is the other way around.

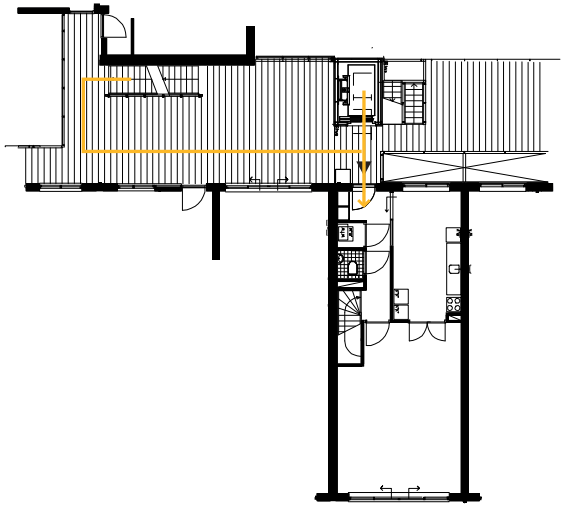
Vrijburcht

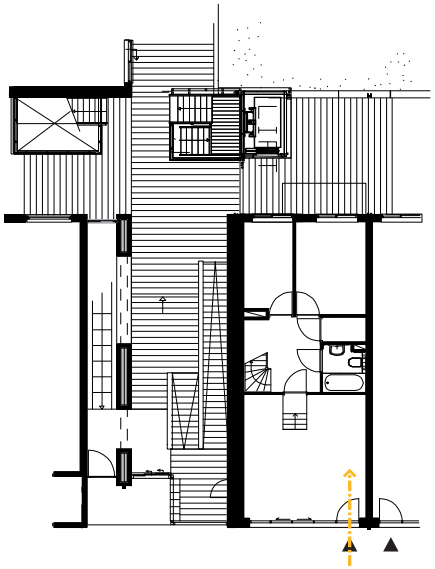
It is very visible in the design of the routing in the complex that Vrijburcht is a private collective initiative.
In the program of the complex a couple of collective spaces are added, like a theater, and some collective office spaces to have meetings.
But the big inner garden is probably the most important part of the collectivity in the complex. From this collective inner space elevators and stairs go up to the collective walkways that are in front of the dwellings.
This creates a meeting point for the dwellers, and a phase inbetween the public outer space and the private space in the dwelling.

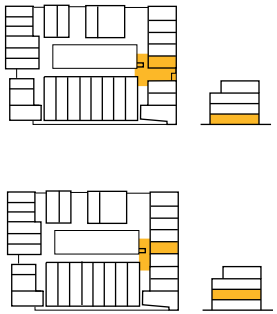
The Vrijburcht complex has a couple of different routing systems.
The work spaces that are situated on the ground floor are accessable directly from the street.
The atelier-dwellings have an atelier space on the ground floor, which is also directly accessable from te street.
The routing to the dwellings that are at the back of this atelier is completely separated from the routing to the atelier.
The dweller accesses his dwelling by walking into the communal garden, going up with the elevator to the first level, and from there the dweller can enter the dwelling.











routing werken

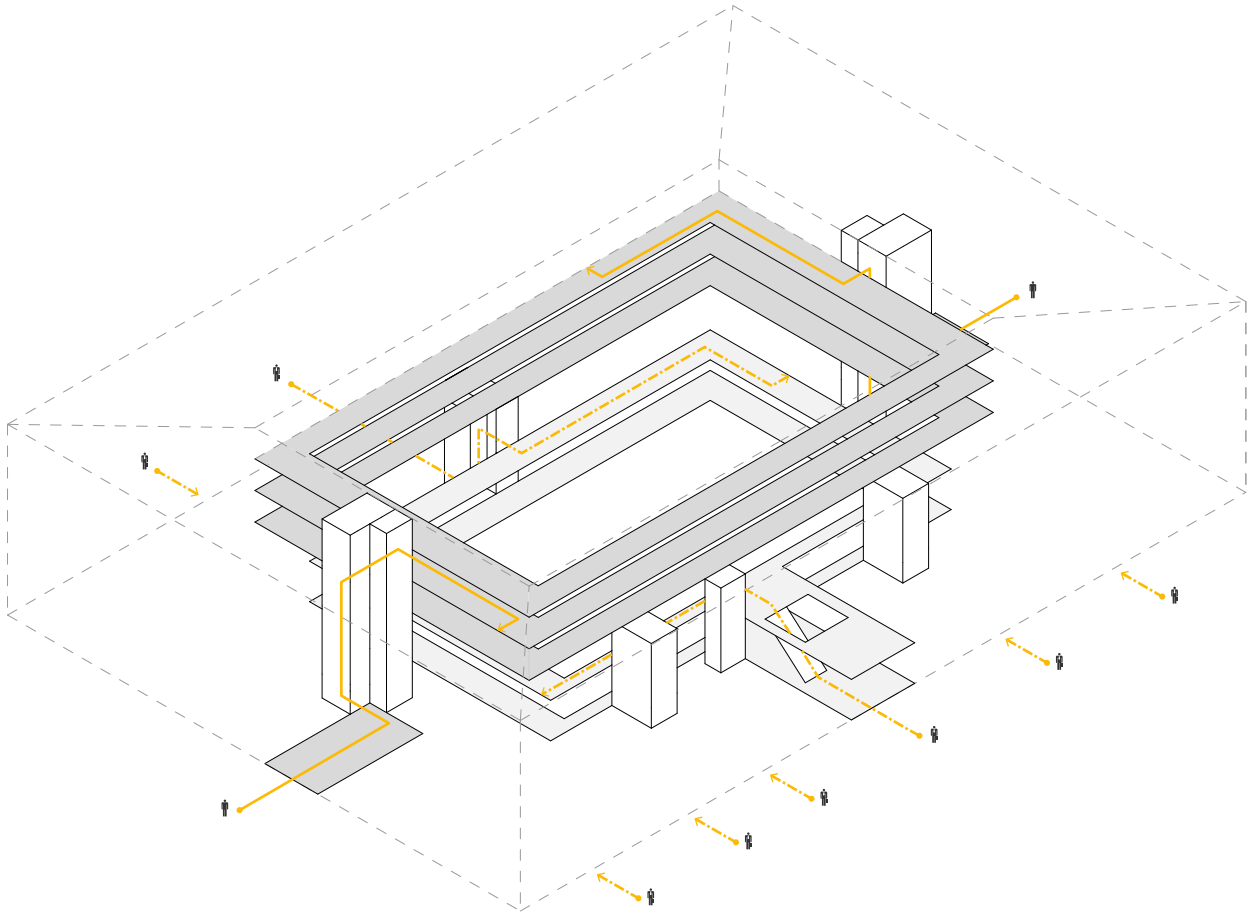
routing wonen

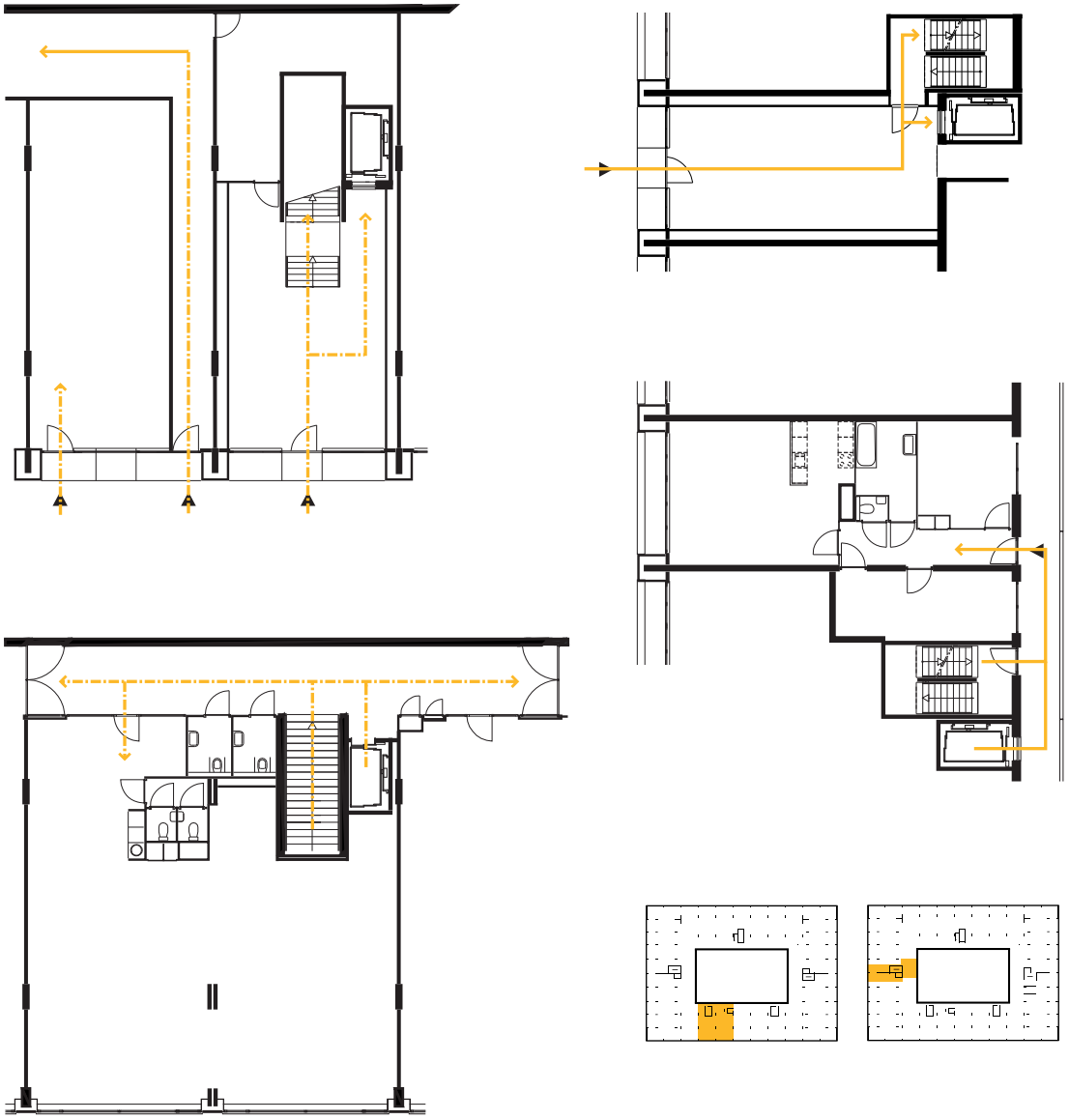
This building was built as a private collective initiative and this is clearly visible in the detailed routing in the building.
The schemes on the left show that the routing for work spaces and living spaces is separated in this building. The bottom scheme is the routing in an atelier dwelling. The arrow shows that the work function is accessible directly from the street. The backside of the ground floor is used as a living space in this typology, but this living space is only accessible from the first floor.
This is what the two upper schemes show, the routing from the ground floor to the stair or elevator, and the routing from the elevator on the deck to the dwelling.

Because the building was built as a collective initiative the architect wanted the dwellers to access their dwelling from the public inner deck. But the question is if the dwellers will accept the longer routing to the living entrance, or will start using the work entrance as well.

Solid 18

The solid contains housing, working, retail and the IJburg Leisure Centre.
The two most important functions in the building are the living and the offices/retail spaces.
On the ground floor some retail spaces are placed. These spaces can be entered directly from the steetlevel.
Partly on the ground floor and on the complete first floor office spaces are located.
These spaces have a completely different route than the dwelling spaces, that are placed on the upper floors.
The routing of these two functions is completely separated in the building.
By designing two elevators for the dwellers, and three elevators for the work spaces, both functions are kept completely separated.
The elevators and staircases that go to the work spaces, only go to the first floor. The walkways on the groundfloor and firstfloor are therefore completely designed for the work spaces.
On the second, third and fourth floor the dwellings are situated. These walkways are not accessable by the work elevators, but the open void in the middle of the building allows dwellers to look down to the work floors and visa versa.



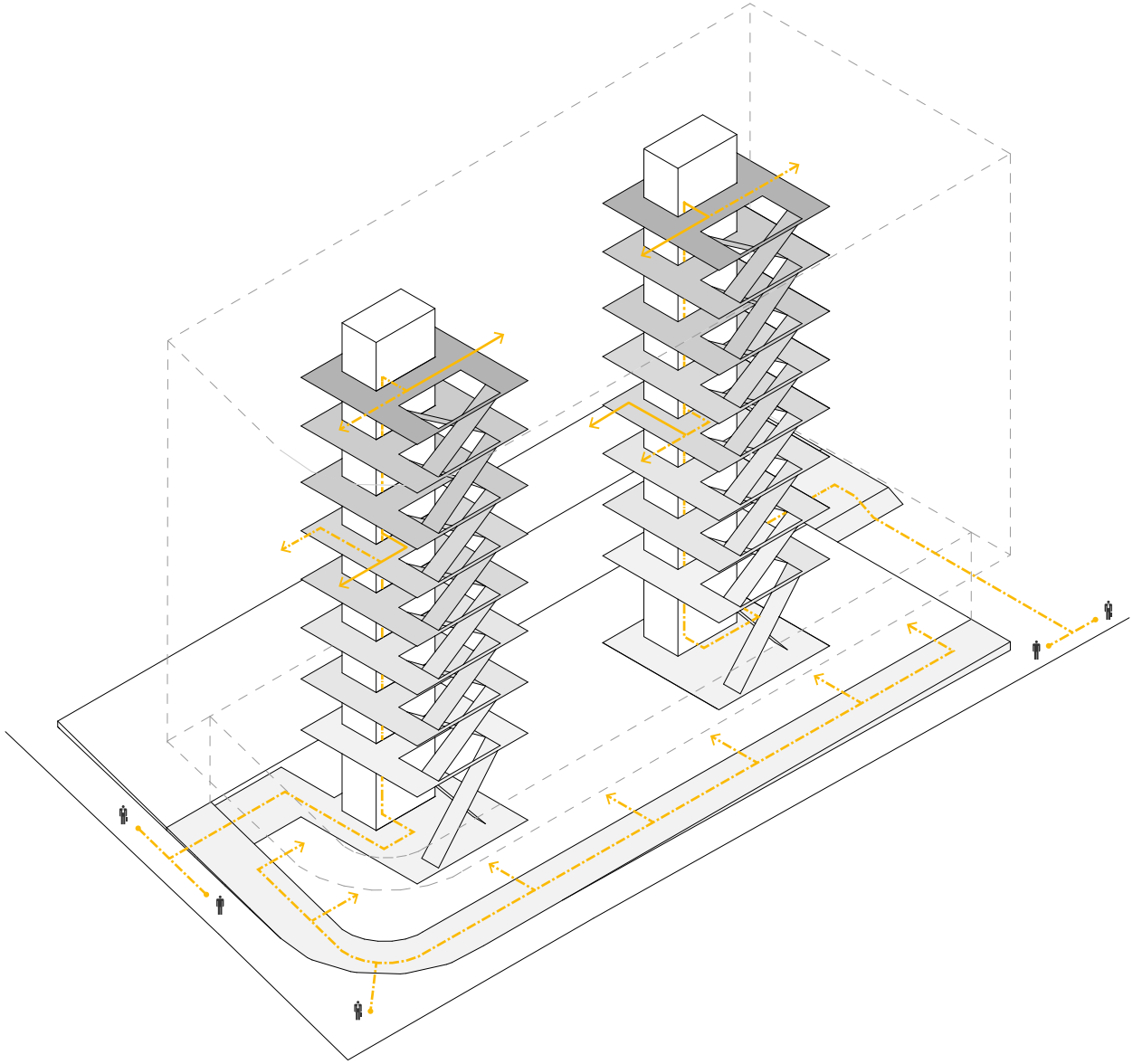


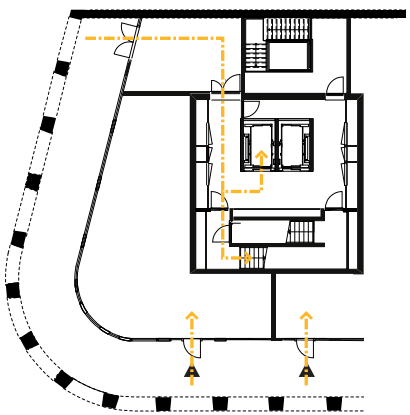
The solid 18 building was set up to be a solid, and completely flexible in which function is placed where. At one point this was given up, and the living and working was divided on different floors in the building.
The ground floor has a lot of working spaces that are directly accessible from the street.
By using the two stair cases for the work floors the work spaces on the upper floors are accessible as well.
The dwellers use the other two stair cases in the building. With these stair cases they will only access the floors where the dwellings are located.
The principle of the routing in this building is with an inner hallway, witch is open to the outside on the top floors, that house dwellings.

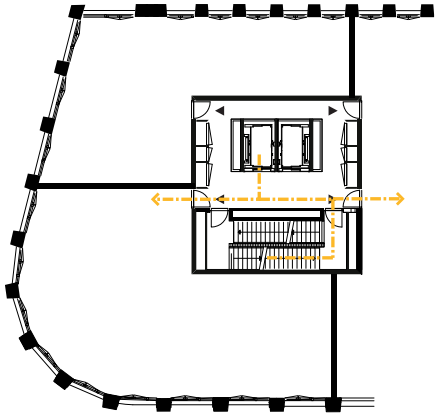
routing werken
routing wonen

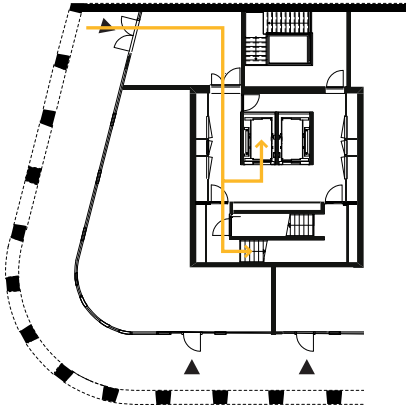
Solid 1 & 2

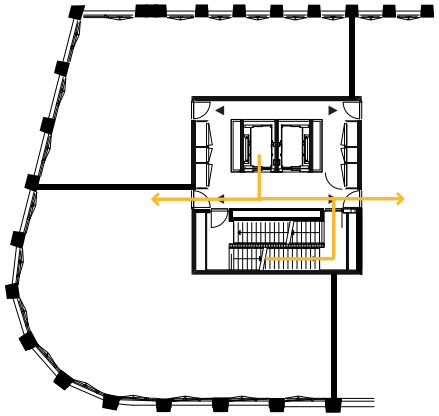
The building consists of two main volumes. From the public space there are a couple of entrances to a semi private innerspace. On the ground floor commercial spaces are located, that are accessable directly from the inner space.
From this semi public space the dwellers and visitors are able to access the buildings above the commercial plinth.
Here they will be confronted with a zone where the vertical traffic is located. This zone is accessable by a portico. In this portico two elevators and a staircase are located. When you arrive on the work/live floor the portico accesses two spaces. The open floors of the spaces make the space very flexible, and therefore the dweller is completely free to design his own house.

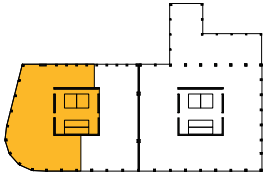












routing werken

routing wonen

This building is designed completely following the solid principles. Which means that living and working can be completely mixed in the building.
The ground floor is the only part of the building that is an exception to that. By giving the ground floor a very high ceiling this floor is particularly designed for working spaces.
The upper floors are all accessible by one of the two stair cases that are located on both ends of the building.
When people enter the portico they take the stairs or the elevator to the floor they have to be at. From there they directly enter the dwelling or working space.
The size of these spaces can be changed by placing the inner walls differently, which makes it possible that a big office space and two small dwellings are located on the same floor.

Canal house

The entrance of the canal houses is usually higher than the streetlevel. This has multiple reasons.
The basement is the lowest level of the building, and is placed into the ground by half a floor height.

