

MASTER

Trifold development center from emergency to development

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TRIFOLD DEVELOPMENT CENTER

**FROM EMERGENCY
TO DEVELOPMENT**

Graduation thesis of Robin Koenhen
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Built Environment
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SUMMARY

This graduation project is about public buildings for refugees. As a group, we analyzed refugee camps around the world to unravel their pros, cons, defects and qualities. As individuals, part of this project, we came with different additions to this refugee camps in the form of a public building. The functions of these public buildings differ a lot from each other. From markets to sport centers and from schools to bath houses. I myself, came up with a multifunctional public building which is able to help the refugees to develop themselves and their environments.

Based on the different phases in refugee camps and informal settlements, I designed a developing building with multiple functions related to this phases. At first, the building starts as an emergency unit,

which provides sanitation, shelter, food and health care. Over time this building evolves in to a more public building with functions such as libraries, communal spaces and ceremony spaces. Together with the sloped public street and the covered public space, this building should be able to evolve into the new public center of the refugee camp.

The building is executed with the trifold building system. This is a system developed by Gijs Bouwens and I during the graduation. This building system should be able to create a full public building considering the criteria valid in refugee camps. Ultimately, the designed buildings can thus be seen as a kind of validity of the building systems.

Keywords: Refugee (camps), development, transforming program, public building, building system

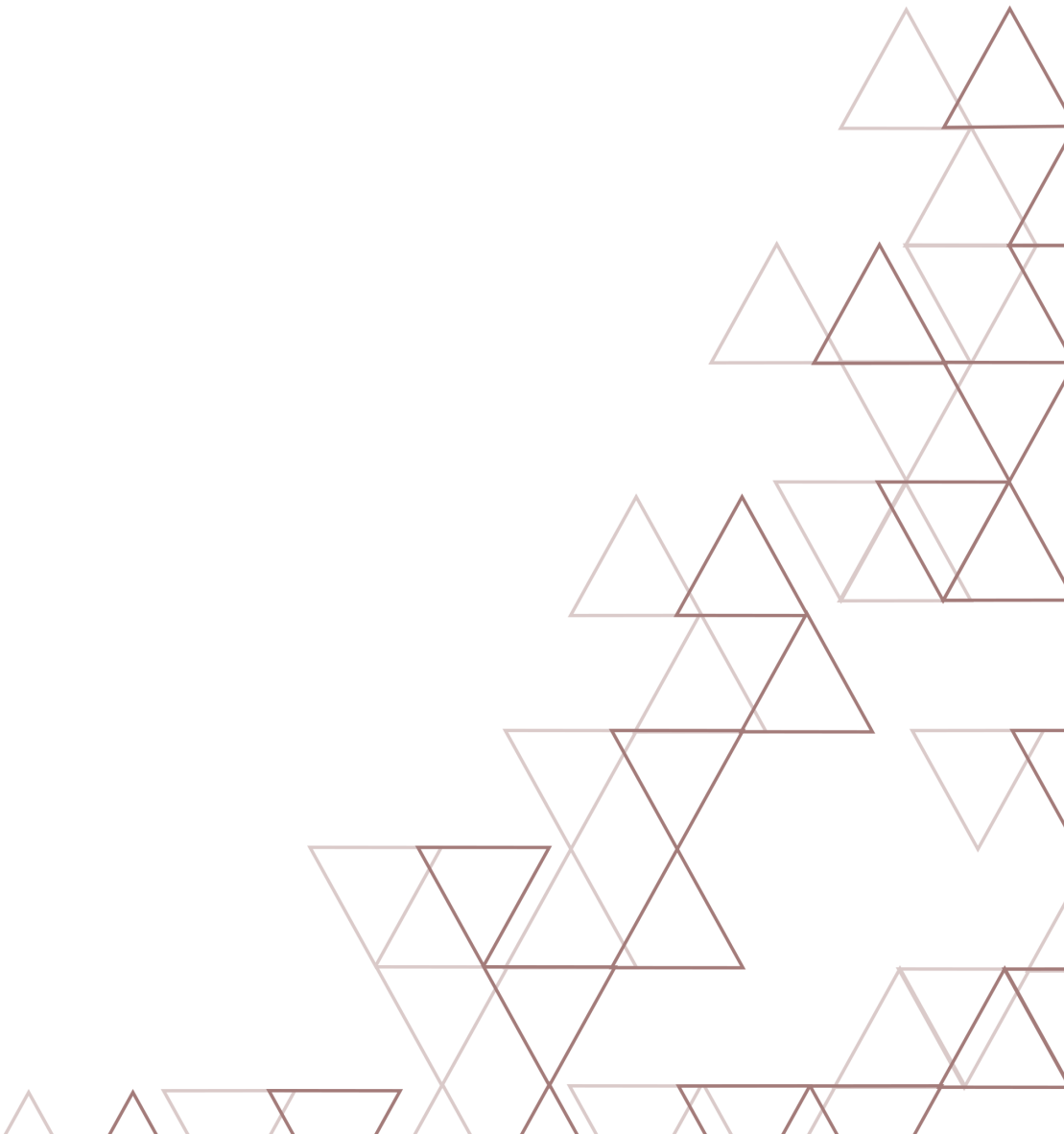
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Chapter 1

