SchelLink

Multidisciplinary project
Group 1

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Ideas and Examples Final Design

The central idea of the ScheLLink project is the development of a pleasant, sustainable environment where young people can live, work and recreate together in the centre of Eindhoven. Of course, the importance of nature is also taken into account. In other words: ScheLLink, connecting people, nature and the city!

Our design focuses mainly on young people (starters, yups, etc.) and couples, including students and (flex) workers (like Hartje Eindhoven), instead of a design for all generations (like SpaceS on Strijp S). The underlying idea is that this target group suits the best in the lively city centre with its many shops, catering establishments and other entertainment. Therefore a wide range of affordable owner-occupied and rental apartments (partly social) will be created, ranging from student studios to middle-class apartments and some more expensive apartments for young families. In addition, for young entrepreneurs there will be flexible working places and some extra retail spaces (e.g. coffee house, design shop) that will further increase the attractiveness of the location.

In order to contribute to the reduction of air pollution, noise nuisance and heavy traffic congestion in the centre, no private parking spaces will be created (like several other projects, e.g. Eurostaete). One can opt for shared electric or public transport and visitors can, if needed, use one of the nearby public garages.

Another important idea was to choose a design that fits into the urban context as well as retains historical values. To make a good connection with the urban context, the total height of the new building must not exceed twice the height of the old monument and the heights of all buildings must flow in a natural way. The heritage is preserved by the renovation of the two old buildings and by implementing a saw tooth roof on the new building (with solar panels on one side and letting light in from the other side).

It is also important that people have a place to relax and connect with each other. For this reason, a private courtyard is planned with lots of greenery and a pergola. In order to establish a connection with the Dommel, greenery, wooden decking and other natural materials will be used in the construction of the inner garden. This further increases the connection with nature and the city. Furthermore the new building will have several green roof terraces where people can relax and meet each other. This emphasizes the connection between people and makes the connection with nature stronger.

Last but not least, climate and sustainability are important considerations in the design of the construction. In this respect use will be made of, among others, durable building materials, solar panels and an ATES system. Furthermore the walls of the new building on the courtyard side will be made of glass with an intermediate space, including balconies. These glass walls or “atria” can function as a solar chimney, which promotes ventilation and therefore less mechanical ventilation. All buildings will be BENG-proof and without gas.

Overview major integral design solutions

	Subject	Decision	Disciplines	Explanation
1.	Target groups residentials	Young generations	RE-U	In this group most demand for housing in the city centre and suits best the social and economic context in the centre
2.	Dimensioning buildings	Residentials not more than 7.000 m2 in total	BPS-RE	Extra residentials may cause problems with energy neutrality
3.	Underground spaces	Not desirable, therefore private storages on the ground floor (under the building)	A-BPS-RE	Underground spaces may also give problems with energy neutrality
4.	Mobility and parking	Shared electric transport (e.g. Amber) and public transport. No parking for private cars	RE-U	Sustainability and climate very important. Strengthening public transport is part of municipal plans
5.	Housing type (1)	Apartments, but no residential tower	A-RE-U	A tower meets possible objections local residents and does not fit in (historical) perspective of the location
6.	Housing type (2)	No ground bounded housing	A-RE	Private outdoor spaces desirable, but not feasible
7.	Housing type (3)	No flex/short stay or traditional hotel rooms (as possible combi with Plaza hotel and Plaza parking space)	RE-U	Short stay in the city centre has a limited target group and is financially infeasible. Uncertain financial future hotel market
8.	Dimensioning apartments	Several options: 20-40-60-80-90-100-120 M2	A-RE-SD	Meet target group’s needs. More options give more flexibility for structural grid
9.	Ventilation (1)	Glass walls/spaces with balconies on the courtyard side (to minimize mechanical ventilation)	A-BPS-RE-SD	Acts as a solar chimney. Also has an architectural value and balcony spaces increase value of the apartments
10.	Ventilation (2)	No large Atrium 563 m2	BPS-RE	Technically suboptimal and too expensive
11.	Energy production	Solar panels on top of the roof of new buildings	A-BPS-RE	Attributes to sustainability and climate goals government. Lower energy costs owners and users
12.	Types/location commercials	Offices, retail and catering in plinth new buildings, Monument and Brewery building	A-RE	Retail and catering fit best in city centre. Offices part of the assignment (= client). Plinth gives attractive appearance and old buildings mean continuity

Location (Urbanism)

The project area plot has a lot of potential as is located right next to the city center of Eindhoven. Schellens is easily accessible since it is located on the inner city ring, the Vestdijk also provides significant space for bicycle traffic. Quite uniquely, the plot is located next to one of the green strips of the city. Together with the Dommel river that flows through the area it makes the Dommel valley the cities most important green artery.

However, currently, little use is made of the plot's full potential.
The street scene is dominated by car and bicycle traffic, which solely uses the area as a flow-through area. Few pedestrians are to be found, which is strange for a central and high potential district like this.

The little use that is made of the area as an area of staying instead of only going through can also be explained through figure 1.3 on the right, which shows the quality of the plinth.

figure 1.1

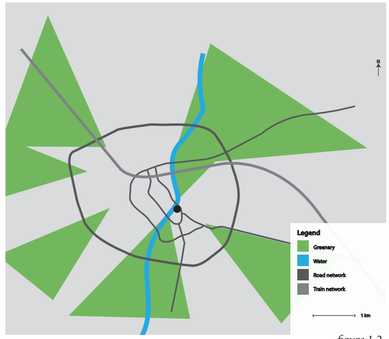


figure 1.2

figure 1.3

Analysis (Real estate)

Location Analysis:

- Total surface space plot 5.000 - 5.500 m2, existing buildings to redevelop (brewery 1.500 m2 UFA + monument 2.523 m2 UFA). Existing halls 3.080 m2 gf have to be demolished. Hotel Plaza with parking (plus minus 45, also used by Dela) is direct neighbour;
- Monument has very good qualities for redevelopment (heigh ceilings and unique historical features), however expensive renovation needed;
- Due to central location with lots of facilities and good connections (incl. nearby public parking) with the rest of the city, the plot has broad possibilities for extra functions.