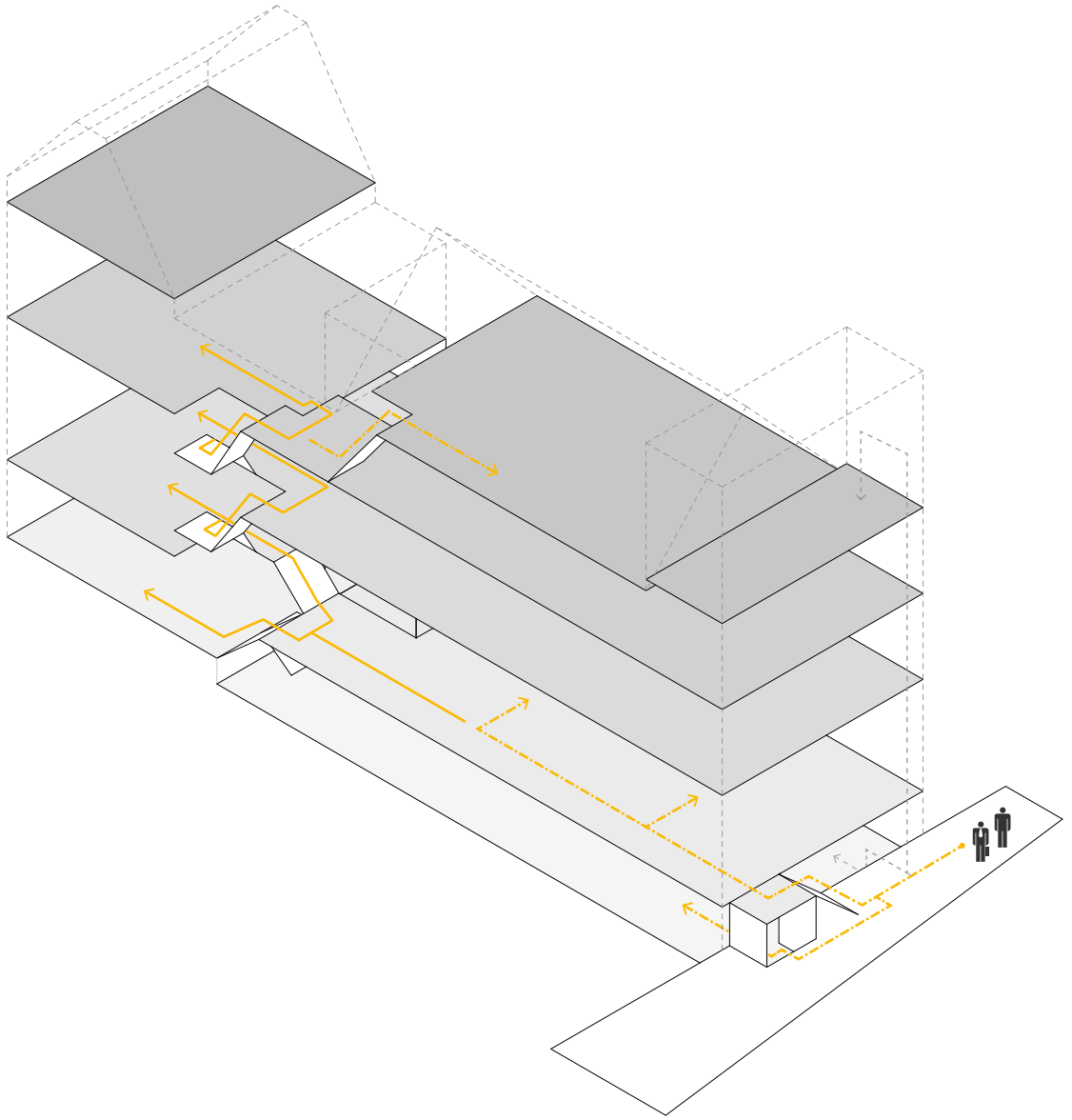
This had to do with the ground water level in Amsterdam, which made a completely sinked basement almost impossible.
For the routing this layout was also very convenient.
When the building was used as a commercial space, this floor was used as a storage space.

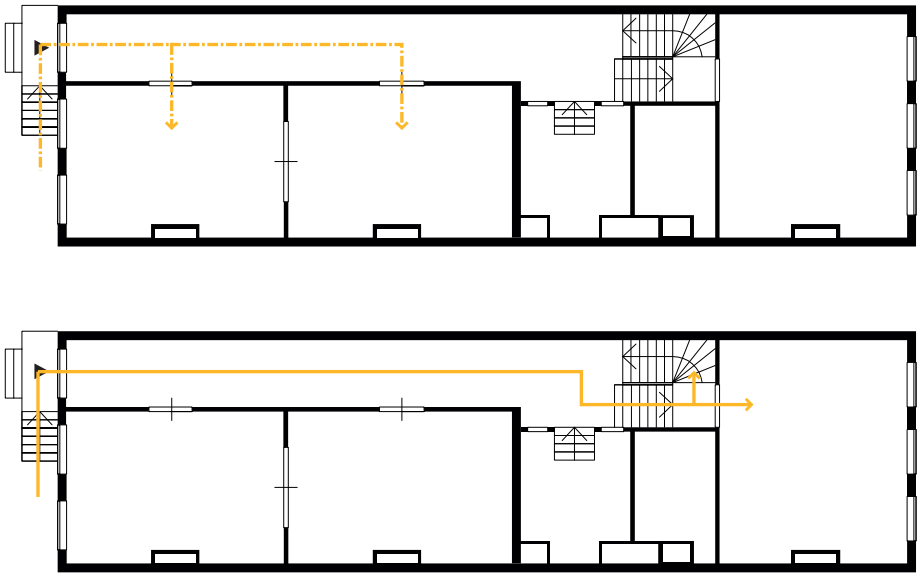
Because the basement was lowered halfway under the street level it could have hatches on the steet level to transport the goods in and out of the building.
On the piano nobile (bel-etage) the main entrance was located.
This creates a semi private space that creates a distance between the public steet and the private dwelling.

Most of the houses, during the time that the canal houses were built, had a very simple routing, and were also shops or warehouses.

Because the buildings had a narrow and long shape, an organisation of the working area in the front of the building, and the living in the back was common.
This living area was often separated from the working area by a staircase. It was lifted up a bit from the front of the building.

The upper floors, usually not more than three or four above street level, could be working areas as well as dwelling spaces.



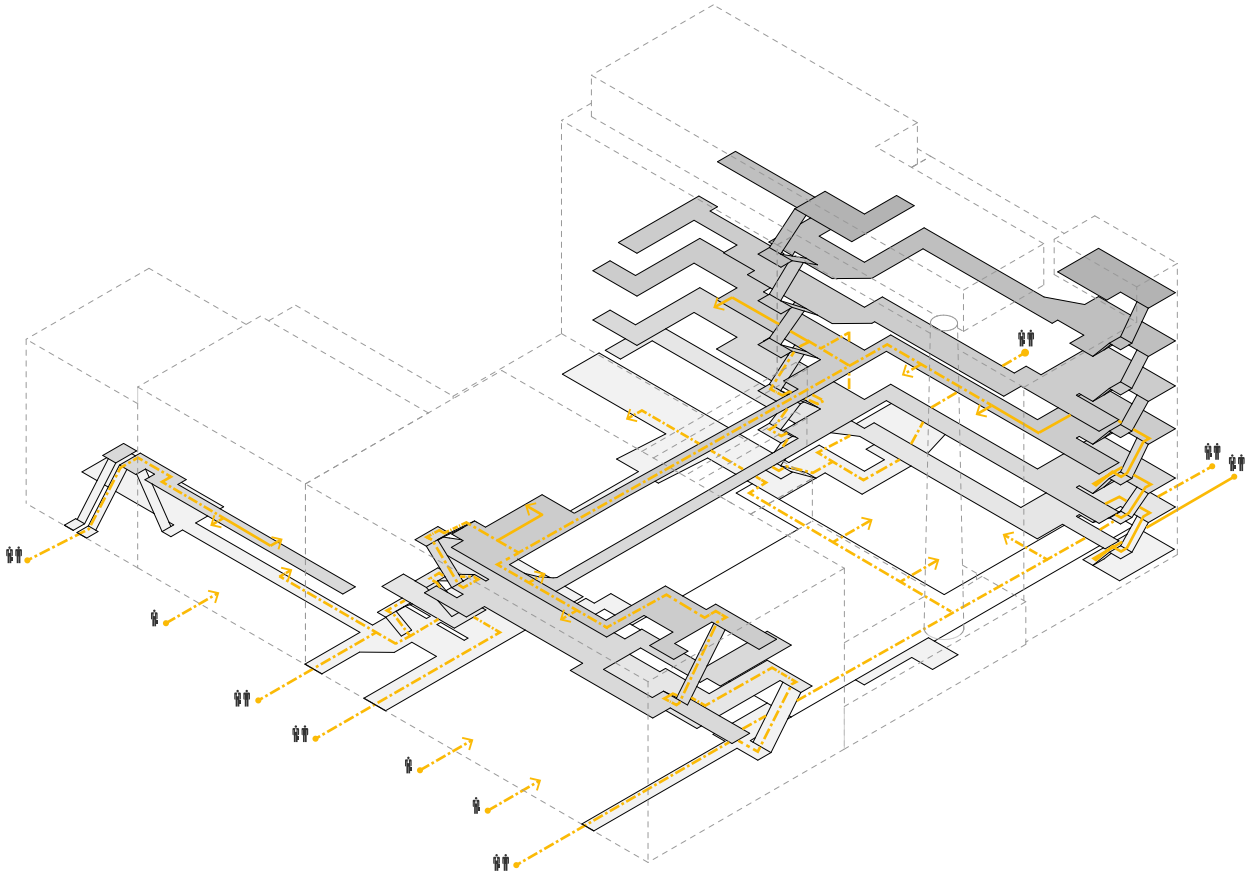


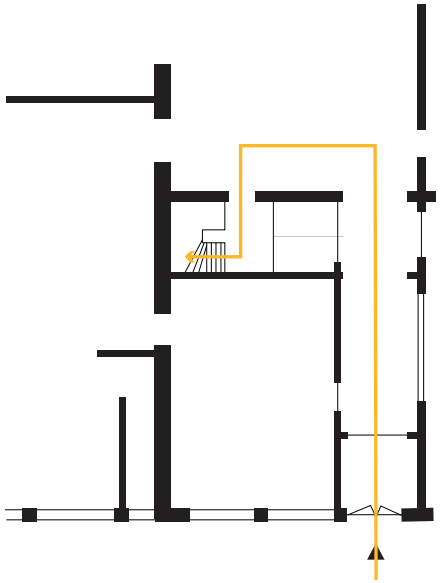
The schemes on the left clearly show that the routing to the work spaces, and the routing to the living spaces are crossing each other in this building.
The canal houses were of course designed to be only a dwelling, but by its high ceiling, and big rooms it was often used as a work function as well.
Because the building had a basement that was accessible from the street it was very easy to load goods into the building.
The work route was the same as the living route in the building. When the building houses a public work function like a shop this was mostly located in the first two rooms of the building. This kept the living spaces, which were located at the back of the building separated from the public.
What helps to separate the two functions is the staircase that is located in between the front part of the house, and the back part which was the more private part.

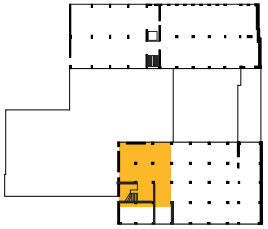
Tetterode

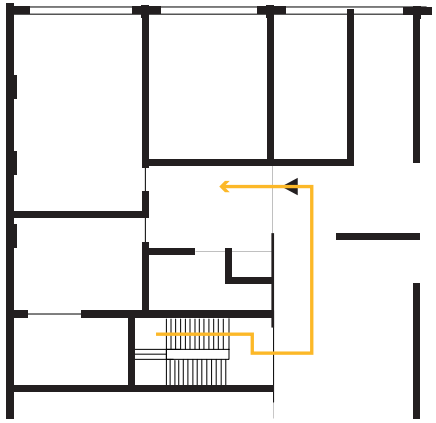
The Tetterode complex is accessible from two streets. Each side has two main entrances that lead to the vertical elevation points and the inner courtyard. (The entrance to the court is part of the closed scheme of the facade). The programmatic functions on ground level have their own entrances. There are a total of four vertical stairways inside the three buildings.

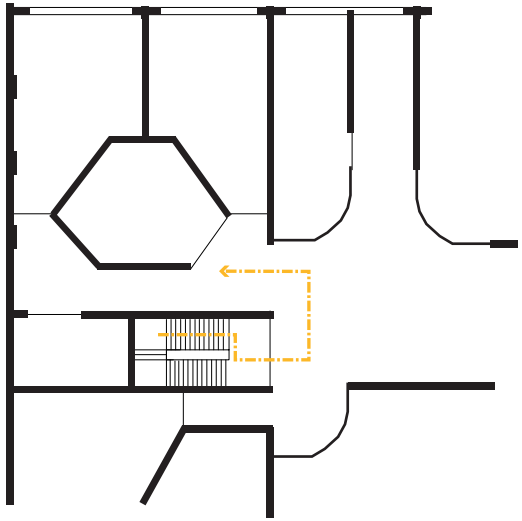
The ground level of the buildings is connected by the courtyard and a corridor system. The upper floors are accessible by the stairways and connected by two floating walkways. These walkways connect the corridors in the 'middle' of each floor, and make circulation from one street side to the other possible. The living and work spaces on the upper levels can be reached by one of the four entrances on street level or one of the four entrances in the courtyard and are accessed from the staircases at the end of the inner corridors.









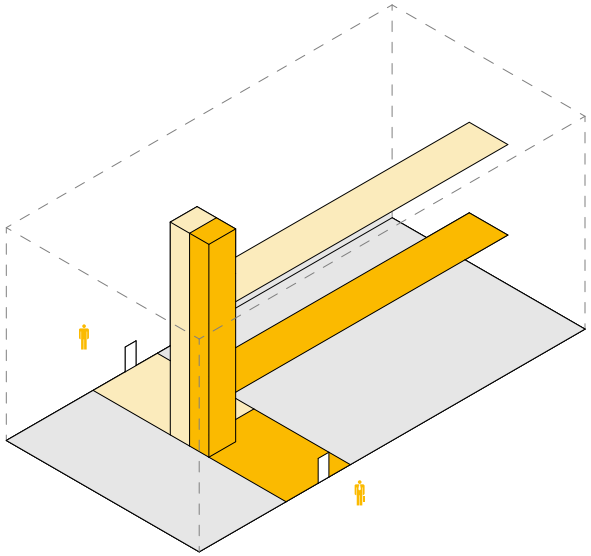


The schemes on the left show a typical route from the street towards a dwelling unit or work space on one of the upper floors. The commercial functions on the ground floor are accessible from the street.

What is clear is that there is only a single route that leads from the street towards the corridor on the upper floors. This means both the dwellers and the business owners use the same circulation space. Once in the corridor each function has its own front door to access the internal space.

routing werken

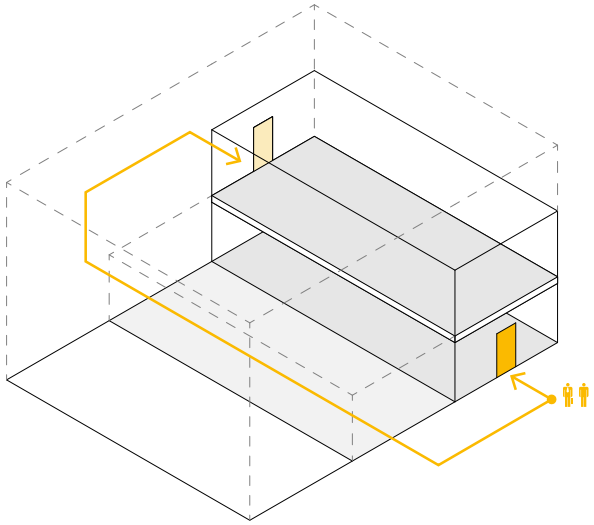
routing wonen



Summary scheme Multifunk

As with the structural system, the routing is organised around the two program groups: work spaces and housing. In the 'main' part of the building this system is applied to the fullest.

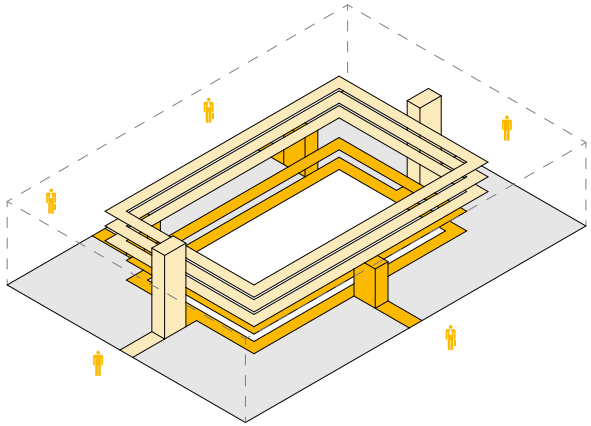
Both the transportation cores (one on each end) are accessible from either side of the building. The 'front' entrance is open to the public and provides access to a single elevator that leads to the floors with work spaces. The 'back' entrance is accessible only for dwellers and leads to an elevator and staircase that provide access to the dwelling floors. Most important is the corridor floor with front doors to the two-storey maisonettes.



Summary scheme Vrijburcht

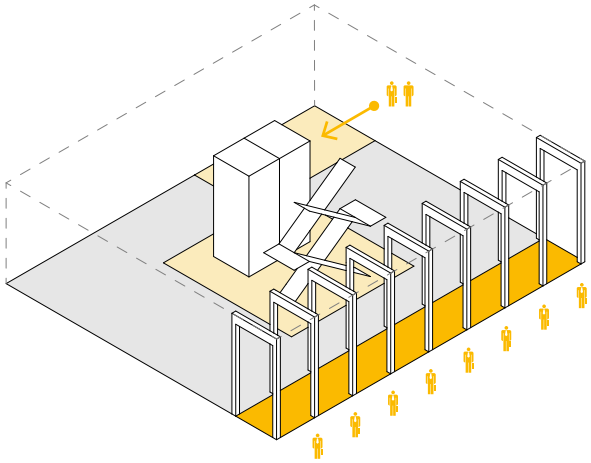
In the project of Vrijburcht the different dwellings are accessible from a complex system of galleries that run around the inner courtyard. Different housing typologies use different access systems like portico's.

The distinction between the routing for housing and the one for work spaces is visible in a specific type of dwelling that occurs several times in the building. The commercial space is accessible from the outside of the building on ground level. The official front door of the dwelling however is located on the first floor along the gallery around the inner court. The dweller can access the courtyard through a series of passageways and use either a staircase or elevator to reach the galleries.



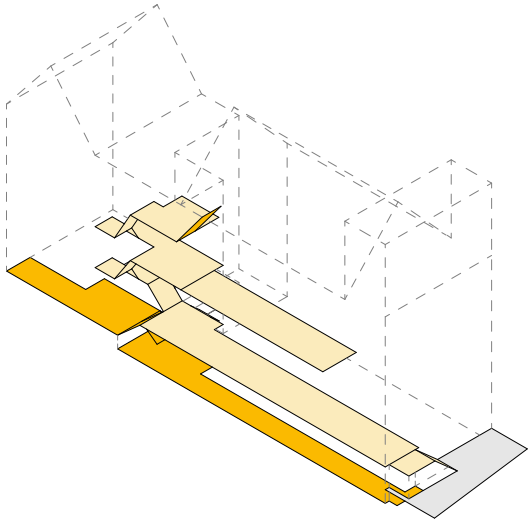
Summary scheme Solid 18

In Solid 18 the two routes are very strictly separated. The commercial program is limited to the ground and first floors and is accessible on ground level from the outside and on the first floor from an interior gallery. The transportation cores that lead to these floors only go up two levels and do not reach the dwelling floors. The dwelling floors are accessible from interior galleries around the courtyard that can be reached by two transportation cores on the other sides of the building.



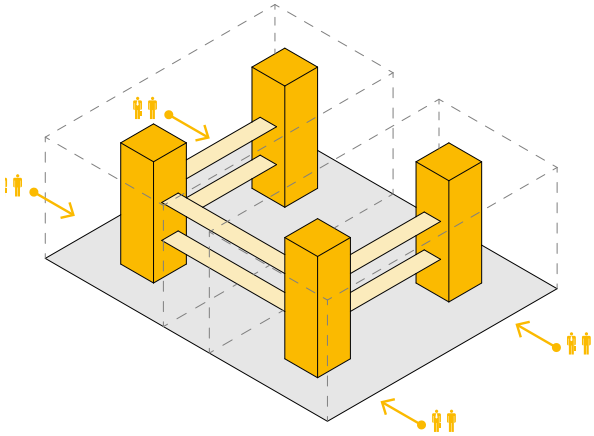
Summary scheme Solid 1 & 2

The routing in Solid 1 & 2 is devided into two specific elements. On the ground floor there is a clear distinction between the collonade that provides direct access to the commercial spaces on street level, and the two cores that lead up to the higher floors. The collonade is aimed purely at clients for the program on the ground floor.
To reach the commercial spaces as well as the dwelling units on the higher floors the same route is used by both employees, clients and dwellers. In this case the routing is intertwined.



Summary scheme Canal house

The routing inside canal houses is different nowadays from the original use in the 17th and 18th centuries. Originally the basement was used by the household staff and for storage of trading goods. The attic as well was used for storage.
The main hallway that goes from the front door all the way to the back house gives access to the adjacent rooms. A central staircase between the front house and the back house leads to the upper floors.



Summary scheme Tetterode

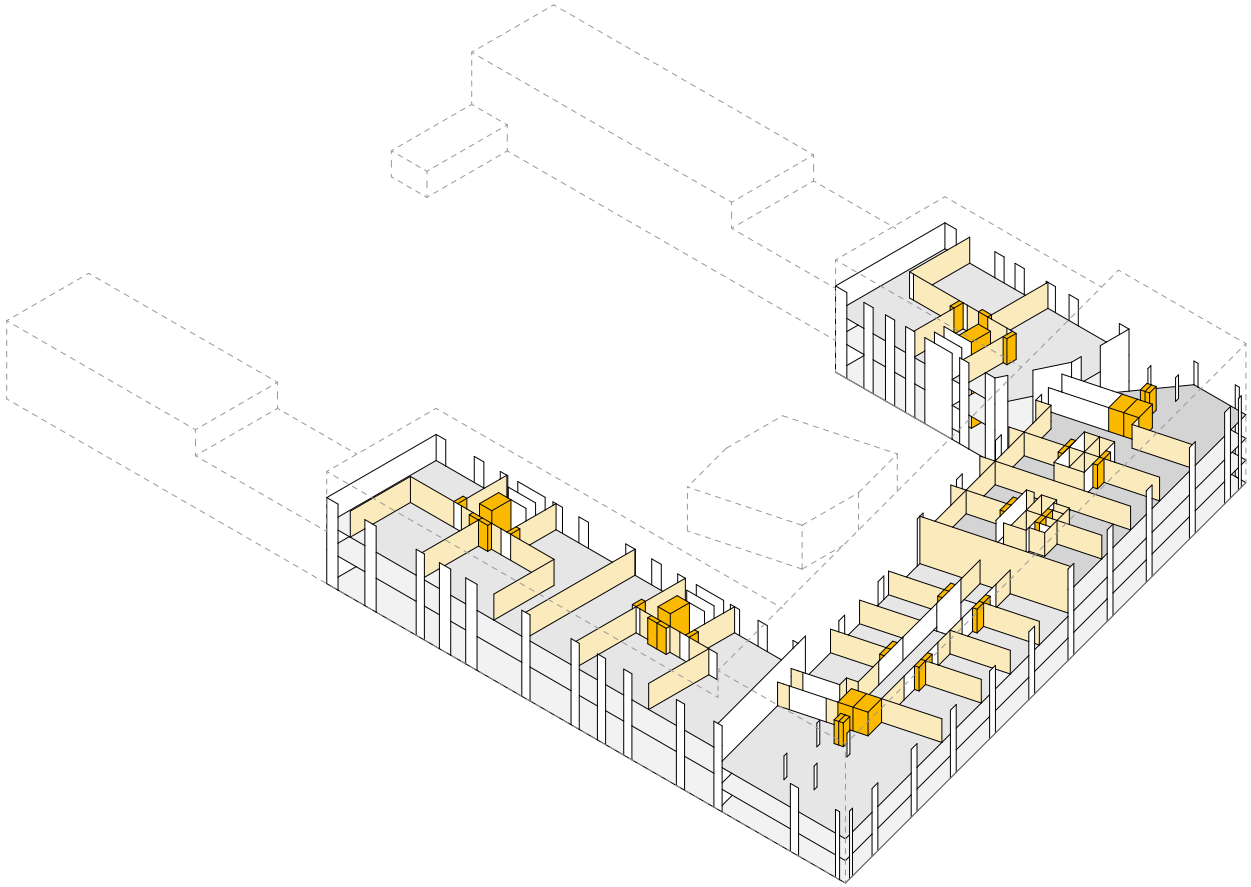
The routing system of the Tetterode building complex consists of central corridors that are connected to eachother by three vertical circulation cores. The entrances to these cores from the street are accessible for both dwellers and business owners or employees. The commercial functions on the ground floor have their own entrances.

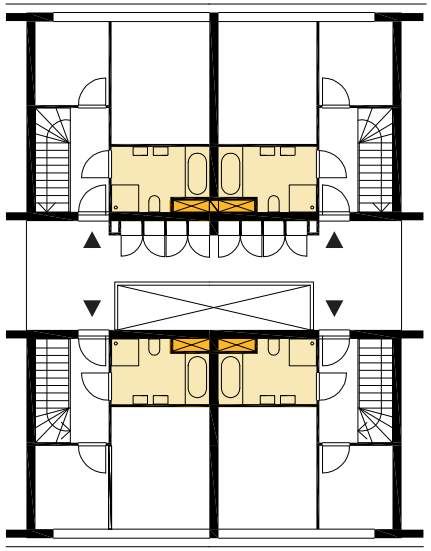
Adding services to a building is often a big challenge. Often service ducts are designed to serve one specific use that the spaces are designed for.
The size of service ducts is here of course important, but also the placement in the building.
A question can be whether you, designing a flexible building that has to accomodate different functions, should integrate the different disciplines or separate them.
For example, should services be cast into the structure, or just kept free from the structure? Why are old warehouses often able to get a second life with a completely different function? Is it the ability of adding services because of the large heights?
Large spans, for example, lead to free floor plans but also often need beams in two directions that give big problems with the horizontal distribution of the services.
All dwelling need service ducts, so should you place those ducts in the center of a building to facilitate a lot of dwellings, or keep the ducts at the core of the building to keep the floor plan as clean as possible?
These are all questions that have to be studied by looking at case studies.

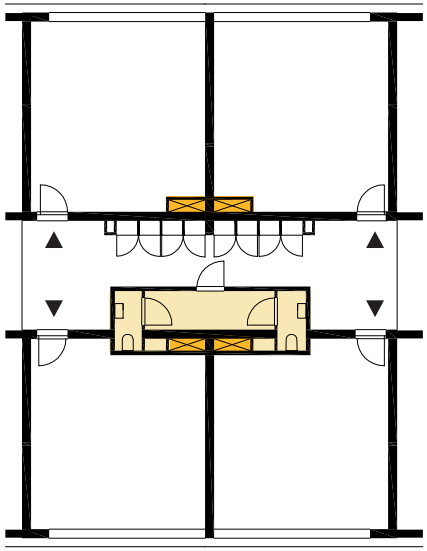
Multifunk

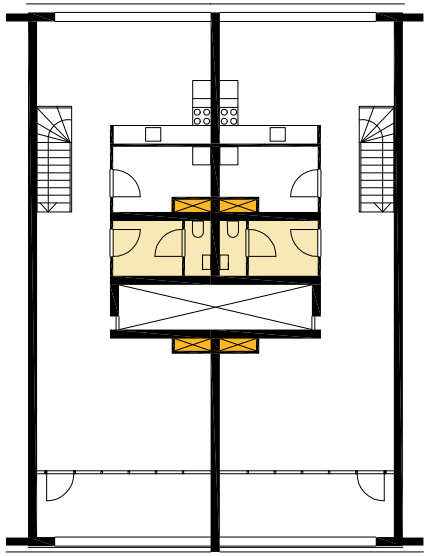
The building is designed looking at the different demands of offices and dwellings. Both functions had other demands in structure and escape routes, but the difference in the demands for installations are probably the most extreme.
The solution in this design is that they designed a building with very few installations.
By skipping the installations where posible, the flexibility could be increased. A crucial point here is the heat load of the office functions.
By adding sun shading and natural ventilation in the facade, an expensive and inflexible ventilation system was not necessary.

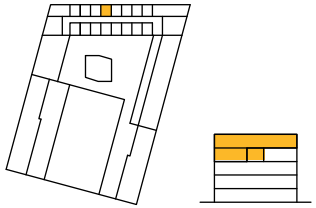
To make the building able to change through time, and therefore change office spaces to work spaces, but also change the complete layout of these spaces, a network of installations had to be created.
The architects designed the building with floors that span from the facade to the structural slabs in the middle of the building, which made beams in the cross direction not nessecary.
This had the advantage that the architects could easily realise an installation zone in the length of the building, connecting to the eight installation cores that are created in the building.
These shafts are also overdimensioned to be able to handle a transformation of the program.











The building has a maximum freedom inside the dwelling because the only load bearing elements are placed in the facade and in the slabs in the middle of the dwelling. This enables the dweller to place the inner walls just as he prefers.

On the left you see three schemes.
On the left the floors are used as a maisonette dwelling where people access their dwelling through a corridor.
On the level of the corridor the bedrooms are located, and with a stair the dweller goes (up or down, depending on the maisonette) to the living area.

On the right you see the same floor organised as an office space. The space that is a void on the dwelling floor plan has now become a toilet unit.
The functions that need installations in the dwelling and in the work spaces are both organised around the same service shafts.

changable walls

solid walls

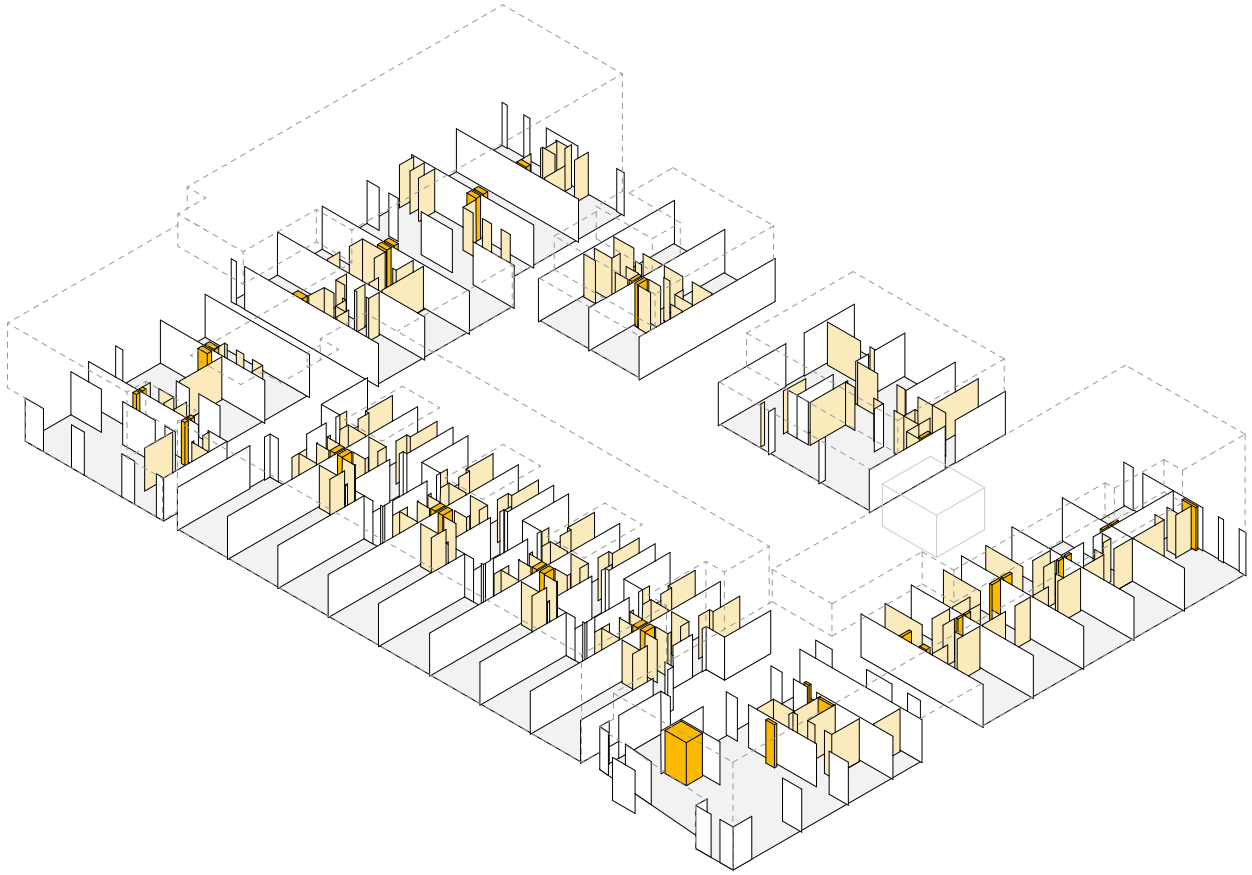
(elevator) schaft

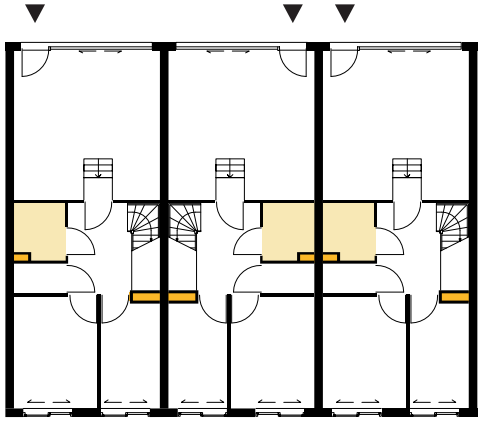
Vrijburcht

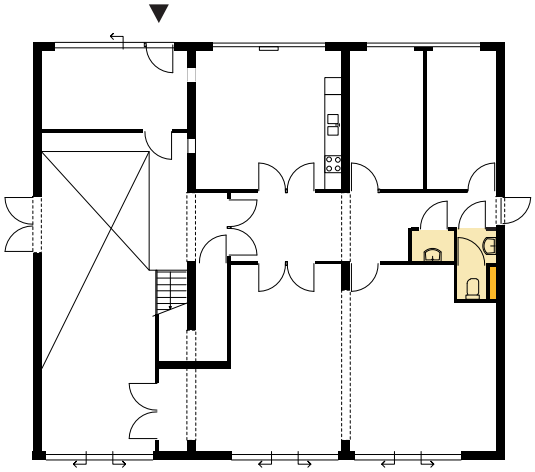
The flexibility in the design of Vrijburcht is mainly on the level of the dwelling. The building is designed looking at all the different needs of the people that signed up for a house, but the internal organisation in the houses is designed flexibly. This asks for an open floor plan in the houses, which the architect made possible by combining the installation shafts and the stairs, both elements that are not flexible.

In the drawing on the right you see the load bearing walls that are white, and the flexible inner walls that are light orange.
What becomes clear looking at the drawing is that the dark orange cores are placed next to the load bearing walls. This keeps the floorplan of the dwelling as open as possible.

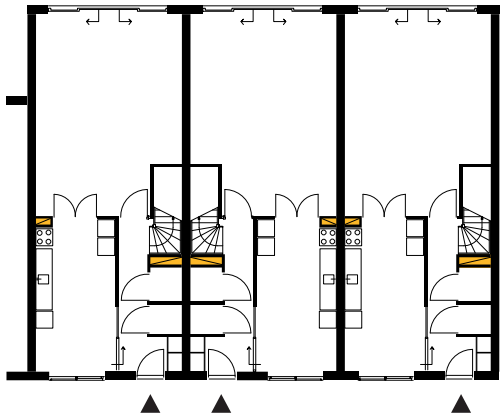
What is also important to see is the different places of the service ducts in the theater and the day care center.
In the theater one big service duct is placed, which contradicts with the idea that the theater must be able to house dwellings in the future.
In the day care center some more service ducts are placed, which allows it to become dwellings over time.







Looking at the service ducts in the Vrijburcht building it becomes clear that the building is not a very flexible building. When we looked at the structure of vrijburcht we noticed that a dwelling grid was used for the dwellings and the work spaces. This provided the building with the possibility to change the work spaces into dwellings and vice versa.
Howver, the services are designed on very different ways in the work and dwelling units.
The dwelling units have service ducts connected to the bathrooms and toilets, giving the dwelling the flexibility to change the inner walls.
But the work spaces and the child day care do not need a lot of shafts and the architect did not design them. This makes it very difficult to change the work spaces into dwellings.



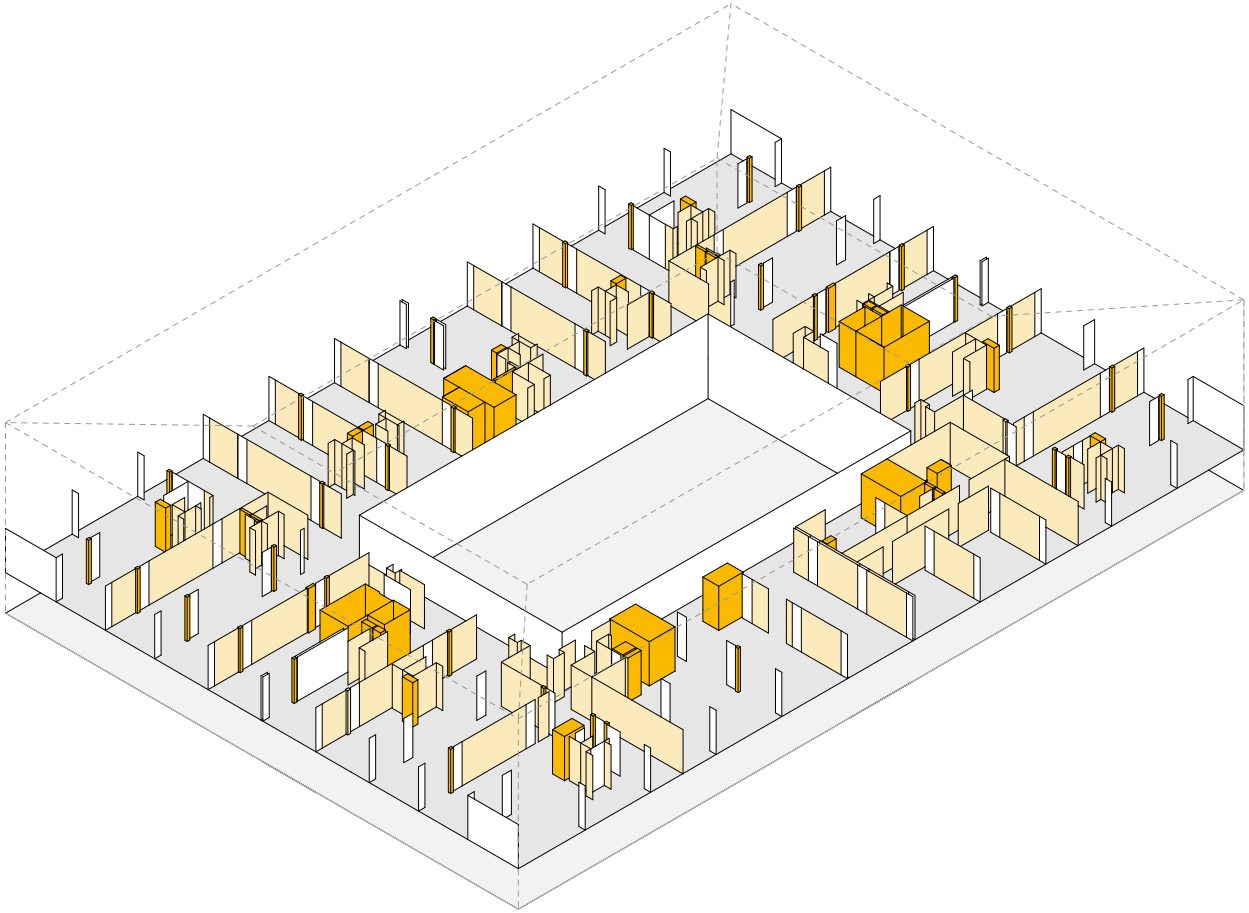
changable walls
solid walls
(elevator) schaft

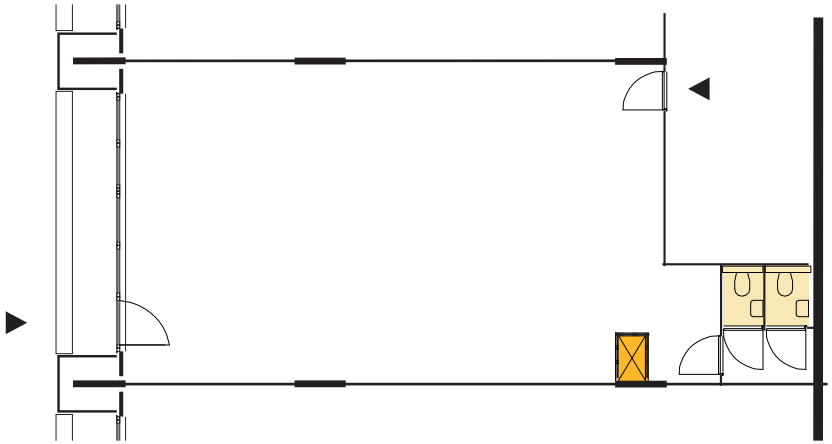
Solid 18

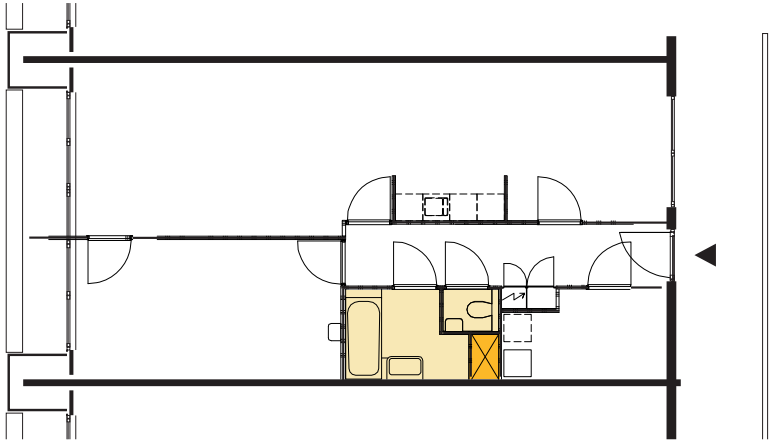
The solid has two completely different types of structure: on the first two floors a column system and on the floors above a system with load bearing walls. This gave the architects the problem of where to plan the services. The open floor plans have a different ideal layout for the service ducts than the upper floor plans.

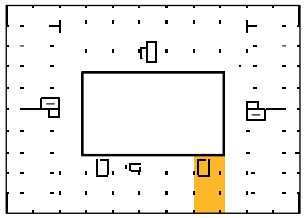
The architects have placed the survice ducts on the upper floors next to the load bearing walls. This enables the dwellers to design the interior of its own dwelling completely as they want.

On the first two floors this means that in the grid system of the colomns also service ducts are situated. Because these ducts are not exactly located next to a load bearing element in the first two floors, the ducts decrease the flexibility in the first two floors.
The possibility of creating offices and retail spaces of all sizes is still possible, but with the positioning of spaces they have to take into account that the shafts should not be in the middle of the office or retail space. The service ducts here limit the flexibility in that way.