Market Analysis:

- Shortage affordable housing (source: Funda, etc.), especially for middle incomes (source: Housing Program Eindhoven 2020 - 2025);
- Most important target group: people between 20 and 50 years old (source: CBS), namely students, urban starters, career couples/yups/dinks and wealthy young families (source: Municipal Report Eindhoven November 13th, 2018);
- Flex working spaces and co-working companies are needed (source: NVM 2018), especially in the centre since most flex places are now located on Strijp-S;
- Sufficient supply supermarkets, cafes and regular shops. Only some extra retail spaces for technical, cultural and design activities (preference municipality of Eindhoven); - The municipality of Eindhoven wants to stimulate a more car free centre (source: vision municipality of Eindhoven), so more parking possibilities are not desirable; - No extra flex housing and hotel rooms due to uncertain financial future (sources: Misset horeca/ Hosta 2020, Colliers International, CBS, ING Economic research and ED 2020).

Stakeholders Needs:

- Future residents: cheap and middle class rental/sale housing. Living space one-two person households 60-90 m2, young families ≥ 100 m2 (source: CBS). Future commercial renters: attractive work environment, good accessibility and affordable rent prices;
- Current renters and neighbourhood: continuity in business and pleasant living area. Plaza Hotel wants to keep their parking facilities directly next to the plot;
- Municipality: sufficient supply of (social) housing for a mixed group of households, green, sustainable environment in a car free centre (source: vision municipality of Eindhoven); - Housing corporation (Wooninc): sufficient supply of (social) housing and suitable redevelopment of the plot, including a new office;
- Investors and developer: a profitable real estate portfolio resp. an adequate (minimum) surcharge for risk and profit.

Vision:

- Focus on young people 20-50 years old and attractive (flex) working spaces; - Pleasant communal atmosphere (e.g. roof terraces and garden);
- No parking places, shared cars only (e.g. Ambers);
- Sustainability, climate and energy neutrality are important. For users and owners energy neutrality means a substantial lower energy bill and a contribution to a better climate.

History (Architecture)

The history maps show us that the building history of the Schellens factory is rather diverse, it all started in 1902 at the time it was mainly focused on the production of Trijp which was then used as the upholstery in trains and cars. Over the years the company flourished and expanded regularly, as can be seen in figure 2.1. This was causing a random collection of styles and building typologies mostly focused on its function, therefore degrading the quality of space (as can be seen in pictures c and d of the site visit). An interesting expansion is the one in 1949 when the Vestdijk moved to the West to accumulate the growth of the city of Eindhoven. The full renovation of the factory and the addition of an extra production hall was paid for by the municipality, implying the importance of the Schellens factory to the city. The façade on the Vestdijk side was designed based on the Monumental building in the South. This was one of the design elements that we valued and preserved. Just as the monument, and the brewery it has its own characteristic.

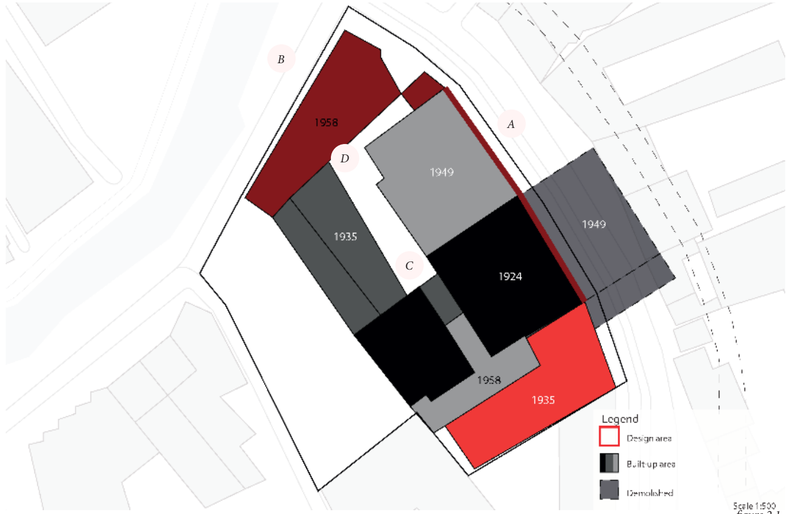


figure 2.1

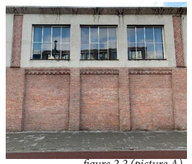


figure 2.2 (picture A)


figure 2.3 (picture B)


figure 2.4 (picture C)


figure 2.5 (picture D)

Vision (Urbanism)

figure 3.1

Dommel currently
The plot is located at the intersection of two important city axes: (a) traffic axis the Vestdijk which provide access to the city center for cyclists and motorists, together with an important cycle network along the Dommel and (b) the green Dommel axis, which continues from het Standswandelpark. Along the Dommel the currently derelict Fabrieksroute flows, which should lead visitors to cultural sights. However, there is no attractive connection for pedestrians (as opposed to cyclists) along the Dommel, while this is a quality that can be better utilized. We want to change this in our vision by combining the areas cultural and natural strengths.

Dommel vision
To utilize the full potential of the Dommel, the area will be transformed to a recreation area. This will be done by extending the usable green of het Stadswandelpark and connecting it with the green pedestrian zone next to de Mariënhagen path to the North. In addition, the connection of the plot with the city center will be strengthened by means of a pedestrian bridge and connection with the green neighborhood next to Het College. This city-scale development is out of scope of the Schellens renovation; however, this project should be the first step in strengthening the Dommel Area: the current DELA plot, where both connections intersect, will play a crucial role as recreational area with alternative 'city beach' function, where Eindhovenaren can interact with each other and the Dommel.