Looking at the place of the service ducts the dwellings with the structural slabs are clearly the dominant functions. The service ducts are placed in the bathroom here to keep the dwellings as flexible as possible.
The work spaces on the ground floor have a different structural layout, so the ducts do not fit very smoothly into these work spaces. On the upper scheme you can see that the service ducts are blocking the open ground floor a bit, which is often resolved by using it to hide the toilet blocks.

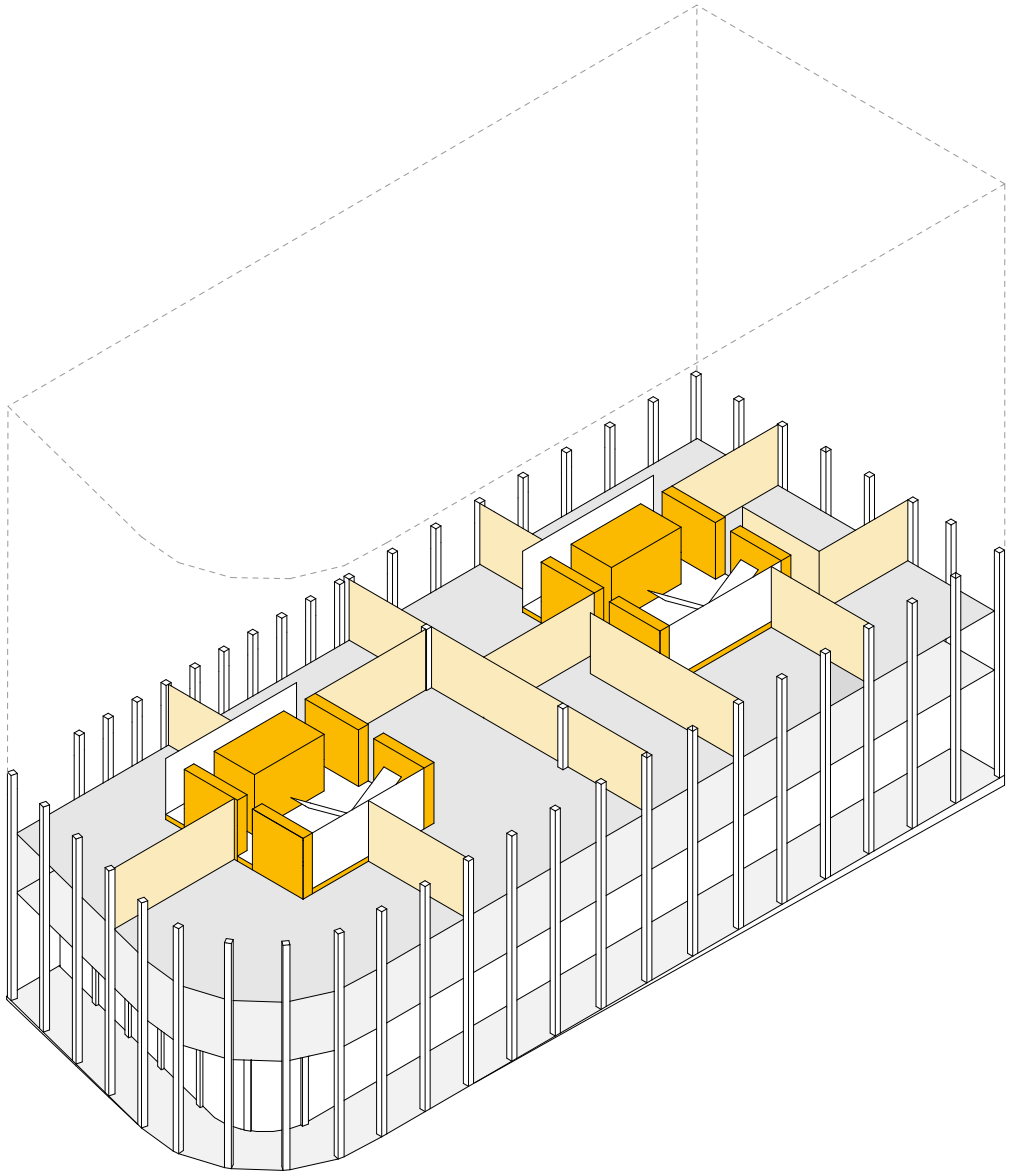
changable walls
solid walls
(elevator) schaft

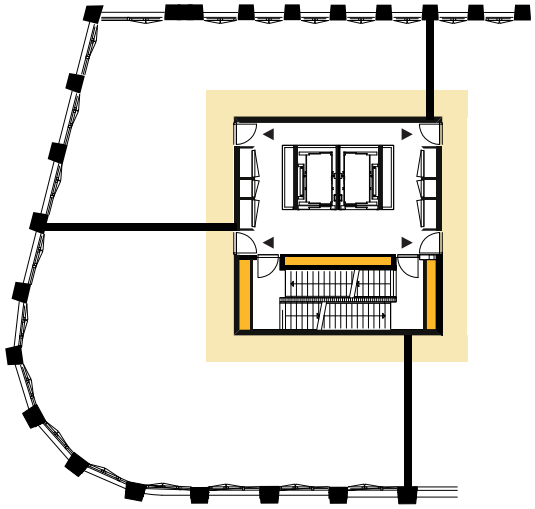
Solid 1 & 2

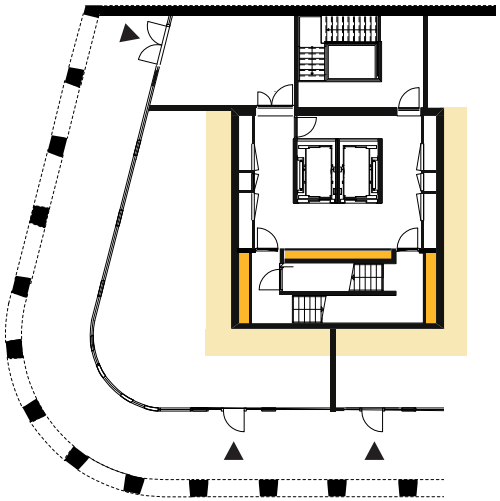
Around the central shaft that contains all the supporting functions, an area in the floor is created where all the service pipes are placed.
This raised slab of 180 mm contains all the connections to different installations such as fresh water, gas, sewerage, electricity and data cables. All around the core these connections are placed in order to allow for many different organisations of program on each floor.

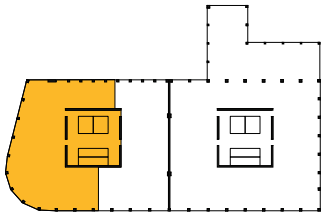
The tenants themselves are responsible for connecting their fixtures to the installation core.

Because of this central cluster of installations the floor plan is left completely open for internal organisation by the users.









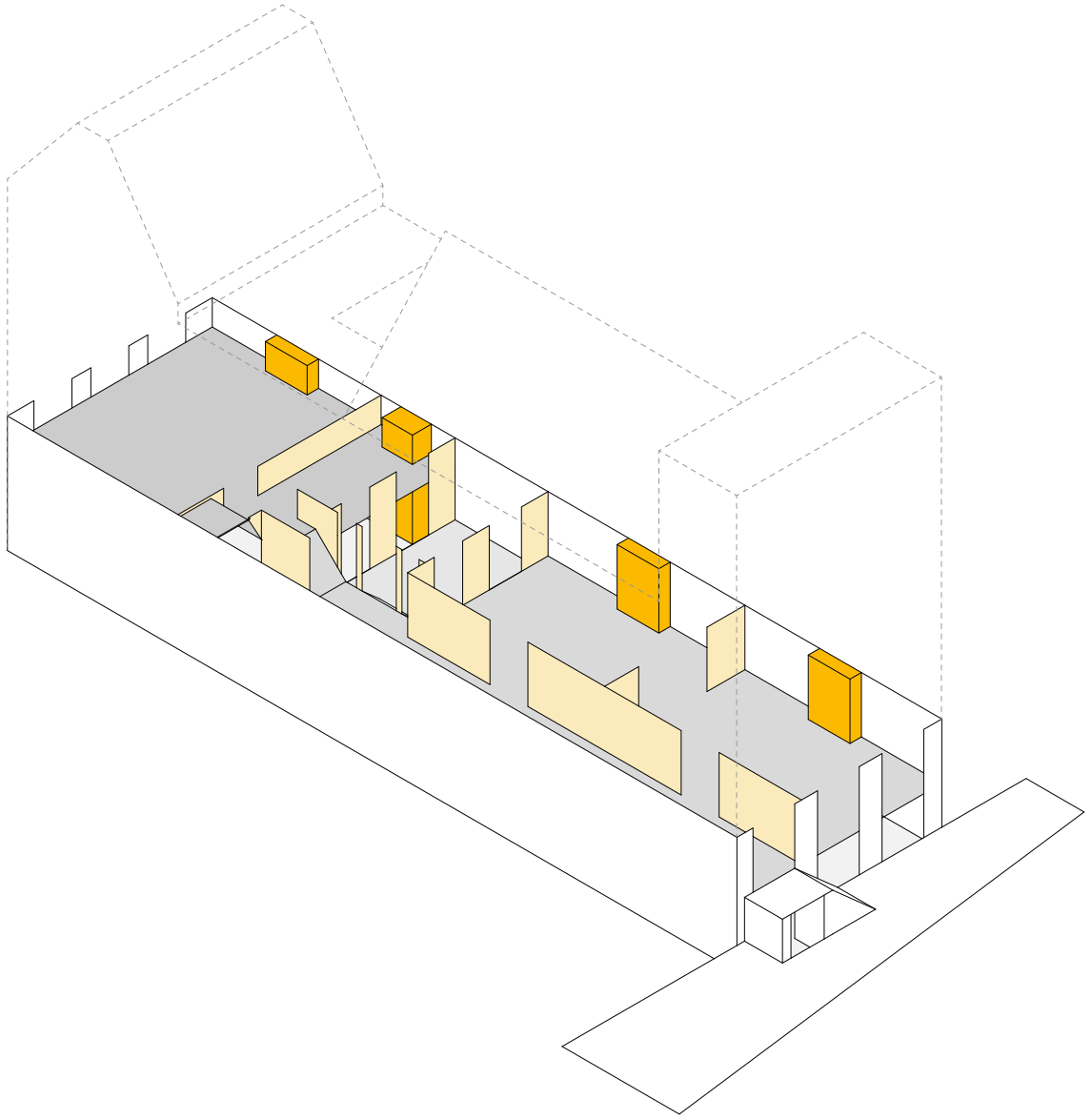
The concept of the solid was to be able to change the complete layout around the routing core. This means that all the vertical service ducts had to be in that central core.
This is done by placing a shaft to the staircase, and the elevator shaft.
To be able to change the amount of dwellings or working spaces the meter cupboards had to be outside the dwellings as well.
The closets that are left open in the schemes on the left contain the meter cupboards that belong to the dwellings on that floor.
To be able to design your own dwelling in the building the dwellers should be able to change the place of their bathroom as well. This gave a lot of programmatic problems. Because normally a shaft is attached to the bathroom.
In this building the floor is a bit higher in the first four meters around the central routing core where a service area is located.
This gives the dweller the freedom to place the bathroom and kitchen etc. in every place around the core they want.

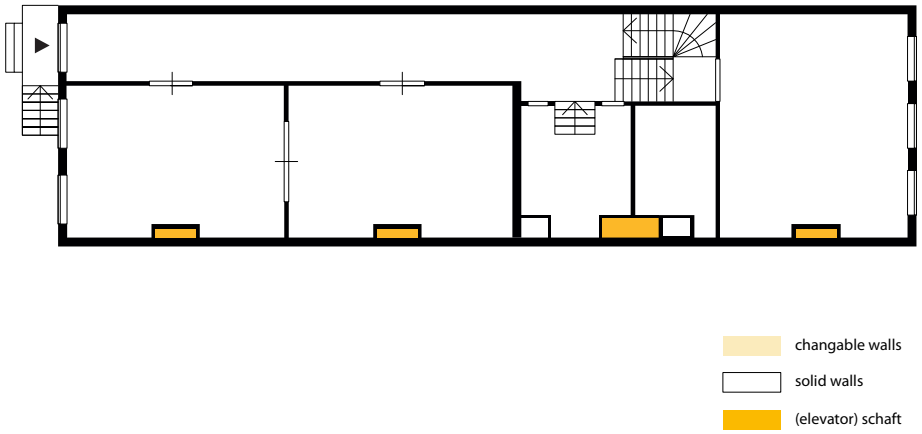
changable walls
solid walls
(elevator) schaft

Canal house

The stucture of the canal houses is very rigid. The houses are devided in three different zones. The outer two function as residential areas, and the middle area functions as a service area.
In this erea the service elements are located, like the bathroom and toilets on the upper floors, and the stairs on all floors.

In the older canal houses, that are build in the 17th century this area contains often one service shaft.
The toilet, bathroom and kitchen are concentrated around this shaft.



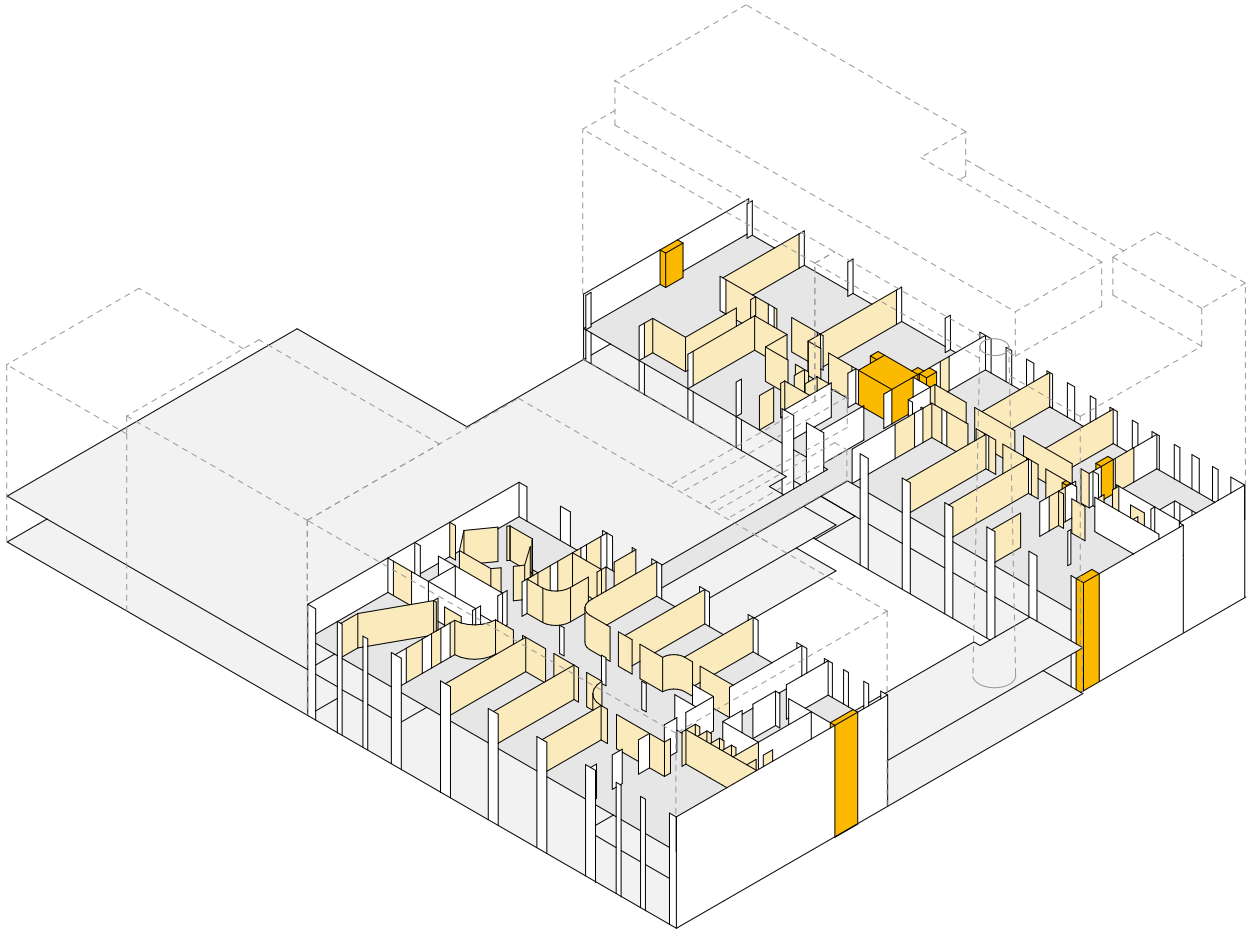


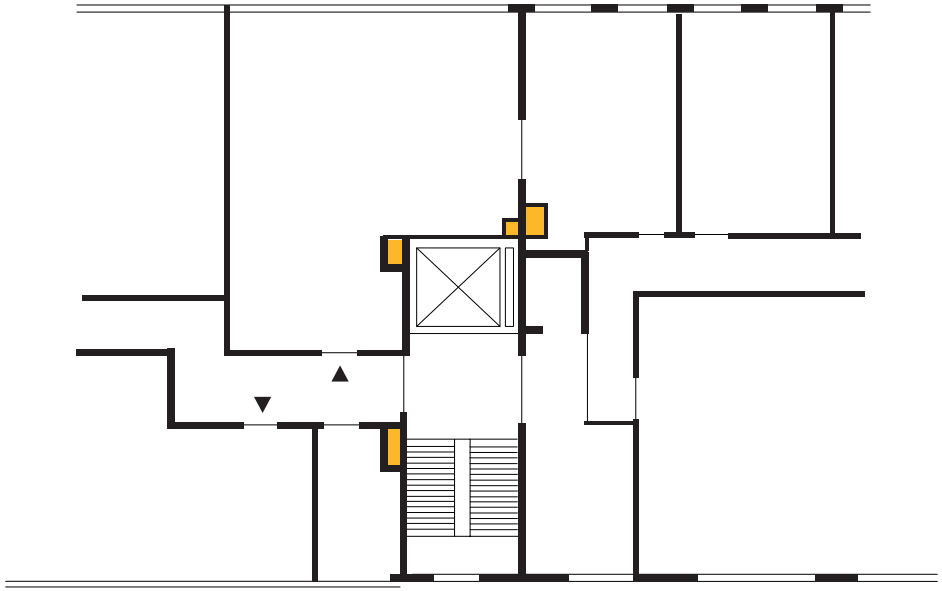
The canal houses are the oldest buildings that we analyse. And one of the earliest examples of buildings that could house different functions. One of the important aspects of this flexibility was that the building had fire places in all the rooms. This gave the dweller the option to turn every room into a sleeping room, working room or dining room for example.
The last 100 years the toilets and bathrooms became more and more important, and these functions had to be integrated into the dwelling itself.
What the schemes show is that every room had its own fireplace, and in the middle of the dwelling a service duct was placed.
Because the canal houses are on a different scale that the other examples, this duct is more that enough for a service duct nowadays.

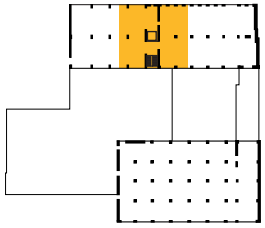
Tetterode

The dark orange color shows the fixed shafts in Tetterode. The elevator shafts are situated in the middle of the three buildings. These structural cores, shown in white, are the places where the services are situated.

The changeable configuration of each floor is illustrated by the light orange color. These walls are not solid and adjustable depending on the configuration on that specific floor. The separating walls that divide the work and living places have in common that they are all in line with the structural columns in the facades. This principle is used in all the three buildings. The width and shape of the corridor in the middle is various.







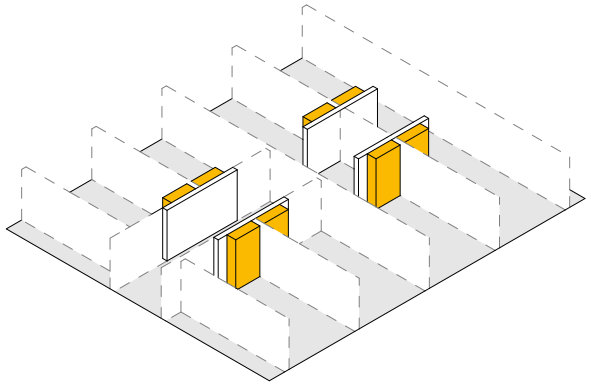
The grouping of installation shafts around the structural grid is illustrated in the scheme on the left. In this typical floor plan the service ducts are clearly connected to one of the structural elements, either the elevator core or a structural column.

By connecting the installations to the structural system the Tetterode complex retains most of its flexible character.

changable walls

solid walls

(elevator) schaft

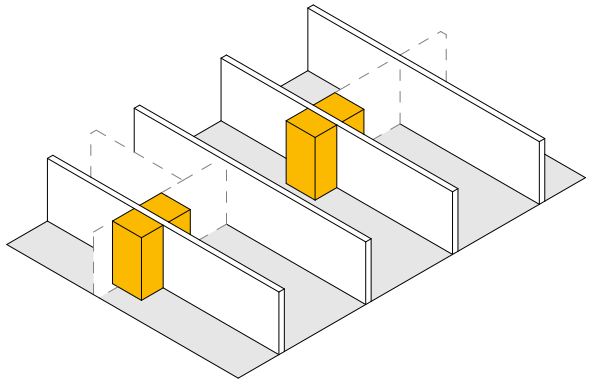


Summary scheme Multifunk

The service cores are, like the structural system, organised in a way that allows maximum flexibility. The cores are situated next to the structural slabs in the middle section of the building and make possible a wide range of interior compartmentalisation.

On the work floors a corridor is created with entrances to the different businesses. These businesses can use as much floor space as desired.

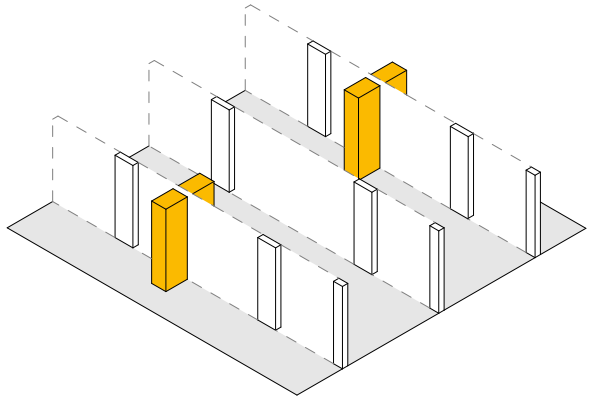
On the dwelling floors the area between the structural slabs is used for service spaces. The remaining floor space is devided by partition walls to create dwellings that run from facade to facade.



Summary scheme Vrijburcht

The service cores in Vrijburcht are organised in a way that is typical for housing. Two cores are situated back-to-back on either side of a load bearing wall and service the two dwellings on each side. In this way the next wall does not need a service core.

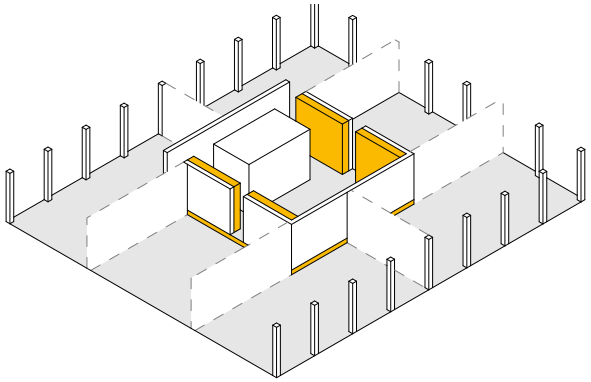
Interior walls can be added in between the structural walls, but wider dwelling floor plans are virtually impossible because of the fixed walls.



Summary scheme Solid 18

The service cores in Solid 18 are organised in a similar way to that of Vrijburcht. Shafts on either side of a load bearing wall or line of structural elements. Each core services the floor space on its side of the construction. On the ground and first floors this can also mean a larger program that uses several service cores.

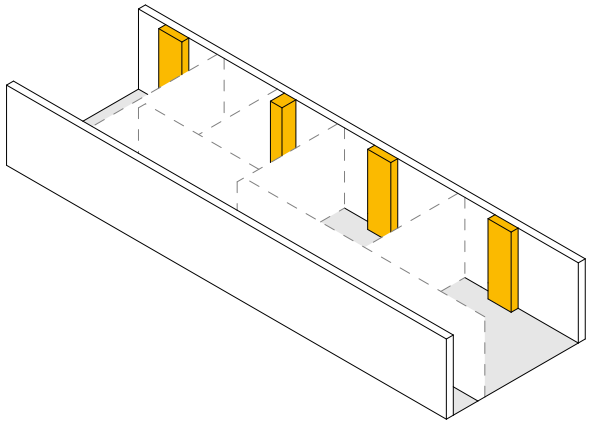
The position of the shafts is derived from the dwelling floor plans on the upper three floors. As a result of the bathroom and toilet spaces the shafts run down vertically and do not connect directly to the structural system. Because of this extra ‘fixed’ elements are addes to the lower floors that can restrict the flexible use of the space.



Summary scheme Solid 1 & 2

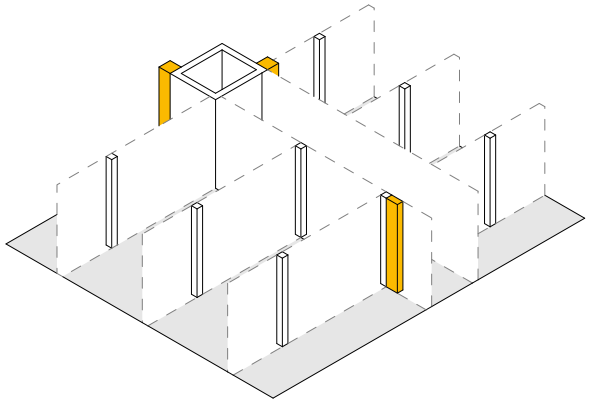
The service concept of Solid 1 & 2 is very similar to the routing scheme. A single core with installation shafts runs through the center of the floor plan from basement to rooftop. All main installations are placed against the walls of this core and can be accessed from all sides if needed.

The floor inside the service core is also raised in comparison to the floor space around it. Because of this the functions that occupy a specific space can use the electricity network or floor heating that has connection points along the edge of this raised floor. Users can decide themselves where to put their installation system inside their rented space.



Summary scheme Canal house

The canal house is an exception when it comes to the organization of services because of the fact that many of todays installations were not yet invented at the time of construction of these houses. The main installation features that were taken into account during the design of canal housing were heating and sewerage.
Heating was done by fireplaces at several different places inside the dwelling. These shafts ran all the way from the basement up to the attic, where the brick and sometimes metal pipes gave off heat to the adjacent rooms. Nowadays the fireplaces are more for show than for heating.
Because of the placement of the fireplaces as well as the toilets against the load bearing walls, the inner dividing walls can be placed randomly inside the floor plan.



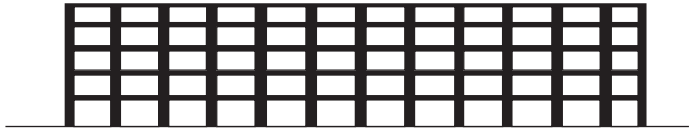
Summary scheme Tetterode

The shafts in Tetterode are situated against the structural walls and columns and around the vertical circulation system. The space of each floor has an open layout which is made possible through the structural elements in the facades and the placement of the installation services. The internal walls are in line with these structure elements but can be taken out to create larger spaces when needed.

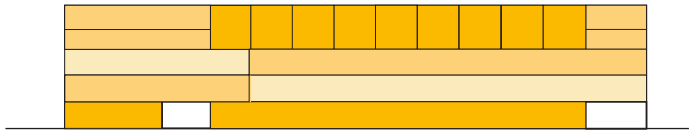
The last theme is the skin of the building.
The skin is very important in the flexibility of the building. Many buildings are designed by the term form follows function. This means in terms of the skin that the facade is a reaction on the functions that are behind it.
Sleeping for example has other demands on the amount of sunlight that has to enter the room than an office space. The same is true for a bathroom and an office space in terms of visibility inside and out.
To create a building that is changeable, and can accommodate different functions the skin has to be able to react on that function change as well.
In the case studies we want to investigate how the facades of multifunctional buildings handle the different functions that are behind it, and if they enable the possiblility to house a completely different function.

Multifunk

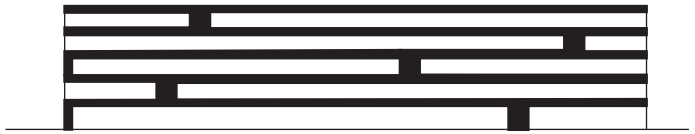
The facade plays a very important role in the design of Multifunk. Where the facade looks like a non bearing facade from a distance, it actually works as a load bearing stuctural elment. This creates a building with less structural elments, which in turn creates more flexibility.
The facade of Multifunk is built up in a couple of layers. The first layer is the load bearing structure. This structure consists off a grid of slabs that are 1,2 meters wide, and are placed every 8,2 meters.
This grid is completely separate from the program that is behind it, to be able to change the program completely.
To create a facade that is able to react on every change in the program, the architect decided to make a horizontal grid in the facade that hides the structural elements in some parts and shows them in others. This allows the architects to connect a room dividing wall on every place in the facade.
To give the building a more diverse look than the normal office buildings, the architects used a couple of different infills in the openings in the facade.
They used panels in different colours, and a couple of different window types. This infill completes the facade, designed as a structural facade, that is able to adapt to every change in program.



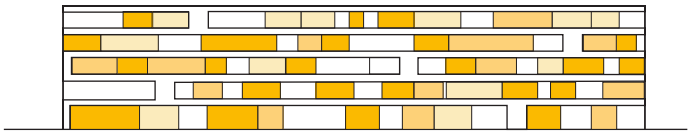
load bearing structure



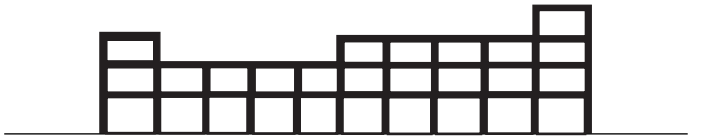
program



open/ closed

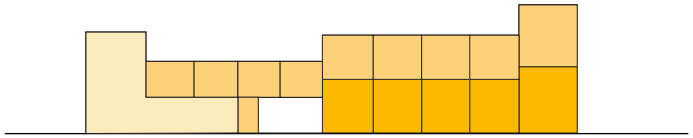


diversity facade openings



load bearing structure

structure



program

living
living & working
theater

open/ closed

facade
openings

diversity facade openings

normal windows
etalage windows
adjustments
walkway

Vrijburcht

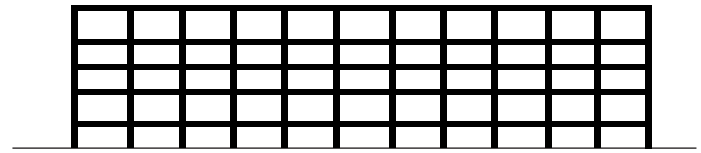
Vrijburcht is designed as a slab construction structure. The load bearing stucture is completely seperated from the facade.
The program in this complex also allows the building to have a rigid stucture, because different functions are clearly seperated in both a vertical and horizontal way.
The facade that is placed in front of the load bearing structure gives the building one overall look.
Looking at the atelier dwellings and the theater, both located at the street, both functions have exactly the same window openings in the facade while both functions have completely different demands on entrances and the light that has to come in.
This overal look that is repeated over the complete facade gives the building some flexibility. The architects looked at the demands that dwellings have on a facade, and repeated this openings in front of every function in the facade.
This makes it possible to change the theater and day care center to housing in time.

Solid 18

The stucture in Solid 18 is very rigid. The only difference in structure is the different height of the floors. The ground floor has a height of 3 meters, and the first floor is 4 meters high.
The second and third floors are both 3 meters high, and the top floor, the fourth floor, is again 4 meters high. This differentiaton in height is a way to let the people outside think that there are different functions, just like normally is the case of a solid.
But in this solid the program is organised on different layers. All the floors are a bit overdimensioned, so the floors with the dwellings can also be changed into workspaces. The size, and height of the first two floors are clearly designed to house office functions.

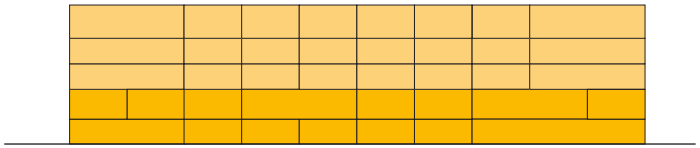
Looking at the open and closed parts of the facade, it becomes clear that the architect has played with the sizes of the columns in the facade.
When you compare the open/closed diagram with the load bearing structure it becomes clear that this is purely a design decision.
The architects wanted to highlight a diversity of functions in the building, by giving the facade some subtile differences.

Looking at the diversity in the facade and its openings the only floor that is different in the appearance of the facade is the first floor. Here big windows are placed at the outside of the structural elements in the facade, while at the other openings the glass is placed at the inside of the structure, to create a balcony.
Again this is done to create the idea of differentiation in functions, while in reality the ground floor houses offices as well.



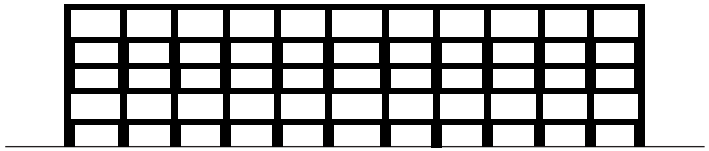
structure

load bearing structure



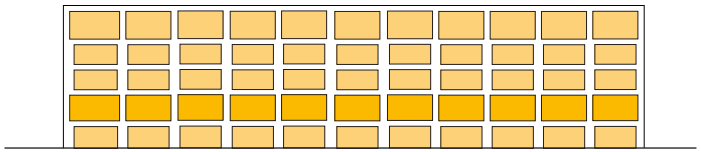
living
working

program



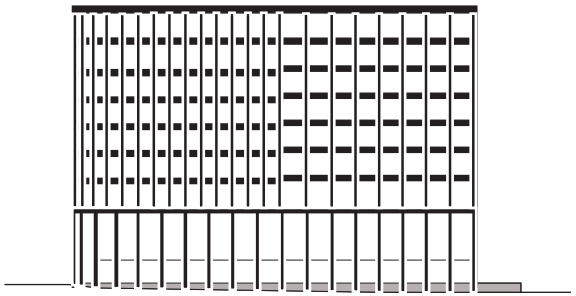
facade
openings

open/closed

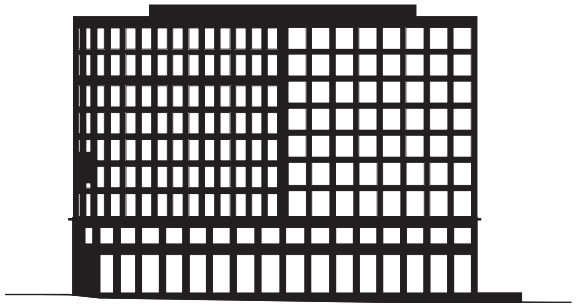


normal windows
etalage windows

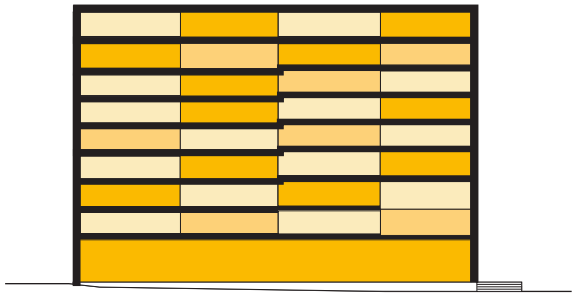
diversity facade openings



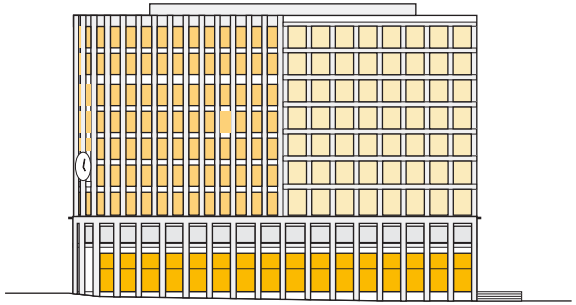
load bearing structure



open/closed



program



diversity facade openings

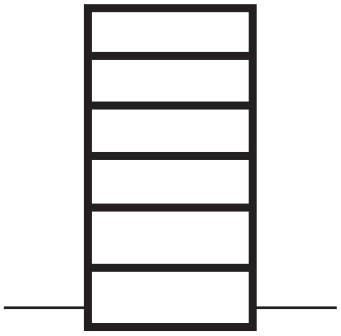
Solid 1 & 2

One of the key aspects of solids is that the buildings are built to last at least 200 years.
This is why the architects have chosen materials that will stay beautiful when they become older.
The facade of Solid 1 & 2 consists of a rigid and regular system of piers, inbetween which glass facades are placed.
This gives the building a classisistic and anonimous image. The facade does not reveal what function is behind it. The only differentation in the facade comes from the different floor heights.
The ground floor is four meters high and the floors above it vary between 2,95 and 3,50 meters high.

To keep the floors as free and flexible as possible the architect decided to place the construction in the facade.
In front of that construction, the building is wrapped with white natural stone. This skin that is placed in front of the stucture is organised in such a rigid structure that it shows the load bearing function of the facade.

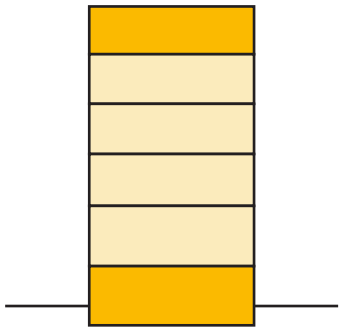
Canal house

The canal houses have changed function countless times during their existence though with no apparent effect on their outward appearance.
Amsterdam has been a live/work city for 350 years where both dwelling and working are continually changing character and location, while the outward appearance, the facades and entrances, remain the same.
Very typical for the canal houses is the high entrance. This provided a stately and beautiful entrance to the house, and also created a direct way to the basement by some hatches on street level.
The canal houses are all overdimensioned in size. This gives the buildings the possiblility to adapt to new functions. The facade is a very rigid and static facade. But the big floor hights are also visible on the outside of the building. The canal houses have large windows, that provide the rooms behind it with enough light for every function possible.
By using a material that will age nicely, and using large windows, no matter what function is behind it, the facade is able to handle every function change in the building.

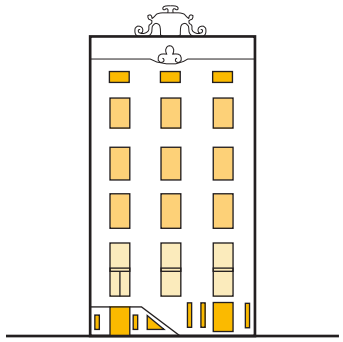


load bearing structure

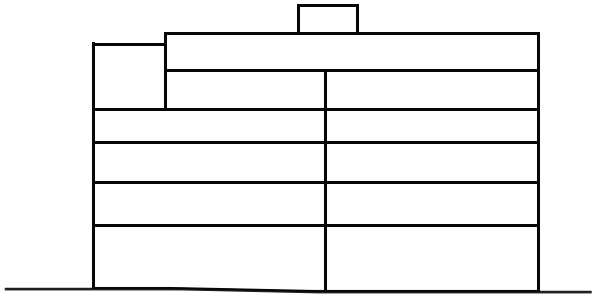
open/closed



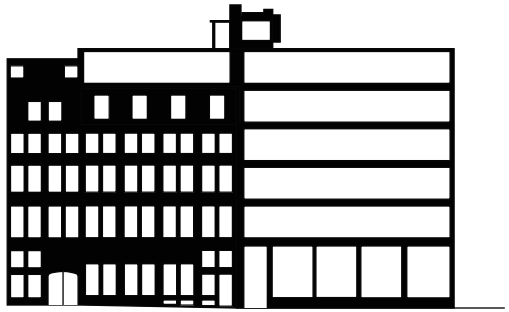
program



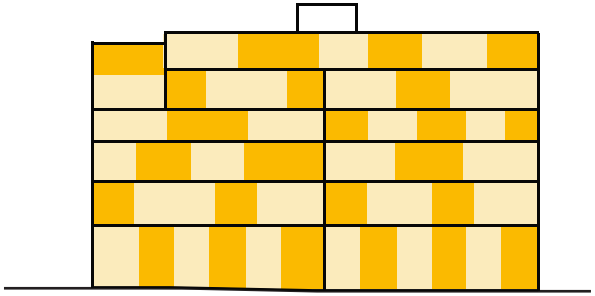
diversity facade openings



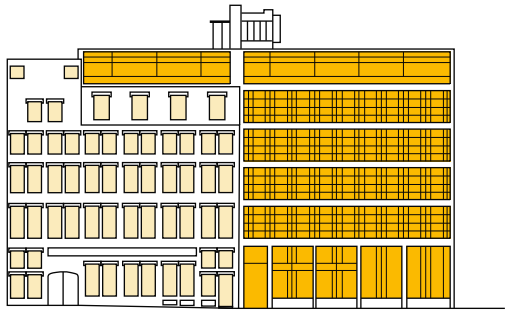
load bearing structure



open/closed



program

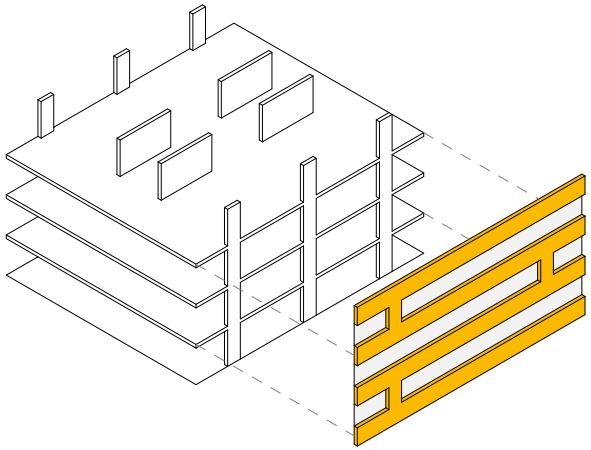


diversity facade openings

structure
facade
openings
living
working
original building - 1901
extention - 1950

Tetterode

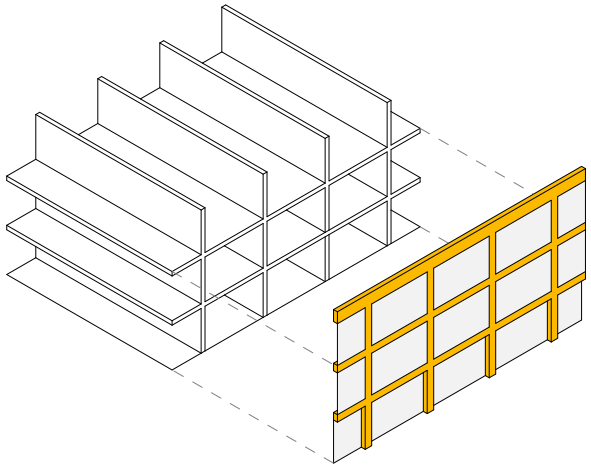
What becomes clear looking at the facade of Tetterode is that the building consists out of several different buildings. It was an old factory that grew by adding extensions over time. This extension took over the same structure of the old building, so in the scheme of the load bearing structure you can hardly see this separation.
However, looking at the open and closed parts of the building you clearly see the differences. Between the old part of the factory, and the new part with a lot of glass and less closed parts in the facade.
Both parts of the building use a column structure, so the facade just has to carry its own weight. Both facades are very different, but use a very repetitive grid.
This is one of the aspects that makes the Tetterode building as flexible as it is. By giving the building a clear grid with a lot of windows it is easier to change the program behind it and still give it enough window openings. Looking at the facade you see two different buildings, but inside the building a lot of different functions are located. The facade does not reveale what function is behind it.