Masterplan (Urbanism)

The quality of life is central in Schellink, cyclists and pedestrians are given priority to promote the liveliness of the street scene and neighborhood. This is achieved by a pedestrian zone that connects Schellink with the city center. In order to optimize this pedestrian climate, the pedestrian flow is separated from bicycle and car traffic in order to minimize the number of (traffic) conflicts. This will be achieved by the new footbridge over the Dommel. This route is strongly reflected in Schellink's spatial design (given that it influenced the building volumes). The walkway forms a physical and visual connection with the monumental part of the factory and is publicly accessible.

Strong historical characteristics such as the brewery and the Vestdijk facade will be retained in order to preserve the industrial image.

To realize and maintain this pedestrian area, conflicting car transport has to be avoided and existing parking areas transformed. Urban parking consumes valuable land in an inefficient way, in our mobility masterplan we use mobility as a service or mobility on demand as a solution. Seen the central location of Schellink and its accessibility by public transport and the rigid cycle path network, the site allows us to set ambitious demands regarding active modes and car parking. This project can be used to actively steer in direction of urban sustainable mobility. In the shared bicycle storage, the Schellink community is offered shared bikes on which a large part of the city is accessible. For larger distances Electric Amber cars are a solution. Eindhoven is a service area for Amber cars, which means that cars can be requested on demand. Or users can collect the car from the Amber hubs next to the brewery or the DELA office, where they are visible and easily recognizable for the public. For visitors limited spots are available to demotivate car transport and normalize traveling by PT.

Public and Private space
The public 'city boulevard' with adjacent public functions gives Schellink an interesting role in the public space. In the design, a distinction is made between the various (semi) public spaces in order to attract the right audience. This is reflected in

figure 4.1

figure 4.2

figure 4.3


figure 4.4

the two recreational locations, where the DELA area is accessible to everyone to stay and recreate there, while the community garden, which is easily accessible, has a more private character. The two are connected by a semi-recreational pedestrian path.

Masterplan Detailed
These different kinds of public and private spaces resulted in the urban master plan as seen in figure 4.4. Priority is given to the pedestrian path along which the spaces are located. This outdoor space mainly consists of 3 area's. The one with the most public function is the recreation area at the Dommel bank. Sitting stairs and wooden piers enable visitors to interact with the Dommel. The design integrates the fluctuations of the water level, as some of the stairs are able to overflood. This area is a place to stay and meet each other as well as a connecting function as the Fabrieksroute flows past the recreational stairs.

Secondly, the square in front of the monument functions as public hub and as entrance for several public facilities located among it. The area has a hybrid flow through and attractive function.

Third is the community courtyard that is primarily designed for inhabitants of Schellink. The square is semipublic as it is accessible for passers-by. The courtyard has a more relaxing function as well as being a social hub where the Schellink community can meet each other. A grass pit with a table tennis facility is applied together with a step-by-step raising green pergola that mimics the green gardens of Het College.

Design (Architecture and building physics)

Green communal spaces
A design principle is defined by the green space inside the plot. This again creates a connection with the Dommel by visually connecting all roof terraces the outside green area is continued inside the built-up area. By focusing all residential roof terraces towards a semi-private courtyard the quality of these areas increases, compared to if it was situated at the Vestdijk side as can be seen in figure 5.1. The roof areas can be used by residents to meet, chat and enjoy the sun and they can be used for city gardening to feel more connected with nature. The solar chimneys in the courtyard form a softer barrier between the space inside the building and the courtyard. Next to the fact it has benefits for the building services, it creates the possibility of inside balconies for the residents. The multi-functional hall can be used for events initiated by the residents, the space beneath the pergola can facilitate these events also.

The two outside areas are defined by the functions focused towards it. The courtyard in the south has a public functions, defined the lunchroom, exhibition and retail spaces. And of course the seamless connection with the Dommel. The square in the North is facilitating a more private function, not only because it can be closed off during the night but also because it is more focused on the residents. The atrium creates besides that another level of private space.

Atrium (solar chimney)
The two atria connected to the main buildings on the middle of the plot form a soft barrier between the courtyard and the indoors spaces as seen in the section in figure 5.2. In the glass enclosed cavities the stack effect improves natural ventilation and thus reduces the operational energy demand. The atrium to the south also prevents overheating.
These atria create the possibility of having semi-private indoor balconies that will promote connectedness between the residents. These balconies also increase the sales value of the residential apartments adjacent to them.
The atria are supported by a glulam beam and column structure that minimizes the use of steel connection plates and uses mostly interlocking timber elements to reduce the embodied energy of the structure. Also in the curtain wall, the use of aluminium is minimized as much as possible.

Sections
The section in figure 5.4 is shows the sequence from the Dommel area to the public square in the North. Besides that, we can see that the pergola creates an open outdoor space without giving the feeling of being lost. While the section 5.3 nicely shows the interaction between the inside of the building and the courtyard.

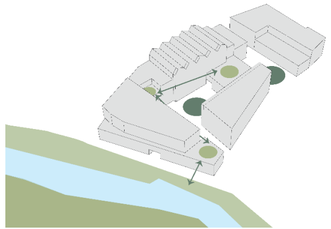


figure 5.1


figure 5.2

Facade
The east elevation in figure 5.5 shows the connection which is made with the plot where Dela is located and flows along with the building towards the square in the South. The building on this site can be closed off by sun shading, which is giving it a more private feeling towards the outside world. Due to this sun shading, the façade has a lively feeling to it, since the use by residents is noticed explicitly from the outside.
The sequence as shown in the bottom façade, is defined by the monumental building and the wall along the Vestdijk like discussed before. This sequence is used to define the structural grid and the sequence of the windows. The wood in the façade is overall horizontally oriented, only on the spaces between the vertical wood elements are placed. This is done to emphasize the sequence also in the façade cladding structure and not only let it define by the windows.
The vertical elements between the windows can be found on all facades of the building, the sun shading on the South-West side, which has been discussed before, takes the vertical orientating to a functional level.
The choice of the main orientation in the façade (horizontal/vertical) is made for each building explicitlye. For instance, the building on top of the brewery has much stronger vertical expression than the façade above the wall facing the Vestdijk. This is because the façade above the wall is expressing a combination of the façade of the monument and the wall at the Vestdijk combined.