Summary scheme Multifunk

Because of the possibility to place walls freely on each floor the facade of Multifunk is designed to be diverse, depending on the program behind it.
This has resulted in a horizontally oriented facade with large window strips.

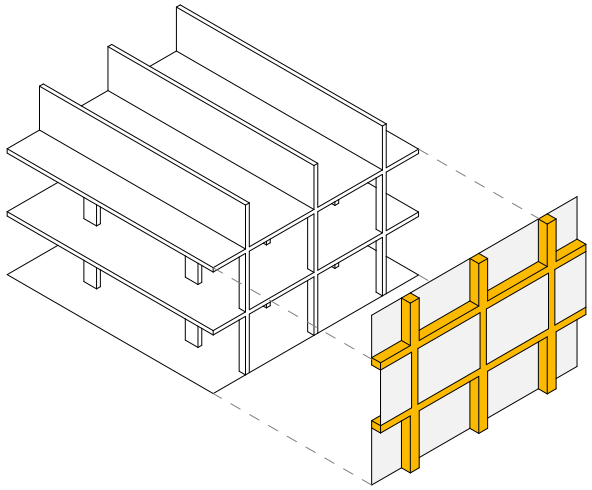
What is interesting is that the underlying construction is hidden behind this horizontal composition. Several vertical connections in the facade reflect the structural columns, but the others are integrated in the lines that devide the transparant part.
The ground floor is left completely open with no vertical facade elements.



Summary scheme Vrijburcht

The facade of Vrijburcht is rather straight forward. Transparant parts follow the spaces behind and create large windows from floor to ceiling. The structural system is reflected clearly in the facade composition.

The difference in program between the ground floor and the upper two floors is very slightly noticeable in the texture of the facade. On the ground floor the windows are set back a little from the facade to indicate the work spaces behind. On the floors above the windows are placed in the same line as the facade.

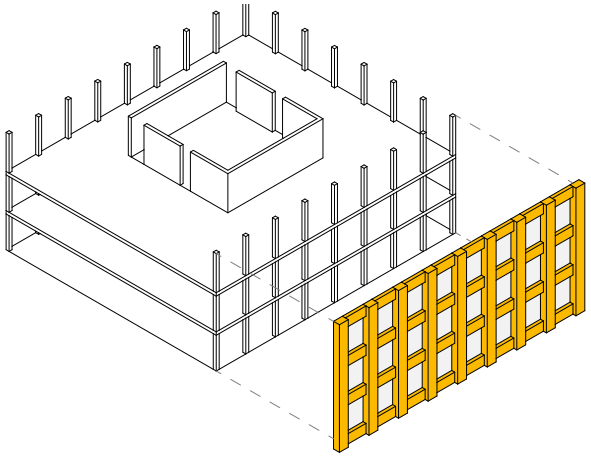


Summary scheme Solid 18

The facade composition of Solid 18 seems to reflect directly the structural grid behind it. On closer inspection it is visible that there are several differences within the composition.

The larger floor height of the first two floors is reflected in the facade and the transparant parts are kept as large as possible between the construction.

On the first and upper floor an exception is made. The vertical elements here are thinner than on the other floors. Additionally on the first floor the windows are placed in line with the facade, suggesting a difference in program behind it. This is not the case however.

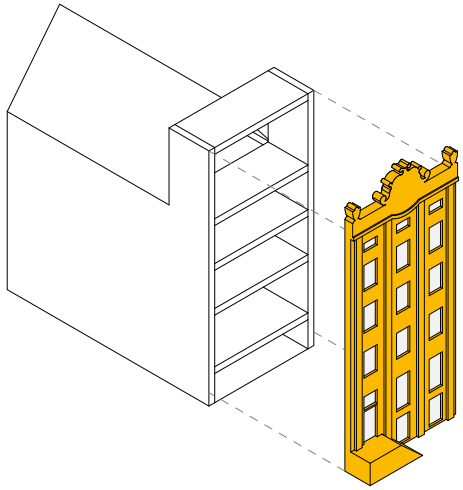


Summary scheme Solid 1 & 2

Because the building was developed as a solid, the functional program was unknown until after the completion of the building. This means the facade was designed without a specific program in mind.

To create an attractive facade the architect decided to use natural stone in a classical, vertically oriented facade composition. These materials should age without deteriorating and thereby ensure a long period of use.

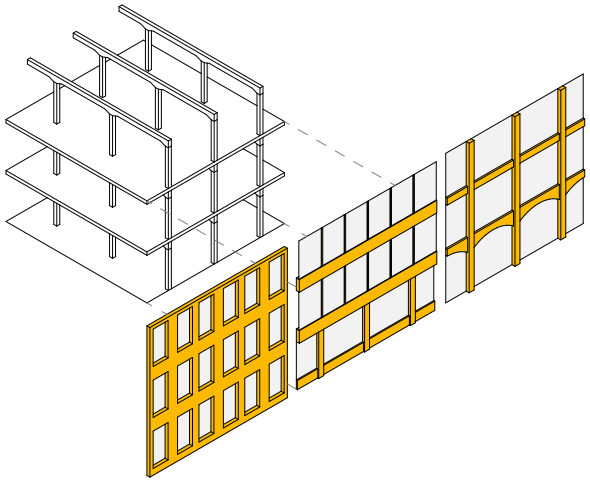
The facade composition reflects the load bearing structural grid and is a simple mesh of vertical columns in front of horizontal strips.



Summary scheme Canal house

As with the structural system the facade also had restrictions that limited for example the size of glass windows. The facade has to carry its own weight and is divided into three vertical bands. The expression of the facade is based on the style of Louis XVI.

Because of the large windows the spaces behind the facade get plenty of sunlight, even though the canal houses are usually very deep. This allows many different functions to be placed inside the building.



Summary scheme Tetterode

The Tetterode building consists of three different parts, constructed in different time periods. This results in three completely different facade compositions.

However, the structural system behind the facades of all three buildings is nearly identical. This means the facade is completely separated from the construction.

General conclusion

To answer the research question formulated in the introduction of this booklet we first look at the individual conclusions of each theme. By doing this it is possible to get an overview of all the aspects that we have analysed before we try to give an overall answer.

Program
The only two buildings that have the functions mixed completely horizontally and vertically are solid 1&2 en Tetterode.
A very important factor for this programmatic organisation of different functions is the circulation system in the two buildings.
Both buildings let the two different functions use the same circulation system. Therefore, both buildings have no preset programmatic layout.
This gives the people the freedom to decide their own location in the building.

Structure
At Multifunk and Solid 1&2 the structure is running along the facades, and in the inner core of the buildings. This gives the buildings the opportunity to place the internal walls wherever they want, making it suitable for different kinds of functions.
Even although a building as Tetterode is not even designed as a flexible mixed use building it still is. This is due to the oversized column system that the old factory had, and the very big floorheights, that make it suitable for different kinds of programs.

Routing
All the analysed buildings have different kinds of routing systems. However, there are two main groups. Multifunk, Solid 18 and Vrijburcht completely separate the working and living routes.
The Canal house, Solid 1&2, and Tetterode combine the living and working routings in the same circulation system.
Looking at what buildings are the most popular and work best, you can conclude that combining the two routes and giving the dweller the freedom to fill in the functional layout, works best.

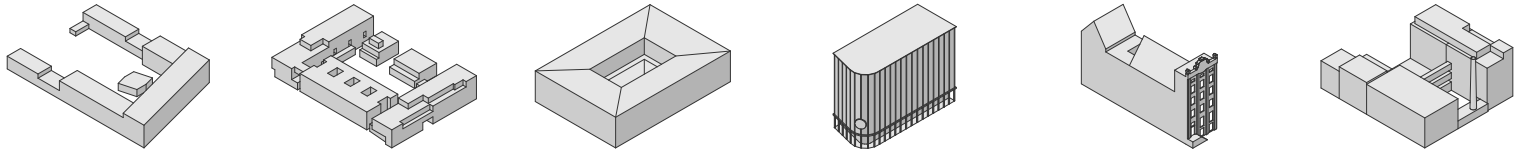
Services
Looking at buildings like Vrijburcht and Solid 18 it becomes clear that services can limit a building in its suitability for mixed use.
Both buildings have a mixed-use program now, but wil not be able to change this program, because the service ducts will not allow different kinds of functions. The concept of Solid 1&2, where the service cores are placed on the corners of the circulation system, allows the most different types of layouts and functions in the floor plans.
The way the cores are connected to the load bearing slabs inside Multifunk also gives the dweller a lot of freedom in size en program.

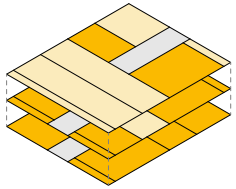
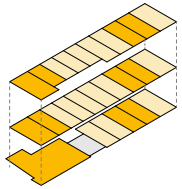
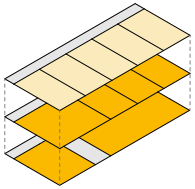
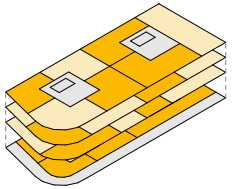
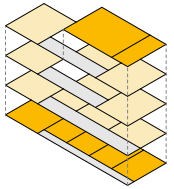
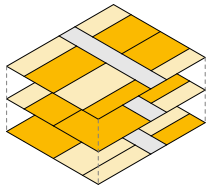
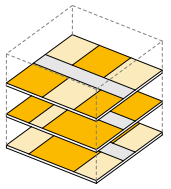
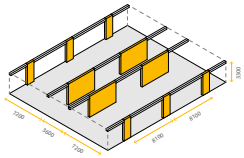
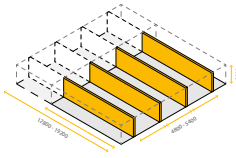
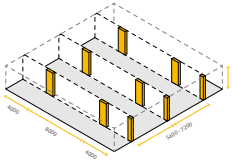
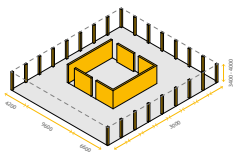
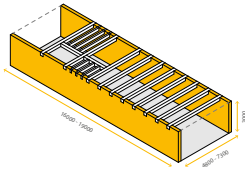
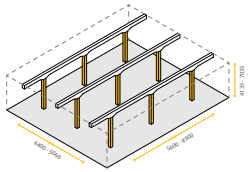
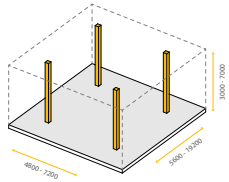
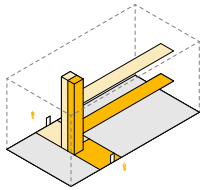
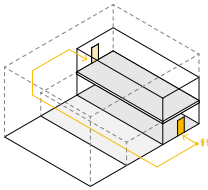
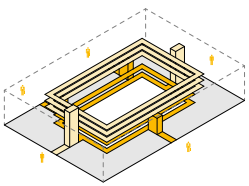
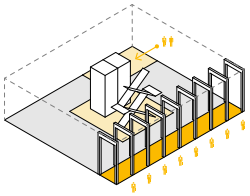
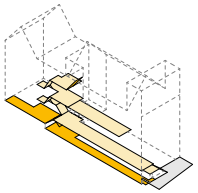
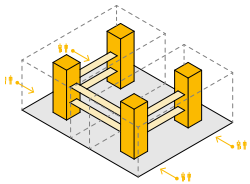
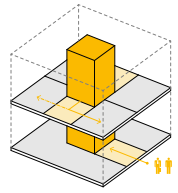
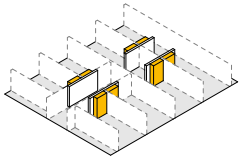
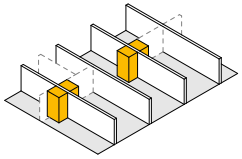
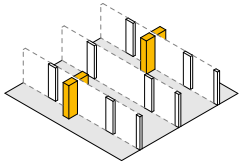
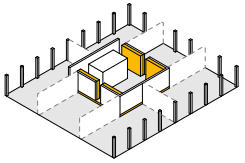
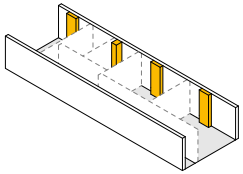
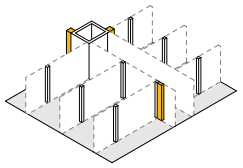
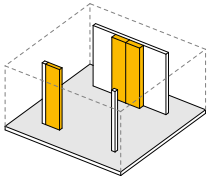
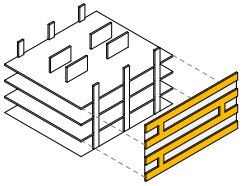
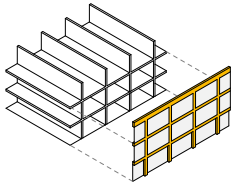
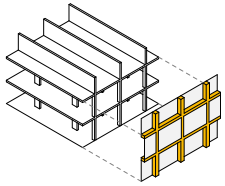
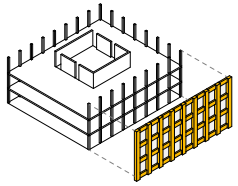
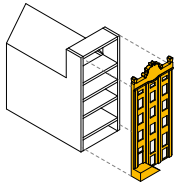
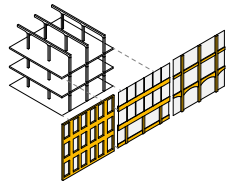
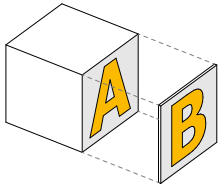
Facade
Different programmatic functions all have different needs for the facade.
Almost all the buildings that we analyse handle this problem by using the large floor heights and keeping big openings in the facade.
This makes the spaces suitable for all functions, and gives the dweller the possibility to open or close the facade with for example curtains.
Only the Multifunk building uses a window grid with closed and open parts, to give the building one look, but is still able to facilitate different functions.
What is interesting is that although most of the case studies have similar structural systems (for example Tetterode), the facade composition does not reflect this similarity.

In the introduction the question was asked which flexible aspects allow a building to combine housing and work spaces (in changeable configurations). What becomes clear from the partial conclusions is that a single overall answer can not be given. What can be provided is a collection of tools that can useful in any design assignment that focusses on mixed-use buildings and flexibility. These tools are the final conclusion of the analysis and are collected in the design tool matrix on the right.

Design tool matrix

All the individual summary schemes of each case study are grouped by theme to show the overall coherence. On the right the last column contains the design tools that can be seen as a culmination of all the case studies.
The design tools are based on the need for a mixed-use building in which the mixed program exists on each floor and is flexible enough to change over time. This means for example that on each floor both dwelling units and work spaces are situated. When we look at the row for Routing this results in a shared routing system for both user types.
The goal of this matrix is to become a valuable source of information that can be used in many architectural design projects.



Program							
Structure							
Routing							
Services							
Skin							

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Images

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2	Luchtfoto steigereiland.com

Vrijburcht

8	Projectblad CASA architecten
9 - 12	ArchitectuurNL #01 2008, p. 34

Solid 18

13 - 18	Brochure - Colliers International Real Estate BV

Solid 1-2

19 - 23	BOUWWERELD # 05

Canal house

24 - 25	Vereniging Hendrik de Keyser
26 - 27	Digitaal Grachtenhuis

Tetterode

28 - 29	David Carr-Smith
30 - 31	Stadgenoot

Appendix

Architectural solids

Society is changing more rapidly than ever before. The speed with which people switch jobs or exchange living environments is increasing every year. The availability of the internet and social media and the ease of transportation have contributed to the possibility of changing ones living and working arrangement in a matter of weeks or even days instead of months or years.
The built environment on the other hand has not yet evolved to this stage. Buildings are still designed to fit a specific program to perfection and to avoid additional costs for any unnecessary features. They are, unlike people, inflexible. However, a change is coming, in the form of solids. Highly flexible buildings that are so neutral and unspecific that they can accommodate any program for centuries to come. The idea sounds promising and durable, but the question arises whether these solids can be called architecture. Is it not the expression of a building that makes it stand out from the rest? How can architects design a neutral, unspecific facade for a client that is unknown? And how can we avoid ending up with repetitive solid-filled city developments?

The concept of the solid is a relatively new one. It originated out of the desire to create new buildings that would function similar to old warehouses. For example the Tetterode complex, where people can work, recreate and live at the same time and inside the same building. Tetterode in this case is the perfect example because it is the building that got Frank Bijdendijk thinking about his concept.
After being used as a type foundry for over half a century the building of Tetterode was abandoned in 1981 and taken over by squatters in a protest against the plans to demolish the complex. During a tour through the building in 1983 Bijdendijk, who was working for housing corporation Het Oosten, was impressed by what he saw there: *"In the former type foundry I saw ateliers, workshops, a theater, a restaurant, an art gallery, a clothing store and a lot of living spaces."*. [1] Eventually Bijdendijk got the municipality and the squatters to reach an agreement to preserve the building and in 1986 a custom made contract was signed by both parties.
This agreement, where the tenants take care of the interior and the owners take care of the structure and facade, is what led Bijdendijk to the formulation of his solids concept: *"A Solid is a sustainable building. In my opinion this is achieved through two qualities: accommodation capacity and preciousness."* [2]
Accommodation capacity is the degree to which a building is able to adapt to future changes. The term flexibility is often used to describe this characteristic. This can mean different types of dwellers but also a complete switch from housing to commercial program.
The second term that Bijdendijk mentions is harder to explain and that is exactly where it gets tricky. Preciousness [3] is the word used to describe the 'likeability' of a building. The users, and other residents passing by, need to feel a connection to the building for it to work. If people do not feel this connection they will not care about the preservation of the building. In other words, a solid needs to be pretty enough to keep it from being demolished ten years later.
But how do you design a building that is still considered pretty in twenty, fifty, maybe even a hundred years from now? Is that not exactly the same question architects have been struggling with since the beginning of architecture?

Bijdendijk agrees that preciousness is not easily defined, let alone achieved in architecture. It remains, no matter how scientifically justified, a subjective term. In his publications and interviews he makes clear that he thinks the functionalist Modernist movement cannot help us with this question. He has a point there; it is after all difficult to implement a 'form follows function' philosophy when the function itself is unknown. Bijdendijk also says that in this case we should look at what people think about the existing built environment. Because these buildings have been around for a while and have proven themselves to be either succesful or not at all, Bijdendijk concludes that people prefer the small scale, craftsmanship and ornaments. [4]
Because the interior of a solid is by definition as empty as possible, the facade is where the architect comes in to design preciousness. Knowing what people like all architects need to do is decide on a composition, use some nice natural stone and add ornaments. Right?

When looking at Solid 1 & 2, many of Bijdendijks ideas become clear. The building on IJburg in Amsterdam, a design by Baumschlager-Eberle, is nearing completion and the first tenants have already moved in. The design features an extra high ground floor with an arcade, a classical facade in natural stone and a large clock welcoming visitors to IJburg. All of these aspects seem to be taken right out of Bijdendijks 'solid handbook'. However, the scale of the building is still large, partly because the two solids have an almost identical facade which makes them look like one big solid. A feature that should not appeal to the people, according to Bijdendijk.
Though this feature can be seen in the two other solids in Amsterdam as well. Both Solid 11 by Tony

Fretton and Solid 18 by Claus & Kaan are large building blocks in a context of mostly smaller scale housing developments. Solid 11 in Amsterdam West also exhibits many of the other characteristics of Solid 1 & 2. The (semi-)classical facade is partly clad in natural stone and the ground floor is higher than the upper floors. The building can be described as two solids connected and accessible by an atrium. Apart from the structural artwork that supports the foot-bridges there are no ornaments visible in the facade.
The same is true for Solid 18. This large block, also on IJburg, has a very clean and grid-like facade composition. The refinement can be found in subtle variations in floor height and the rough texture of the brickwork. The collective entrances aren't made special, but are incorporated into the overall composition.
According to Bijdendijk these buildings will have a hard time becoming precious enough to people. Unfortunately the only way to be sure about this is by asking the users and passers by what they think about the building in at least fifty years or so.

Seeing that time travel is still a few years away we might as well use some more of Bijdendijks advice: analyse what we already know. For the general public this apparently boils down to small scale units and ornaments. However, this focusses mainly on housing. It is generally known that the old city centers of Amsterdam are very well liked among people. This is also why architects like Rob Krier believe that traditionalism is the way to go. But solids are not just housing blocks. They are meant to be multifunctional and, therefore, we need to look further to find out what makes solids work.
We can do this because although the term solid is a relatively new one, the buildings in IJburg and


fig. 1 Solid 1 & 2


fig. 2 Solid 11


fig. 3 Solid 18

Amsterdam West are not the first examples of this concept.

The first example is an obvious one. The Tetterode building complex was the inspiration for the solid concept, because it was and still is very suitable for mixed-use. Several aspects are responsible for this flexibility. First of all the overdimensioned floor heights and large spans allow for a large variety of functions to occupy the spaces. Dwelling units can utilize the height to put in entresols and the high ceilings are ideal for artists working with large objects. The mix between housing and businesses in Tetterode is unique and most likely a result of the type of users. Because the building was taken over by squatters, it became their home first, and their work place later when the arrangement with Het Oosten was made.
In many of the other examples this process went different. Because of governmental intervention a new programmatic use was assigned to an unused building that prohibited the mixing of different functions. In most cases old warehouses and large public buildings were transformed in either housing or business complexes. However, the absence of mixed-use does not mean these buildings became less of a success.
Housing complexes like St. Jobsveem, the Entrepotdok and the Lloyd Hotel show that somehow these buildings are capable of adapting to a completely different program and extend their durability by a significant period of time. The same applies to (creative) office buildings like Hotel de Goudfazant, the Kauwgomballenfabriek, the Westergasfabriek and even the current office of Stadgenoot (formerly Het Oosten). All of these buildings share many of the flexible characteristics that make them ideal for

internal reorganization.
But it is not only the interior spaces that make these buildings attractive for redevelopment or squatters for that matter. After all squatters are often the first to acknowledge the potential worth of abandoned buildings. It is also not the flexible interior these people are primarily interested in.

What is often the most important aspect of a building is its character or personality. This can be the result of many different things, but ultimately determines a buildings most precious feature. Whether it is a historical event, a political association, a structural or architectural innovation or simply its extraordinary looks, at a certain point in time every building acquires - or renews - its personality.
The most common of these factors is history. In general the longer a building survives the more precious it becomes to people. For example, who would ever disagree that the pyramids are special and that they should be preserved? This does not mean that everybody likes the way they look or would ever consider living or working in one. History provides these buildings with their character. Another example is the old inner city of Amsterdam. Together, perhaps with their looks, the canal houses represent memories of a time that clearly appeals to the public.
Closely related is the aspect of politics. Governmental institutions often occupy large representative buildings that are either liked from the start or have gained the historical quality after their usually long 'community service'. Buildings like the royal palaces for example.
Another aspect that secures a buildings prolonged service period is being the first, best or last of its kind. Clear models of an architectural style or early examples of innovative construction methods have such an important representative value that they are conserved and studied. The Van Nelle factory in Rotterdam by Brinkman and Van der Vlugt is such a representative building, in this case of Dutch (functionalist) Modernism, that it earned monumental status and is currently a popular haven for creative businesses and architecture firms.
The same aspects mentioned above are visible in the early solids. In fact the last example, the Van Nelle factory, can even be called a solid considering it changed function from being a factory to an office building. But where then does that leave us with the question of preciousness? The early - unofficial - solids as well as the recently completed solids in Amsterdam show a wide range in architectural expression. The Van Nelle factory is even the embodiment of the architecture that Bijdendijk dismisses in his publications. How then can he state that this is not what the people want?

And that is exactly where the problem lies. On the one hand Bijdendijk refers to research done regarding the general public, which results in a generalising conclusion. On the other hand he also states that no two people are the same. [5] These two statements contradict each other. What can be seen in the examples of flexible buildings (or solids) above is that there is a wide range of architectural styles, expressions and personalities that each attract a different group of people.
This can be seen when a comparison is made between three of the earlier mentioned examples. The Tetterode complex, the Van Nelle factory and Solid 1 & 2 all fall within the description of a solid. A highly flexible building that withstands the test of time and provides the space for a variety of program. However, the current users of these buildings have very different backgrounds. Tetterode was first occupied by squatters and now houses many starting artists and younger dwellers. The Van Nelle factory attracts mainly architectural firms, design agencies and smaller start-ups. Solid 1 & 2 is currently becoming a mix of commercial program, offices and social housing. What becomes clear when looking at these differences in users is that each of these groups is highly unlikely to be interested in renting a space in one of the other two buildings.
The difference in character and architecture is exactly what attracts this wide range in users and that should in fact be one of the main features of a true solid, according to Bijdendijk.

So what does this mean for architects faced with the task of designing a solid? In *Frame and generic space*, Bernard Leupen suggests a possible solution.
In his publication Leupen describes a system of layers that together constitute a building. In total five layers are defined: structure, skin, scenery, services and access. In turn each of these layers can become the frame of the building when it frees another layer. [6] When a layer is freed it then becomes the generic space that is free to be placed inside the available space. For example when the structure is able to carry all the loads of the building, the interior walls (which fall under the scenery layer) can be placed in the floor plan randomly. A layer is free when it no longer shares any function with another layer (in this example loadbearing).
Therefore, according to Leupen each of the five layers can be seen as a separate set of architectural elements that fulfill their own specific function and

that, when freed from the frame, become the generic space of the building.

In the case of solids this concept can be translated and used to very clearly show the role of each of the five layers. The first of the qualities of the solid, accommodation capacity, can be devided into two parts. The first part forms the frame and consists of the structure, services and access. These layers together provide the building with its flexibility. The second part of the accommodation capacity consists of the scenery. This layer becomes the generic space and can be filled in by the users of the solid.
This leaves the last of the five layers for the second quality of the solid. Preciousness is achieved primarily through the expression of the facade, or skin, of the building. Because the skin is not part of the flexible frame it belongs to the generic space. This means the skin is freed from performing any other function than its own: separating inside and outside and presenting the building to the outside world. [7]

To avoid excessive amounts of vacant office space and the necessity of demolition in the future a new kind of building is needed. Solids can very well be this new typology. But how can architects design a facade for an unknown user? And is it possible to avoid endless repetition when solids become the standard?
The solid concept can be a big step in the right direction, if not the final step, albeit with a few minor changes to its definition. The solid needs to be seen as a building with two attributes. Its flexible nature can be achieved by combining construction, installations and access systems into a frame that is highly adaptable. This frame can be optimized and will most likely be repeated many times in different projects. The solid's second personality trait lies in its expression to the outside world. Because no two places and no two people are the same, this asks for diversity and that is exactly where the architect comes in.

Footnotes

1 F. Bijdendijk, *Met Andere Ogen*, p. 14
2 F. Bijdendijk in: Leupen, *Time Based Architecture*, p. 42
3 Bijdendijk uses the Dutch word 'dierbaarheid'
4 F. Bijdendijk, *Met Andere Ogen*, p. 98
5 F. Bijdendijk, *Met Andere Ogen*, p. 15
6 B. Leupen, *Frame and generic space*, p. 31
7 B. Leupen, *Frame and generic space*, p. 32

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Images

fig. 1 http://www.solids.nl/content/image/solid-totaal-straatzijde_01/900_600.jpg

fig. 2 http://www.dailytonic.com/wp-content/uploads/2012/01/tfa-solid-11-pc-1a-35.jpeg

fig. 3 personal photograph

“Veranderende samenleving”

Van Habraken tot de 21e eeuwse solids..

We leven in een snel veranderende samenleving. En de eisen die mensen aan hun alledaagse voorzieningen stellen nemen net zo snel toe.
Door de toegenomen welvaart, opleidingsniveau, en informatie voorzieningen is de individuele controle van mensen op de consumentenmarkt sterk toegenomen.
Maar deze veranderingen zijn niet zichtbaar op de huizenmarkt. De bewoners hebben hier nog steeds geen enkele invloed op.
De stagnatie van de woningmarkt is niet een probleem dat de laatste jaren pas gaande is,
In het boek: “the structure of the ordinary”[1] wijst de Nederlandse architect Habraken zijn lezers al op het gebrek aan inspraak van de individuele bewoner op zijn woning.
Dit essay beschrijft hoe Habraken naar oplossingen voor dit probleem zocht, en vergelijkt dit met hedendaagse voorbeelden, zoals de solids, die de bewoner meer vrijheid en keuze mogelijkheden geven.

Verandering

Zo lang als mensen in permanente woningen leven, zijn ze ook bezig met uitbouwen, renoveren en veranderen van de indeling van hun woning.
Bijna alle oude woningen hebben meerdere lagen behang op de wanden, zijn met der tijd menig maal verbouwd, en hebben verschillende keukens en badkamers gehad.
Een bewoner laat een hoop zien van zijn constant veranderende levensstijl in zijn woning.
Dit laat zien dat de gebouwde omgeving zijn eigen leven leid. Het blijft groeien, en zichzelf vernieuwen. Hierdoor kan de gebouwde omgeving alleen overleven door zichzelf constant te blijven aanpassen aan de veranderingen in levensstijl.

Een hoop gebouwen zijn heden dage gebouwd voor een specifieke functie, op een specifieke gestandaardiseerde manier. Deze woningen staan geen enkele fundamentele verandering in de woning toe.
Door het voorschrijven waar de bewoners hun tafels, banken, en bed moeten zetten – generatie na generatie – zijn wij als architecten een van de belangrijkste veroorzakers van deze uniformiteit.
Deze manier van ontwerpen, in grote aantallen, voor een gestandaardiseerde manier van leven, word op zo’n niet inspirerende manier gedaan dat al de variaties, die een gebouw identiteit geven, verloren gaan. Juist deze identiteit zorgt er voor dat bewoners zich thuis voelen in hun eigen woning. Iedereen is het er over eens dat een huis je uitvalsbasis moet zijn uit het dagelijks leven. Maar wat zegt de architectuur van een gebouw over de gemoedstoestand van zijn bewoners. Kan iedereen in elk standaard ontworpen huis wonen?

Een goed voorbeeld van identiteit en flexibiliteit zijn de zeventiende eeuwse grachtenpanden in Amsterdam.
Deze statige grachtenpanden werden gebouwd door de eeuwen heen, en zijn getuige geweest van heel wat veranderingen in het leven, in bouw materialen en in bouw stijlen.
Toch zijn deze woningen nog steeds zeer populair om in te wonen. Wat deze oude grachtenpanden zo leefbaar maakt is de flexibiliteit van de woning.
De bewoner kan in elke ruimte in de woning werken, slapen of relaxen, door de grote afmetingen van de ruimtes. Hierdoor kan de bewoner elke ruimte gebruiken zoals ze het zelf voor ogen hebben.

figuur 1: Typische grachten panden in het centrum van Amsterdam.

De gebouwde omgeving

Verandering en vernieuwing worden steeds belangrijker in de bouw de laatste paar decennia. We gebruiken de gebouwde omgeving niet als kunst om naar te kijken, maar we gebruiken het om in te leven. En ondanks dat we bouwen om te volharden, om de tijd te weerstaan, weten we dat uiteindelijk de tijd toch wel zal winnen.
Wat eerdere generaties gebouwd hebben voor de eeuwigheid, slopen wij weer. Waarna we, met de zelfde instelling als eerdere generaties, op de zelfde plek weer beginnen te bouwen.
Meer en meer word de architect een soort agent van de verandering. En volgens mij moet de architect een agent zijn die zich moet kunnen aanpassen aan deze veranderingen.
De gebouwde omgeving bestaat door de mensen

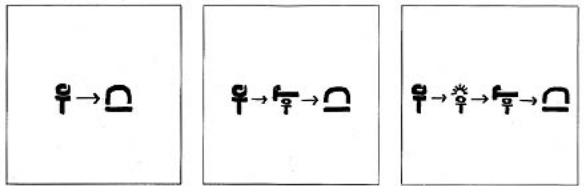
die er in wonen, werken en leven.
Deze bewoners brengen leven en sfeer in de gebouwen. Hierdoor kwam Habraken tot een van zijn statements over de rol van bewoners in het bouw proces: *"Zolang zij actief zijn, en een bepaald gebouwde omgeving de moeite waard vinden om te vernieuwen, veranderen, en uit te breiden, blijft het doorgaan"* [2]

Iedereen probeert zijn omgeving te veranderen tot de manier waarop hij het wil, en ervoor probeert te zorgen dat dit zo blijft. Kantoor medewerkers zetten bloemen neer, hangen foto lijstjes op van familie leden, en zetten hun eigen boeken op de rekken. En studenten hangen bijvoorbeeld posters op de wanden. Deze persoonlijke aanpassingen leiden tot het behoud van de gebouwde omgeving.
En zijn uit te leggen als pogingen van bewoners om zich thuis te voelen in de gestandaardiseerde omgeving waarin ze wonen of werken.

De rol van een architect
De huidige gebouwde omgeving is voor het overgrote deel gevormd door architecten en politici. Zij bedenken en bepalen alles. De mensen moeten zich maar zien aan te passen in de voor hen bedachte huizen. Dit in tegenstelling tot het verleden waar nederzettingen als een natuurlijk proces vanuit de individu of kleine gemeenschappen groeide en waar architecten zich alleen bezig hielden met het ontwerpen van het bijzondere bouwwerk zoals de kerk en het paleis.

Groeiprocessen hebben altijd bestaan zonder tussenkomst van architecten en planners, de tijd is ls het ware een ontwerp middel. Dorpen, steden, wijken ontstonden uit de noodzaak van een dak boven het hoofd.
Dit bouwproces, waarin vele verschillende groepen beslissingen nemen over de woning van iemand die ze niet kennen werd door Habraken in 1998 benadrukt in het boek *"the Stucture of the Ordinary"*. [3]
Hij benadrukt hierin het belang van een "eenduidige communicatie structuur", wat cruciaal is voor een bouw proces, om zo soepel mogelijk te gaan.
Hij stelt dat een architect die ontwerpt zonder te weten wie de bouwer zal zijn, of hoe de bouwer werkt, niet precies kan bepalen hoe het bouwproces zal worden uitgevoerd.
Niet alle feiten zijn bekend, en de risico's kunnen niet altijd bepaald worden. Verschillende stijlen en methoden van communicatie kunnen het proces nog verder compliceren, en dit maakt het eindproduct gevoeliger voor fouten of te leurstelling.
Vanuit het perspectief van een eigenaar kan het nuttig zijn om te werken met een nauw verbonden team van architecten en bouwers.
Dit is iets dat Habraken ook in zijn boek stelt:
"Wanneer een heleboel verschillende mensen beslissingen over de toekomst van een persoon zijn leefruimte maken, in verschillende fasen van het project, is het essentieel dat de mensen die deze beslissingen nemen een gemeenschappelijke methodologie in het maken van deze keuze hanteren." [4]

De huiseigenaar moet vanaf het begin van het bouwproces er al bij worden betrokken, zodat aan zijn behoeften, zorgen en verlangens wordt voldaan. De eigenaar/ bewoner moet er zeker van zijn dat zijn eisen zullen worden vertegenwoordigd tijdens het hele bouwproces.



figuur 2: schema over relatie bewoner en woning. In eerste figuur directe relatie bewoner woning. Tweede en derde figuur komt de architect en aannemer er tussen.

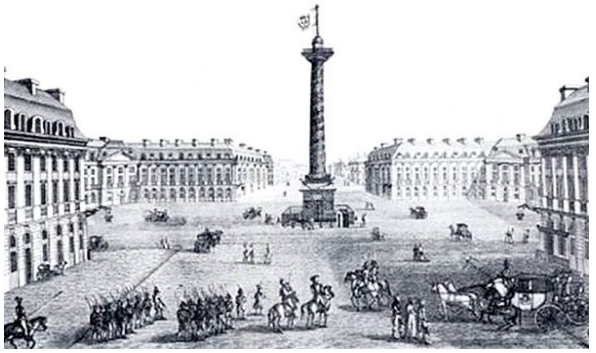
Drager en inbouw
In 1961 verwoorde Habraken zijn gedachten over de bouw sector in de publicatie van
"De dragers en de mensen". Volgens Habraken diende het bouwproces opgesplitst te worden, hierbij krijgt de bewoner volledige zeggenschap over de woning en de gemeenschap over de resterende ruimten.
Om deze theorie werkelijkheid te maken, moet onderscheid in drager en inbouw gemaakt worden. Met een open en collectieve structuur kunnen bewoners door zelfbouw of met behulp van industriële elementen aan hun woning bouwen en verbouwen.
John Habraken stelde voor om het bouwen te splitsen in twee *"sferen: drager en inbouw."* [5] Op basis van een open, collectieve structuur, konden de bewoners - door zelfbouw of met behulp van een set gestandaardiseerde industriële bouwelementen- aan hun woning bouwen en verbouwen.
De drager reflecteerde de sfeer van het gemeenschappelijke, de gemeenschap, de inbouw die van het individuele.
In navolging van de ideeën van Habraken werd in 1964 de Stichting Architecten Research (SAR)

opgericht met het doel de besluitvorming rondom de woningbouwproductie een nieuwe impuls te geven. De bewoner moest er een centrale rol in vervullen. De drager werd vertaald naar een draagstructuur (casco) die met inbouw pakketten kon worden ingevuld. Bewoners kregen de mogelijkheid uit verschillende inbouw pakketten te kiezen of soms onderdelen van de vaste structuur te laten veranderen.

Dit was in feite een aanzet tot de hedendaagse solids, maar voordat we hier aankomen moeten eerst nog een aantal belangrijke stromingen en invloeden worden besproken.
Een belangrijke speler op de flexibele woningbouw markt is het *"open bouwen"*.
Het voornaamste doel van de "Open bouwen" aanpak, is het onderzoek naar transformaties in het bouwen volgens de eisen van de verschillende deelnemers in het ontwerp- en bouwproces. Hiermee doelend op ontwerp en bouw teams, krediet verstrekkers, eigenaren, huurders en fabrikanten.
Nieuwen open architectuur introduceert het begrip flexibiliteit in de bouw wereld, wat ruimte maakt voor transformatie.

De oorsprong van het open bouwen concept ligt in het eerder besproken boek van Habraken, die daarin al zei: *"we moeten niet voorspellen wat er zal gebeuren, maar proberen de voorzieningen te maken voor het onvoorziene".* [6]

Vrijheid in ontwerpen
Het concept van een gebouw dat de bewoners de vrijheid geeft om hun eigen woning te ontwerpen is niet van de laatste jaren.
Al in 1702 ontwierp een Franse architect, genaamd Jules Hardouin Mansart, het Palace Vendome in Parijs. Hij ontwierp een monumentale gevel in neo classicistische stijl. Het plein, inclusief de gevel, werd gebouwd door de stad Parijs op verzoek van de Koning.
Het project, met de afmetingen van 245 bij 233 meter, was een groot open plein, dat werd benadrukt door Napoleons kolom in het midden van het plein.
Om de waarde van de grond te verhogen werden er een aantal belangrijke functies aan het plein toegekend. De Koninklijke bibliotheek, de universiteit, het wereldberoemde "Ridge" hotel waren enkele van de belangrijke functies.
De gevel werd gebouwd om een uniforme uitstraling te creëren, maar al de overige percelen achter de gevel waren te koop.
In de daarop volgende jaren bouwden bankiers, belasting-inners, en andere rijke inwoners hun eigen woningen achter de gevel. Allemaal met hun eigen architect.
Deze gebouwen zijn met de tijd blijven veranderen, maar de monumentale gevel van Jules Hardouin Mansart is nu nog steeds in de zelfde staat.
Dit gebouw wordt beschouwd als een van de eerste voorbeelden van een twee delig georganiseerd gebouw.[7]
Wat betekend dat de ene architect het ruimtelijk kader ontwerpt, waarbinnen andere ontwerpers vervolgens hun eigen ontwerpen kunnen maken.



figuur 3: Tekening van het Palaca Vendome in Parijs.

Leegstand van gebouwen – Tetterode
De laatste decennia worden steeds meer kantoorgebouwen verlaten. In Amsterdam staat op dit moment al om en nabij de 1,6 miljoen m2 aan kantoorruimte leeg. Dit zijn voornamelijk de kantoorgebouwen uit de jaren vijftig die niemand meer wil hebben. Deze gebouwen kunnen geen tweede jeugd krijgen, herontwikkeling blijkt te duur en te lastig.
Er zijn echter oude kantoorpanden en fabrieken die wel her ontwikkeld kunnen worden. Deze gebouwen hebben vaak kwaliteiten als overmaat en een klassieke uitstraling.
Het Tetterode complex is een goed voorbeeld van een oud industrieel pand, dat succesvol is omgetoverd tot een levendig woon en werk complex.
Het Tetterode gebouw is een oude Lettergieterij gevestigd aan de Da Costa kade in Amsterdam.
De lettergieterij werd in 1901 geopend door Nicholas Tetterode. Maar in 1981 fuseerde de lettergieterij met een ander bedrijf, en werd het bedrijf te groot voor het pand in het centrum van Amsterdam. Het verhuisde naar een industrie terrein buiten de stad.