The integration of the building in the urban context is done by examining the building heights carefully, the total height should not extend twice the height of the monument as well as it has to run smoothly over the full length of the building. The stair-shaped masses are oriented towards the South to fully use the qualities of the sun. The difference in heights between the right part of the building at the Vestdijk is essential to make it possible to have three floors on top of the brewery. This makes the building heights flow more naturally. The building at the bleekweg is placed not at each of the brewery. This, to make the transition from the Dommel area to the built-up area more natural, besides that it is done to make it structural possible. The foundation of a column can not be too close to an existing façade or column.


figure 5.3


figure 5.4


figure 5.5


figure 5.6

Housing typology (penthouse example)
The different housing typologies are based on the market analysis done. We can see how the integration of the wall along the Vestdijk works with the apartments. The windows are due to this a located more deep in the apartment compared to the other ones. This is compensated by the significant size of the windows. Not all 120m2 apartments have two outside walls, this makes it more difficult to facilitate three bedrooms: Resulting in two different layouts.
The floorplans of the apartments, especially the 120 m2 apartment on the top floor, show an integration of the good qualities of several disciplines. The heritage is preserved by implementing the saw tooth roof in a modern way, the roof is facilitating solar panels on one side and letting light in from the other part of the roof. This creates an interesting indoor quality of a high ceiling and windows which let light in from above, elevating the indoor quality of the apartments. Or adding value in real estate language.


figure 6.1

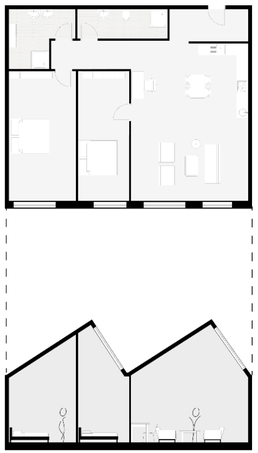
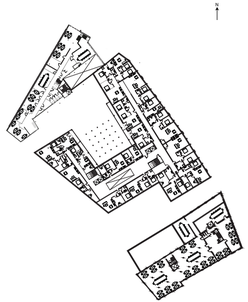


figure 6.2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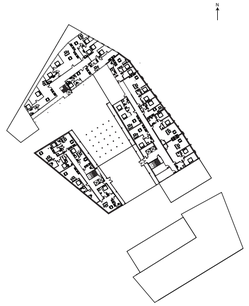
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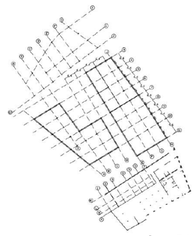
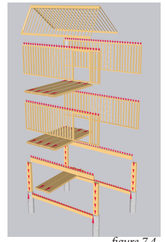


figure 7.1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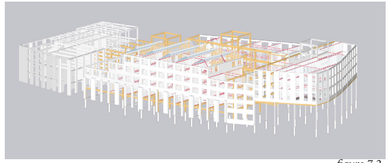


figure 7.2

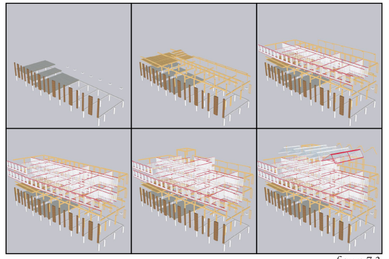


figure 7.3

Gridlines
The gridlines of the new structure are mostly determinate by the façade along Vestdijk. The spacing between façade elements is 3,2 m, making the spacing between the grid lines is 6,4 m. The gridlines of the structure on top of the brewery/restaurant are mostly determinate by the existing structure and the functions on the ground and first floors. To ensure continuous sightlines between the Dommel and the monumental part, an oblique gridline is used at the west side of the structure (gridline A in figure 7.1).

Material choice
The embodied energy of a timber column or beam is lower than the embodied energy of a similar concrete one. However, timber has lower strength and stiffness in comparison to concrete and expected to have a larger cross-section than concrete. Therefore, a timber structure has approximately the same embodied energy as an equivalent concrete structure. Besides that, timber is lighter, recyclable, reusable and has a lower CO2 footprint in comparison to a steel or a concrete structure making timber the main structural material of this project.

For the new structure on top of the brewery/restaurant, a concrete structure is chosen because concrete structural elements have a smaller cross-section than timber ones. Another reason for choosing concrete is the fact that the columns on the backside of the existing brewery/restaurant structure are in direct contact with the weather (see figure 7.2)

Structural elements
The ground floor of the new structure hosts functions such as a gallery, retail and a café. For this reason, GL Timber columns and beams are used. GLT columns and beams are also used for the structure of the solar chimney. The following floors are made for a residential function and have a high need for acoustically well-insulated walls. For that, prefabricated load bearing timber wall panels are used. The facades are also made of prefabricated timber wall panels. Prefabrication plays an important role in cutting down the expenses at the construction phase.

Vertical loads
The vertical loads are transferred from the floors elements to the load-bearing walls. The weights are transferred to the beam, to the foundation through the columns figure 7.4.
Prefabricated foundation piles are used as

foundations. This is especially important to the columns closer to De Dommel as the soil is expected to have a lower bearing capacity. The vertical forces of the roof shed are transferred through the rafters to the load-bearing facades figure 7.5. Thicker posts are needed at the end sides of the prefabricated façade panel to transfer the concentrated loads.

Stability

Stability in both directions is provided by shear walls (at least three in three planes) and by rigid floors. The prefabricated wall panels are provided with a single layer of OSB sheathing and double gypsum boards on both sides to improve their acoustical performance. The gypsum boards along with diagonals in the wall panels create a stable structure that can transfer the horizontal loads to the foundations through the columns. At the ground floor level, three diagonal are needed to stabilize the beam and column structure.

Solar chimney

The structure of the proposed solar chimney is made of GL timber columns and beams as in figure 7.8. The figure shows the way the structure of the solar chimney is connected to the main structure of the new building. The connections make minimum use of steel and made mostly of interlocking timber elements. Figure 7.9 shows a detail of the connection of the shed roof to the beams and columns of the solar chimney where the normal forces are transferred through the diagonals to the columns. The steel plate is used to put all the structural elements in place. To fit within transportation limits another interlocking connection is made in the GL timber beam, approximately L/5 from the column-beam connection where L is the clear span of the beam.

Figure 7.10, shows another connection made between the grider, the diagonal beams and façade panels. Both the diagonal beams are connected with the use of steel cable. The use of a steel cable helps to reduce horizontal forces in the timber beam.

Floor connection

To connect columns and beams at the ground floor level, an interlocking connection is used as in figure 7.11. Hollow core slabs are chosen for the ground floor and Lignatur floor elements are chosen as floor elements for the following floors because they are relatively lighter and have less embodied energy in comparison to CLT floors.

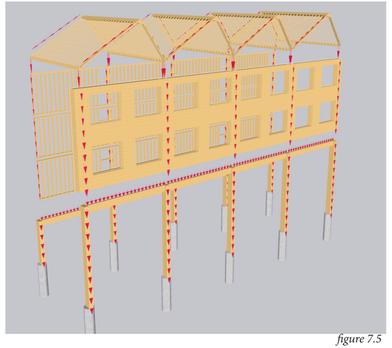


figure 7.5

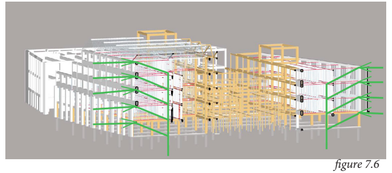


figure 7.6

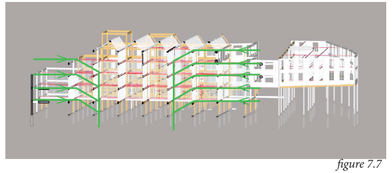


figure 7.7

figure 7.8

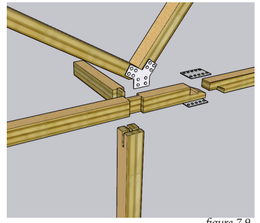
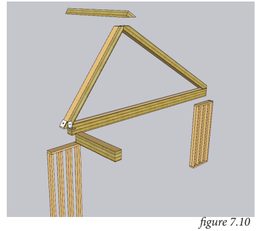


figure 7.9



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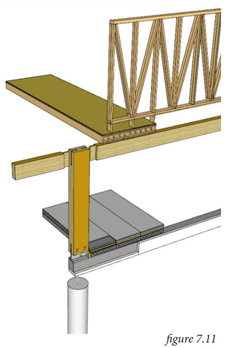


figure 7.11

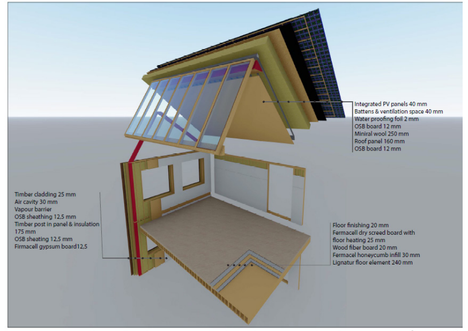


figure 7.12

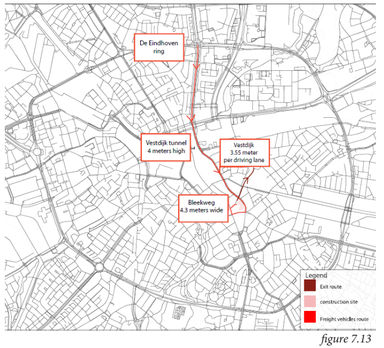


figure 7.13

figure 7.14

The detail in figure 7.12 shows the way the roof panels are mounted on the structure. The roof panels transfer half of their loads immediately to the wall panels and the other half to the main grider. Subsequently, the grider transfers the loads to the façade panels through to the main diagonals. The composition of the floor, façade and roof panels is depicted in figure 7.12.

Transportation and site access

Transportation of structural elements to the building site plays an important role in choosing the type of structure. Transportation up to 12 meters is made possible through Vestdijk as in figure 7.13. Heavy machinery (e.g. cranes) can access the open space in the middle through a 7-meter entrance at the west of the building as in figure 7.14

Energy management (Building physics)

Materiality
Multiple design decisions were made to minimize the energy required to realize this project, both operational and embodied energy.
In collaboration with mainly the structural design discipline, the choice was made to use a lightweight timber structure that consisted out of timber stud walls and Lignatur floor elements in the new buildings. These materials have a low embodied energy density.
Additionally cellulose in combination with wood fiber boards, two natural insulation materials with a low embodied energy density, were used to provide insulation in the new buildings as well as the monumental building.
The façade of the new development has a modern character with thermally hardened timber cladding. On the vestdijk the use of original masonry wall respects the traditional heritage of the site. Movable timber louvres create an element of depth in the façade, while also preventing overheating in the summer. In the summer an additional sun shade sail can span the two main buildings to provide shade, thus preventing overheating and creating a more enjoyable environment in the courtyard.

Ventilation
The residential apartments are use mechanical extraction ventilation with CO2 sensors and Invisivent NL ventilation grilles prevent draught. In the retail spaces and communal spaces on the ground floor a balanced ventilation system provides fresh air, additionally heat recovery (from the atria) reduces heat losses due to ventilation and reduces initial heating temperature differences.

Energy generation
On the roof PV and PVT panels supply electricity and thermal energy, furthermore an ATES-system acts as storage and heat recovery system. The green, sedum roof improves water retention and creates a gradual drainage system for water recovery. Rain and grey water from the water collection system are used to flush toilets. This can reduce the water demand of the building up to 15%.