Uiteindelijk wil een ontwikkelaar samen met BAM het complex veranderen in een aantal luxe woningen, een plan dat woede bij veel krakers oproept.
Op 17 Oktober 1981 wordt het Tetterode complex voor het eerst gekraakt. Het duurt echter maar twee weken voordat de krakers er weer uit worden gezet.
In de daarop volgende vijf jaar verandert Tetterode vijf keer van eigenaar. Doordat verschillende ontwikkelaars wel mogelijkheden zien in het complex, maar de financiering uiteindelijk niet rond krijgen en worden gefrustreerd door de krakers.
In 1986 krijgt woningbouw directeur Frank Bijdendijk een rondleiding door het complex.
In zijn publicatie over het Tetterode complex schrijft hij over deze rondleiding:
"Ik zag de pioniers van de grote stad. Ik zag dat ze heel liefdevol met het gebouw omgingen. Het was hun nieuwe wereld, hun stad in de stad. Ik zag dat geen twee mensen gelijk waren. Iedereen wilde wat anders, iedereen bouwde wat anders. Maar wel allemaal in hetzelfde gebouw. Ik begreep dat hun uitgangspunt was dat wonen, werken, recreëren en allerlei andere activiteiten ondeelbaar met elkaar verbonden zijn. En zij wilden al die activiteiten met elkaar delen." [8]

Bijendijk besloot met de krakers tot een "Casco" huur model. Refererend aan het basis casco van het gebouw, zoals de gevel en de ontsluitingen.
De krakers huurden het casco van woningbouw vereniging het Oosten, en de woningbouw vereniging zou het casco dan onderhouden.
Het gebouw huist heden dagen 80 bewoners in 65 appartementen. Daarnaast zitten er ook nog ongeveer 55 werkplekken in het gebouw.
Tetterode is nu nog steeds het voorbeeld van een levendig gebouw, waar bewoners zelf hun woning of werk plek naar eigen wens kunnen inrichten.


figuur 4: Gevels van Tetterode complex, met links de uitbreiding uit 1912 en rechts de uitbreiding van Merkelbach.

Solids
De directeur, Frank Bijdendijk was zo geïntrigeerd door het idee van een open flexibele manier van leven, zoals bij het Tetterode complex was toegepast, dat hij besloot dit concept in een meer commercieel gedreven product om te zetten.
Lofts zijn de laatste decennia steeds populairder geworden. Deze ruimtes door de populariteit echter veel te duur geworden, en zijn niet meer de flexibele en aanpasbare ruimtes waardoor ze zo populair zijn geworden.
Een hoop projecten proberen tegenwoordig in te spelen op de grotere vraag naar flexibiliteit, maar komen vaak niet verder dan het vrij plaatsen van een aantal binnenwanden.
Het antwoord van woningcoöperatie Het Oosten op de vraag naar flexibiliteit is de Solid.
Deze naam refereert naar een van de basis uitgangspunten van het gebouw: zijn extreme lange levens verwachting van 200 jaar.
Het idee van de solid is gebaseerd op het idee van open bouwen, net als bij het Tetterode complex. De woningbouw vereniging bouwt het gebouw (de constructie, gevel en infrastructuur). En de bewoners bouwen binnen deze schil hun woning zoals ze dit zelf willen. Binnen deze opzet wordt geen onderscheid gemaakt tussen wonen en werken.
De woningbouw vereniging wil zich eigenlijk zo min mogelijk bemoeien met de indeling binnen het casco. Uiteindelijk kan iedere geïnteresseerde zijn eigen woning ontwerpen, en de prijs wordt via een publieke veiling op internet bepaald.
De prijzen van de woningen worden bepaald door wat mensen ervoor willen betalen, en niet wat de markt ze verplicht te betalen.
Daarnaast krijgen armere mensen een handicap binnen de veiling, om zo te zorgen dat ook zij kans maken op een woning.

De gebouwen bestaan eigenlijk uit grote open ruimtes, met een ruim gedimensioneerde draagconstructie om alle veranderingen in programma te kunnen opvangen. Bij de solids die tot nu toe gerealiseerd zijn betekend dit dat de ruimtes binnen het gebouw beginnen bij 60 vierkante meter, en de grootste ongeveer 200 vierkante meter beslaat. Daarnaast hebben de ruimtes zeer hoge plafonds, wat voor flexibiliteit in het programma zorgt en een hoop daglicht genereert. De verdiepings hoogte bij solid 1&2, ontworpen door Dietmar Eberle is 4,5 meter op de begane grond, en 3,5 meter op de verdiepingen. Dit zorgt voor de mogelijkheid om een

extra tussen verdieping toe te voegen op de begane grond. En geeft op de verdieping ruimte om een verlaagd plafond toe te passen, en alsnog ruime en hoge ruimtes over te houden.
Daarnaast dient de gevelindeling van de solids zich te lenen voor een vrije in deelbaarheid en moeten er mogelijkheden zijn voor buitenruimten.
Daarnaast zijn ook de installaties zeer belangrijk. Naast de ontsluitingen worden over gedimensioneerde leiding schachten aangebracht, en verder zijn de ruimtes binnen de solid echt alleen een casco. De afbouw hiervan wordt aan de bewoners zelf overgelaten.

De woningbouwvereniging schat dat, door de over dimensionering van de draagconstructie en van de schachten, een solid zo'n vijftien tot twintig procent in kosten boven een normaal woongebouw uitkomt. Een normaal woongebouw moet de kosten echter binnen vijftig jaar terug verdienen.
Dit zorgt ervoor dat de solid na 100 jaar al ruim boven de inkomsten van een gestandaardiseerd woongebouw uitkomt.

Conclusie
Terugkijkend kan wel geconcludeerd worden dat Habraken, samen met de SAR een pionier op het gebied van flexibiliteit in de woningbouw was.
Al rond 1960 begon hij zich af te zetten tegen de uniformiteit die de woningbouwprojecten van dat moment nog steeds als leidraad namen.
Hij ontwikkelde een strategie om deze uniformiteit en anonimiteit te doorbreken, maar dit werd nooit echt op grote schaal toegepast. De beroepsbranche en de algemene bevolking vonden de SAR-methodiek, die vroeg om een geavanceerd industrieel vervaardigd systeem, waarbinnen de bewoners dan zelf de ruimtes konden bepalen, een aantasting van hun keuze vrijheid met betrekking tot aannemer en bouwmaterialen.

Gebouwen zoals Tetterode in Amsterdam en het veel oudere Palace Vendome in Parijs waren echter wel zeer succesvol. De overeenkomst die deze twee oude gebouwen en de heden daagse solids hebben is een volledige vrijheid in het interieur van de woning.
Waar binnen Tetterode de bewoners zelf, met minder geld, maar daardoor juist zeer creative oplossingen hun eigen woon en werk ruimtes hebben gecreëerd, kon dit binnen de SAR-methodiek niet.
Ook het veel oudere Palace Vendome bestond eigenlijk alleen uit een monumentale buitengevel, waarbinnen de bewoners met een eigen architect hun eigen woning mochten ontwerpen. Al stond dit complex alleen grond gebonden woningen toe.
Het concept van de solids heeft echter wel de positieve uitgangspunten vanuit het "drager en invulling" principe van Habraken. Bij beide dient de drager ontworpen te worden zonder dat daarbij een plattegrond voor ogen staat. Deze plattegrond zal immers pas ontstaan door het initiatief van de bewoners. Dit geeft bewoners de vrijheid om hun woning volledig naar eigen wens in te vullen.
De solids geven de bewoner met betrekking tot de SAR-methode minder vrijheid aan de buitengevel, aangezien de buitengevel al in een eerder stadium ontworpen is. Maar bij een solid word echt alleen het casco en de ontsluiting ontworpen. En kunnen de bewoners de lay out, de grootte, de oriëntatie en het materiaalgebruik volledig zelf bepalen.
Daarmee neemt het solid concept het grootste obstakel van de SAR-methode weg, en geeft het de bewoner een zeer grote vrijheid om, midden in de stad, zijn eigen woning te ontwerpen.

Daarnaast is functieverandering de laatste decennia steeds belangrijker aan het worden. Fabrieken worden kantoren en kantoren worden woningen. Functie verandering is normaal. De stad leeft immers. De hedendaagse interpretatie van het functionalisme, waarbij de vorm als een folie om de bewoner klemt past niet meer bij de hedendaagse samenleving. De markt van de toekomst is immers niet echt te voorspellen. Daarom moet het solids concept zo flexibel mogelijk zijn. Niemand kan voorspellen hoe mensen hun woning willen bewonen. Solids geven bewoners ruimte om zo veel mogelijk fantasie aan de gebruiker over te laten. Ruimte die bovendien met de tijd weer kan veranderen. Om zo aan de eisen van de toekomstige gebruiker te voldoen.
Het solid concept is hiermee een voorbeeld van een flexibel gebouw, dat zo min mogelijk een knellend keurslijf zal vormen. En sluit hierdoor mijns inziens perfect aan bij de huidige, turbulente samenleving, waarin de wens naar flexibele woon en werk ruimte steeds groter zal worden.

Noten

1 Habraken, N.J. The structure of the ordinary, p. 32

2 Habraken, N.J. De dragers en de mensen, p. 7

3 Habraken, N.J. The structure of the ordinary, p. 24

4 Bosma, K. Housing for the Millions.

5 Habraken, J. De dragers en de mensen.

6 Habraken, N.J. The structure of the ordinary, p. 22

7 Habraken, N.J. Change and the distribution of design, p. 21.

8 Bijdendijk, F. Met Andere Ogen, p. 15

Afbeeldingen

1 Grachtenpanden Amsterdam: http://79amsterdam.com/Hotspots.html

2 Schema Habraken, uit: Habraken, N.J. De dragers en de mensen.

3 Palaca Vendome: http://www.hoteldevendome.com/uk/place-vendome.php

4 Tetterode complex: http://www.tetterode.org

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The static scheme, and its relation to the dynamic use of buildings

"*Freedom – and the ability to change is a form of freedom – will destroy itself without a bounded framework.*" [1]

This quotation from Hegel is used by Leupen in his book 'Frame and generic space' to address the need of the frame in architecture, to acquire a certain degree of changeability. Freedom can't exist without a bounded framework. But which characteristics has a framework. How does a intended boundary accomplish a certain freedom of changeability, multifunctionality and polyvalence?

This search toward the frame, the static scheme where every building should be build up from, has been questioned by different people from different point of views, including John Habraken, Herman Hertzberger and Bernard Leupen. Their search towards the frame, the static scheme, consisted and intertwined whit the search towards changeability, the dynamic use of buildings. But what makes their ideas relate? What can we learn and adept from the idea of thinking in static and dynamic systems in designing?

SAR

To answer this correctly I must start my story by mention and explaining the Foundation for Architects' Research (SAR). This collaboration between the Dutch institute for architect's (BNA) John Habraken and several architectural firms started, in the Dutch sense, the search towards static and dynamic. As leading member Habraken could extend personal writings about mass produced housing into practice. In response to the dominant methods of mass produced housing schemes, he introduced the term support, propagated a change in the build process, and wanted to gave the occupant, instead of the production, a central positioning in the mass produced housing.[2]

The main aim of the SAR was accordingly to explore the application of industrial manufacturing methods into the scheme of housing. This led to the introduction of a 'standardized support structure' that had standardized dimensions based on industrial production techniques. There hypotheses was basically based on the notion of the static and dynamic. Mass produced housing could be seen as two products; "carcass" and "finish". Carcass would represented the dwelling structure, the finish the infill package.[3]

First I want to address the role of this infill package. This finish could be seen as the translation of Habraken's quest to gave occupants a central role in mass-produced housing schemes. The separation of structure and infill led to the implementation of a standardized support structure that could regulate the dimensions and placement of both structure and infill. This system gave the dweller the possibility to personal statement, [4] because it focused on zones rather than only on the production of the structure

The zones where based on a grid of 30 centimetres (an alternation of 10 and 20) and translated programmatic infill into the structure scheme. The alpha zone for instance was assigned to 'dedicated spaces' such as living and bedroom spaces. The Beta zone was the utility space; the wet cells and suchlike (the servant spaces). The gamma zone was set aside for access space, galleries and stair halls. The clarification in zones could attune and correspond the production of industrial infill material, the basis for this personal statement in the larger scheme of the structure. The infill package made individual control, variation and personal authority, next to the communal structure, possible.

Habraken

To understand the structure principle of the SAR methodology we can look into theoretical work of Habraken himself. He proclaims in his essay "change and the distribution of design" his statement towards designing carcass and finish. Her he speaks of levels of intervention; the levels where a building is build up from in relation to the process of designing.[5] A design based on levels, could constrain but also guide lower positioned levels. This is not only a logical continuation trough a certain natural hierarchy in things, but also part of the way a design could work properly trough time, as we will read later on.

To understand the way Habraken sees hierarchical positioned levels in design, I will describe his paper "Notes on hierarchy in form". Trough the description of patterns in for instance a tree, a network, a plan or

a framework, Habraken describes the way hierarchy works and how hierarchical positions could be found both in nature as in man-made things.

As typical example of hierarchical positions in the real world he describes the tree branch.[6] A branch can be seen as elements of branches. It is constructed from different branches that all have a certain location on the higher levelled branch. This higher levelled branch serves as a infrastructure to the lower hierarchically positioned branches. It offers a certain amount of freedom yet it limits it! This 'capacity' is the rang of the different variations the higher level allows for the lower levels.

According to this principle Habraken claims that certain specifications set by higher levelled design equals constrains and norms followed by the lower level design. Hierarchy in a form is there to make interventions on different levels possible. When we acquire the ability to see this hierarchy in structure, we can understand how interventions on the different levels can be made and, its ability to transform over time.

If we go back to his essay Habraken connects this principle to different design examples from the past where 'levels' actually provide a base for balance, control, and (new) intervention. The Place Vendome for instance, a neo-classical building in Paris from the late 17th century, is constructed as a uniform facade which still stands. They idea behind the uniform facade was that it acted as a structural framework from where other designers could make up their own design. The space behind the overall scheme was for sale and to be designed by others. This space changed during the centuries while the structural framework of the facade hasn't been compromised.[7]

A second example where uniformity played a evident role in the facades, without being all the same, is the typical canal housing in Amsterdam. Here the framework of the urban plan brought about a coherence in the total scheme and acted as a higher levelled design. Each canal house could be constructed by different clients, and however their differences, the type was familiar to both the inhabitant as the builder.

The Place Vendome is a typical example of a facade that is becoming part of the urban space, and an example of certain variation behind a higher levelled designed screen. The canal house enables variation by means that the screen could be replaced, without disturbing the higher urban level design.

According Habraken these hierarchical positions could even be found in ancient examples like the atria housing typologies found in preserved Pompeii. Here every house surrounded an inner atria. The atria where connected to a public street grid. The atria functioned as semi-public spaces and where stable places in the cityscape. Behind the walls of the atria the scheme of housing, the lowest level in the design, could be changed without disturbing the higher hierarchical atria and grid system that preserved the existing cityscape.

These examples put forward the distinction in levels in designing, and explain how the structure principle of Habraken worked. The 'base building' as designed by the architect, en de 'fit-out' for its user,[8] allow certain changes without overwriting the structure in the infill principle. It acknowledges a certain hierarchy in the design task and distributes design levels.

Hertzberger

Herman Hertzberger describes the relation between change and architecture by introduction the world polyvalence in the architectural debate.[9] Although having a different starting point, his notion shows similarities and can be compared to Habraken structure and infill.

He indicates in his essay 'Time-based buildings' the importance of time. A building should be able to be interpreted differently trough the course of time. Hertzberger defines the static in relation to use and interpretation of space. Architecture (in the case of time; interpretable architecture) is designing something that is aware of its temporality. He puts forward that change is even subjected to change. Even changeability, the way thinks where predicted to change, are subject to change. If infill (the program) is too specific, it forfeit's the possibility of being interpreted differently.[10] Not the program should make the conditions but the structure.

To understand Hertzberger definition of the static and it's relation to changeable solutions I will describe the word polyvalence. Polycalence for Hertzberger means a form that in itself is lucid and permanent trough the ability to be interpreted differently. This doesn't strictly mean that every space should be one of multipurpose (the literal and French translation) because a space whit multiple purposes gives the idea of flexibility, which Hertzberger compares to neutrality. A space should be valence to different function without providing neutral architecture.

The experimental Diagoon housing in Delft are examples of how Hertzberger used the notion of polyvalence to created housing that posses the lucid and the permanent. In the Diagoon houses different patterns of live may be possible trough certain similarities in the specified space.[11] The open interior space is vertically and horizontally displaced. Two closed elements with in-between a void, provide sanitary facilities, kitchen and staircase, and connect the spaces functional and spatial. Due to the identical nature of the interior spaces, in dimensions and height as in their relation to the closed elements, the use is 'left open' and not totally predetermined. The interior spaces are polyvalent without being neutral boxes.

Like Habraken, Hertzberger also links his theories to historical examples. In his essay he compares for instance the (western) church and the temples in Bali. The use of the temples is in contradiction the a church also subjected to change. When a holy event is finished the space is used as celebration space are playing ground. The structure of the temples can be seen as open-ended, therefore they are free to use by different functions. Hertzberger also describes overall forms like Le Coubuiers Plan Obus, or his own design for a housing project in Düren Germany. In his own project the large form accommodates space for different dwelling types.

In this Düren project Hertzberger speaks, in contrary to Habraken and his carcass and infill theory, of competence and performance. The large form signify competence[12] (the capacity to be the overall scheme). The diversity of the infill material is the performance (the space for different dwelling types as the result of the competence).

Leupen

To extend on the interpretation of the static and dynamic, we can continue by addressing Bernard Leupen. Leupen dedicated a study to the changeable dwelling, which he proceeded from the permanent. Contrary to Habraken carcass and infill, Leupen speaks of frame and generic space. The frame is the permanent and the specific. The generic space is the space where changes can occur, the space that is general.[13]

To understand Leupen idea of the generic space I can formulate his essay "Towards time-based architecture'. Leupen also writes about the time aspect in architecture and its relation to the generic space. Next to being polyvalence, a word that can be linked to Hertzberger description of polyvalence, a building could also have changeable configurations. The generic space could have a degree of changeability.[14]

Leupen describes this changeability by mentioning extendibility and alteration. Extendibility is the enlarging of a space inside the existing framework, which can happen in all directions. Alteration is changing and removing elements, and revising the internal layout.

The frame in Leupen concept is not only somethingpermanent, but also as something that has multiple layers. A total of five layers constitute the total frame and combine into a build form. Leupen subdivision of the frame goes beyond the structure. The frame covers next to the structure, skin, scenery, services and access.

Conclusion

The above described theoretical positions of Habraken, Hertzberger and Leupen give a sense of what the characteristics of a framework could be, and what the words such as change and multifunctional, mean in the sense of designing housing schemes.

Of course it must be taken in consideration that these idea's originate from different time periods, where the issue of manufacturing housing depended on temporal circumstances in the industry and society. In addition, Habraken theoretical work looks at the housing scheme at a very large scale. In comparison to Hertzberger and Leupen spatial ideas there is a scale difference. However these difference, there proclamation about a base form and some infill space certainly extend beyond the typical way of thinking about changeability; a space that can be used differently by for instance having a flexible layout.

If we compare their proclamations we see a match in the manner of subtracting the build form into something static and dynamic. According Habraken a design could be seen as two products, a dwelling structure and a infill package. According Hertzberger it's all about a competence and a performance. Leupen describes it as a permanent frame and a generic space. These different pronounce words mean that a design that wants to integrate a certain time factor, has to have a permanent carcass-structure, which has to generate a certain finishing infill space.

If we go beyond the theoretical manner, the ideal design would accomplish both. It would be in the order of having a static frame that uses the layers described by Leupen. It would have dynamic and

defined space whit the possibility to change in a way of being polyvalence. And would incorporate a relation between the static and dynamic based on levels whit a clear hierarchical positioning between them. Of course there isn't such a thing as the ideal design. But inserting at least some of their ideas into the design practice, would make the build environment certainly better equipped to deal with future chances.

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Footnotes

1 B. Leupen, *Frame and generic space*, p. 22
2 K. Bosma, D. Hoogstraten, M. Vos, *Housing for the milions,* p. 144
3 B. Leupen, *Frame and generic space*, p. 163
4 architectuurgeschiedenis.nl/projecten/p_09_uk.html
5 J. Habraken in: Leupen, *Time Based Architecture*, p. 23
6 J. Habraken, *Notes on Hierarchy in form* p. 7
7 J. Habraken in: Leupen, *Time Based Architecture*, p. 22
8 J. Habraken in: Leupen, *Time Based Architecture*, p. 28
9 B. Leupen in: Leupen, *Time Based Architecture*, p. 13
10 H. Hertzberger in: Leupen, *Time Based Architecture*, p. 85
11 B. Leupen in: Leupen, *Time Based Architecture*, p. 13
12 H. Hertzberger in: Leupen, *Time Based Architecture*, p. 90
13 B. Leupen, *Frame and generic space*, p. 43
14 B. Leupen in: Leupen, *Time Based Architecture*, p. 12