Acoustics
One of the technical problems that was encountered during the design process was the difficulty of acoustic insulation of a timber structure. Due to the low mass of the timber structure, particularly contact noise could cause noise disturbances for residents

figure 8.1

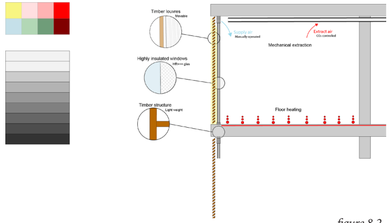


figure 8.2

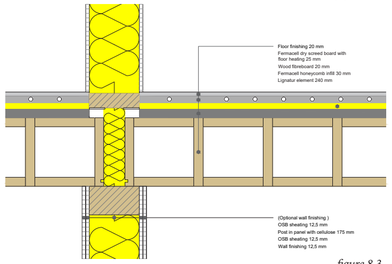


figure 8.3

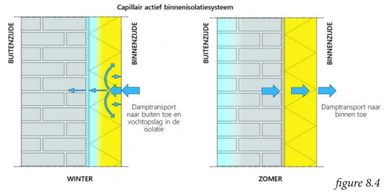


figure 8.4

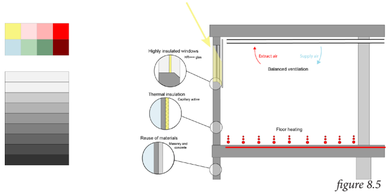


figure 8.5

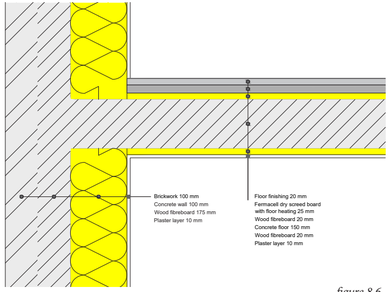


figure 8.6

on floors below. To prevent this 30 mm of Fermacell honeycomb infill was added to the floor system to increase the mass, on top of this 20 mm wood fiber board provided acoustical and thermal insulation. In the Fermacell dry screed board layer of 25 mm, floor heating pipes are applied to provide heating for the spaces above.

Insulation
In the monumental building, most of the structure and façade has been reused to preserve the original character of the building and to reduce the need for additional building materials. To lower the operational energy demand, the inside of the building is thermally insulated. Due to the thickness of the exterior walls, a traditional insulation method will result in the accumulation of moisture in the building envelope.
Therefore a capillary active insulation system with wood fiber boards was chosen. Capillary active systems are vapor open, so during the summer moisture can evaporate on the inside of the façade.

Ventilation
To improve moisture control and reduce energy costs, a central ventilation system with heat recovery is applied. Floor heating provides thermal comfort for the occupants in the different offices and exhibition hall. The different modules are using the PVT panels and the ATES system that provide warm water for the floor heating.

Conclusion
All these different design decisions have resulted in three distinct buildings with different operational and embodied energy values.
The monumental building has a high operational energy, but a low embodied energy. 74% of the mass of the building consists of concrete, but this accounts for only 1% of the embodied energy. The HVAC and solar panels account for 57% of the total embodied energy.
The second building, a combination of the old brewery and new building on top of it has a higher embodied energy density. Some steel and concrete structural elements were required to create the structure, however the embodied energy was reduced by reusing steel from the old site.
Buiding 3, the main building, has a low operational energy demand and a higher embodied energy demand. Both timber and finishing materials contribute significantly in terms of mass as well as embodied energy.
All of these buildings will be climate neutral by 2050.

Program and project results (real estate)

Table 1: Program residentials

Type	Number	Rooms	Bathrooms	Toilets	Prices	Location
Studio: 21 m2	14	1	1	1	€ 442 p/m	NB
Apartment: 60 m2	12	3	1	1	€ 752 p/m	NB
Apartment: 80 m2	22	3	1	1	€ 1.100 p/m	NB + BB
Apartment: 90 m2	9	3	1	1	€ 375.000	NB + BB
Apartment: 100 m2	13	3	1	1	€ 417.000	NB
Apartment: 120 m2	13	4	2	2	€ 550.000	NB + BB
NB = New building; BB = Brewery building; The 60 m2 apartments are intended for social tenants						

Table 2: Program commercial spaces

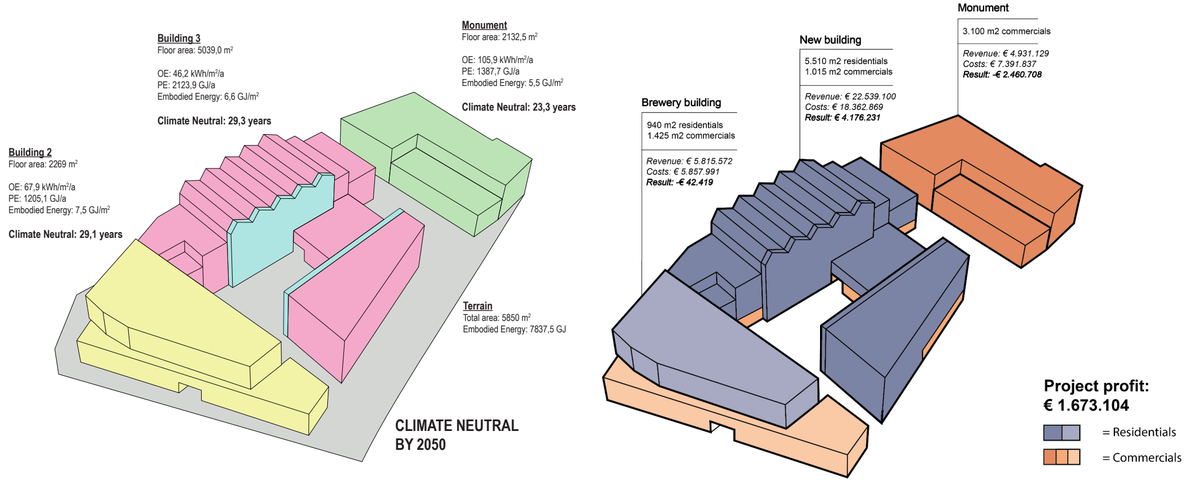
Type	Renter	M2	Price/m2/p.a.	Location
Office	Seats2meat	3.000	€ 180 p/m	BB + M
Exhibition space	Incubator	550	€ 150 p/m	M
2 multifunctional halls	Incubator	325	€ 150 p/m	BB + M
Horeca	incubator	185	€ 300 p/m	PNB
Office	Wooninc	75	€ 180 p/m	BB
3 retail spaces	New renters	180	€ 500 p/m	PNB
Brewery/café	100 Watt Brewery + Café	750	€ 180 p/m	BB
Office/shop	Studio Sander Mulder	75	€ 180 p/m	PNB
Office/shop	Lucifer CoffeeRoasters	150	€ 180 p/m	PNB
Office/shop	S-Plaza	250	€ 180 p/m	PNB
PNB = Plinth new building; BB = Brewery building; M = Monument				

Table 3: Project result per building (in euro's)

	New building	Brewery building	Monument	Total
Revenues:	22.539.100	5.815.572	4.931.129	33.285.801
Costs:				
- Acquisition/construction:	- 17.304.225	- 5.789.330	- 7.301.836	- 30.395.391
- Atria + communal spaces:	- 1.058.644	- 68.661	- 90.001	- 1.217.306
Profit/loss:	**4.176.231**	**- 42.419**	**- 2.460.708**	**1.673.104**
Calculations and detailed specifications see appendices				

Information Residentials and Commercials:
Urban complex where mainly young people live and work together;
All buildings energy neutral (BENG isolation + solar panels, CO2-sensored ventilation and "atria/solar chimney", ATES) and without gas;
Apartments have view on the courtyard and/or the Dommel. Apartments on top floor new building have views through a glass ceiling;
Apartments (excl. studio's) have private storages in the basement for bycicles + other things;
No private parkings. Possibility shared electric transport + public transport/garages nearby;
Centre with shops, restaurants, cafés and other facilities in short distance.

Schematic overview (Real estate and building physics)



Appendix

Revenues developer:

Residentials 6.450 m2 (UFA)	Type of real estate	M2 (av.) per unit	Number of units	Estimated sales price or rental price per month (*)	GIY (**)	Revenues total (***)	
1	Rental (student) studios	21	14	€ 442	3,8%	€ 1.955.697	*New building*
2	Rental social apartments	60	12	€ 752	3,8%	€ 2.850.935	*New building*
3	Rental apartments	80	22	€ 1.100	3,8%	€ 7.642.105	*New building (17) + Brewery building (5)*
4	Sale apartements	90	9	€ 375.000	-	€ 3.378.199	*New building (7) + Brewery building (2)*
5	Sale apartements	100	13	€ 417.000	-	€ 5.421.801	*New building*
6	Sale apartements	120	13	€ 550.000	-	€ 7.150.000	*New building (10) + Brewery building (3)*
			83			**€ 28.398.737**	

(*) Prices: maximum housing subside + maximum social housing + comparative method (funda, etc.).

(**) Source: MSCI (2019), Oxford Economics (2019), JLL (2019) and Syntrus Achmea Real Estate & Finance (september 2019).

(***) Revenues rental apartments based on gross investment yield method (GIY). Revenues sale apartments based on comparative method (funda, etc.).

Commercials 5.540 m2 (UFA)	Type of space	M2	Number of units	Estimated rental price per m2/p.a. (*)	GIY (**)	Revenues total (***)	
1	Offices (Seats2meet)	3.000	-	€ 180	9,0%	€ 6.000.000	*Monument 2400 m2 + Brewery 600 m2*
2	Exhibition space (= incubator)	550	-	€ 150	9,0%	€ 916.667	*Monument 318 m2 + 232 m2 Ext. Monument*
3	2 multifunctional halls (= incubator)	325	-	€ 150	9,0%	€ 541.667	*Monument 75 m2/Ext. Monument 75 m2 + new building 175 m2*
4	Horeca (= incubator)	185	-	€ 300	8,0%	€ 693.750	*Plinth new buildings*
5	Office housing corporation Wooninc	75	-	€ 180	9,0%	€ 150.000	*Brewery building*
6	3 retail spaces	180	-	€ 500	8,0%	€ 1.125.000	*Plinth new buildings*
7	100 Watt Brewery + café (current renter)	750	-	€ 180	9,0%	€ 1.500.000	*Brewery building*
8	Studio Sander Mulder (current renter)	75	-	€ 180	9,0%	€ 150.000	*Plinth new buildings*
9	Lucifer CoffeeRoasters (current renter)	150	-	€ 180	9,0%	€ 300.000	*Plinth new buildings*
10	S-Plaza (current renter)	250	-	€ 180	9,0%	€ 500.000	*Plinth new buildings*
		5.540				**€ 11.877.083**	

(*) Prices: comparative method (funda, etc.).

(**) Source: MSCI (2019), Oxford Economics (2019), JLL (2019), Syntrus Achmea Real Estate & Finance (september 2019) and Cushman & Wakefield/NVM Business (2020).

(***) Revenues rental commercial spaces based on gross investment yield method (GIY).

Costs developer (building, renovation):

Building costs per function (incl. BENG)	€/m2 (*)	Additional costs 30%	VAT 21%	Investment costs incl. VAT per m2 GFA	Incl. VAT per m2 GFA Ratio GFA : UFA
Storages					
Storage under building (gf)	€ 758	€ 227	€ 159	€ 1.145	€ 1.231
Housing					
Student studios	€ 1.400	€ 420	€ 294	€ 2.114	€ 2.782
Social housing	€ 1.317	€ 395	€ 277	€ 1.989	€ 2.600
Apartment building	€ 1.356	€ 407	€ 285	€ 2.047	€ 2.624
Horeca					
Incubator	€ 1.326	€ 398	€ 278	€ 2.002	€ 2.250
Offices					
Permanent	€ 1.314	€ 394	€ 276	€ 1.984	€ 2.229
Shops					
Retail	€ 1.326	€ 398	€ 278	€ 2.002	€ 2.250
Other + Public Space					
Atrium/Chimney (105 m2)	€ 1.876	€ 563	€ 394	€ 2.833	€ 2.833
Balconies atrium (258 m2)	€ 550	€ 165	€ 116	€ 831	€ 831
Garden (2.276 m2)	€ 66	€ 20	€ 14	€ 100	€ 100
Pergola (220 m2)	€ 583	€ 175	€ 122	€ 880	€ 880
Roofterrace (720 m2)	€ 497	€ 149	€ 104	€ 750	€ 750
(*) Source: IGG Bouweconomie, BouwkostenKompas Woning- en Utiliteitsbouw 2021 + HomeAdvisor/werkspot/verbouwkosten (online) other/public spaces prices					

Renovation costs	quantity m2 (GFA)	€/m2 (*)	VAT	Investment costs incl. VAT per m2 GFA
Monument				
Outer skin facades	1.269	€ 83	€ 17	€ 100
Inner walls	315	€ 186	€ 39	€ 225
Installations	2.793	€ 269	€ 57	€ 326
Brewery building				
Outer skin facades	783	€ 83	€ 17	€ 100
Inner walls (1st floor)	96	€ 186	€ 39	€ 225
Installations (1st floor)	675	€ 269	€ 57	€ 326
(*) Source: IGG Bouweconomie, BouwkostenKompas Installaties 2021 + werkspot/offerteadviseur (online) kosten gevelrenovatie/binnenmuren				

Costs developer (acquisition land/buildings, financing, demolition):

Land and building costs		M2	Price/m2 (*)	Total investment
Brewery building	(UFA)	1.500	€ 2.000	€ 3.000.000
Monument	(UFA)	2.523	€ 2.000	€ 5.046.000
Land	(GFA)	3.430	€ 733	€ 2.514.259
Transfer tax (8%)				€ 844.821
Total acquisition costs land/buildings (excl. financing/demolition)				**€ 11.405.079**

(*) Source landprice: ESRI (2015) Open Postcodevlakken [online], ESRI (2016) World Light Grey [online] and CBS index 2016-2021.
Price Brewery building and Monument based on comparative method (funda, etc.).

Financing costs during construction phase (2 yrs)	Amount bankloan	Rate (*) (nominal %)	Rate (NPV %)	Total financing costs
Bank interest	€ 11.405.079	3,5%	3,4%	€ 775.545

(*) Source: financiering-regelen (online) projectfinanciering bouwproject vastgoedontwikkeling.

Demolition costs	quantity m2 (GFA)	€/m2 (*)	VAT	Total investment costs (incl. VAT)
Complete (3.080 m2)	3.080	€ 25	€ 5	€ 93.170

(*) Source: IGG Bouweconomie, BouwkostenKompas Sloopwerken 2021

Overall result developer:

Building	Type of real-estate (Function)	Future owner	Estimated costs (building + renovation)	Estimated revenues	Margin (incl. VAT)
1	**Residentials: 6.210 m2 (UFA)**				
	* Rental student studios	Housing corporation	€ 834.474	€ 1.955.697	€ 1.121.223
	* Rental social apartments (60 m2)	Housing corporation	€ 1.871.769	€ 2.850.935	€ 979.165
	* Rental apartments (80 m2)	Investor	€ 4.618.432	€ 7.642.105	€ 3.023.673
	* Sale apartments (96 m2)	Private user	€ 5.542.118	€ 8.800.000	€ 3.257.882
	* Sale apartments (120 m2)	Private user	€ 4.093.610	€ 7.150.000	€ 3.056.390
			€ 16.960.403	**€ 28.398.737**	**€ 11.438.334**
2	**Commercial spaces: 5.640 m2 (UFA)**				
	* Offices	Investor	€ 3.561.751	€ 10.058.333	€ 6.496.582
	* Retail	Investor	€ 404.951	€ 1.125.000	€ 720.049
	* Horeca	Investor	€ 416.200	€ 693.750	€ 277.550
			€ 4.382.902	**€ 11.877.083**	**€ 7.494.181**
3	**Storages: 474 m2 (UFA)**		**€ 583.828**	**€ 0**	**-€ 583.828**
4	**Atrium (with balconies) + public spaces:**		**€ 1.472.939**	**€ 0**	**-€ 1.472.939**
				Total margin:	**€ 16.875.747**

Total margin (incl. VAT and before land & building costs):	€ 16.875.747
VAT (21%):	-2.928.849
Land & building costs (acquisition, financing, demolition):	-12.273.795
Overall profit developer:	**1.673.104**

1. Monument (incl. new extension):

* Revenues developer:		€ 4.931.129
* Costs developer:		
- Acquisition buidling (incl. finance costs):	€ 5.820.258	
- Building costs new extension Monument:	€ 684.417	
- Renovation cost old Monument;	€ 1.108.293	
- Communal space (garden + pergola):	€ 108.901	
- VAT (21%):	-€ 330.032	
		-€ 7.391.837
		-€ 2.460.708

2. Brewery building:

* Revenues developer:		€ 5.815.572
* Costs developer:		
- Acquisition buidling (incl. finance costs):	€ 3.460.320	
- Building costs new extra layer	€ 2.498.152	
- Renovation cost old Brewery building:	€ 319.950	
- Communal space (garden + pergola):	€ 83.081	
- VAT (21%):	-€ 503.511	
		-€ 5.857.991
		-€ 42.419

3. New building:

* Revenues developer:		€ 22.539.100
* Costs developer:		
- Land (incl. finance + demolition costs):	€ 2.993.216	
- Building costs new building:	€ 17.316.322	
- Atrium + Communal space (garden, pergola + roofterrace):	€ 1.280.958	
- VAT (21%):	-€ 3.227.627	
		-€ 18.362.869
		€ 4.176.231

OVERALL PROFIT: **€ 1.673.104**