Introduction



1. INTRODUCTION

Since time immemorial a better life is considered by many of us. A better society and an ideal environment in which to reside and live. In every period of our rich cultural history, utopias have been thought about of ideal societies. Some imaginary, some concrete. In these ideals it is often the aim to turn the back to the present reality, including its shortcomings, and to offer an alternative.

Thinking about utopias offers the possibility to imagine today without its deficits and provides space for wishes, aspirations and ideals. However, between these Imaginations and the harsh reality there is a wide gap, or even a ravine. A ravine where many ideas are dismissed as fairy tales, where only one is seen as a landmark for the realization of an ideal living environment.

This thesis is trying to be the one. That one theory or invention that actually can be at the base of change. A well-founded and also concrete idea about an improved society. But not just any ordinary society. A vision of the future will be discussed which must improve the existing refugees camps and settlements drastically.

The main aim of this vision is to create circumstances wherein refugees are able to break free from the conditions in which they stay nowadays. A situation in which the refugees are no longer just waiting for something to happen, but can use their time to build up new lives. A situation wherein refugees are able to develop themselves with knowledge, care for themselves by making a living and develop their environment into acceptable living spaces. Are we talking about an ideal city? Who knows? The city is too complicated for a solitary definition, and perhaps it is one of our greatest mistakes to think of it as a singular, measurable quality [1]. In line of this thought this utopia might indeed be gathered under a city ideal. What it is, in any case, a way to give refugees hope for a better future in which they are able to rebuild their lives with dignity and in peace.

In this booklet, an element is elaborated which is part of this vision. A vision about the refugee city of tomorrow. This element should have a

stimulating effect on the transformation from refugee camps in emergency situation to refugee cities in development. In other words; the building should catalyze the transformation from camp to city. An enormous ambitions which, if we look at it realistic, is impossible to achieve with only one building. So maybe we should not look at this project as the solution for this thesis, but more as a smaller part which can help to create a solution. For this reason, this project specifically focusses on a smaller part of the bigger transformation; the transformation from emergency to development.

In practice, many refugee are stuck in emergency situation, while they are willing to develop themselves and their environments. Facilities, shelter, infrastructure, etc., all designed and constructed to serve as an emergency solution, but are often used for very long time spans. This permanent temporality has to end.

It is thus very important to help these refugees to make the next step. A step whereby emergency situations transform in situations of development. Contributing in making this step by providing a building off course raises some question;

- How can a public building, in the context of informal refugee settlements, catalyze the transformation from emergency phase to development phase?

This question can be divided in multiple smaller questions;

- Which program suits the best for the needs of refugees and is able to stimulate transformation of its environment?

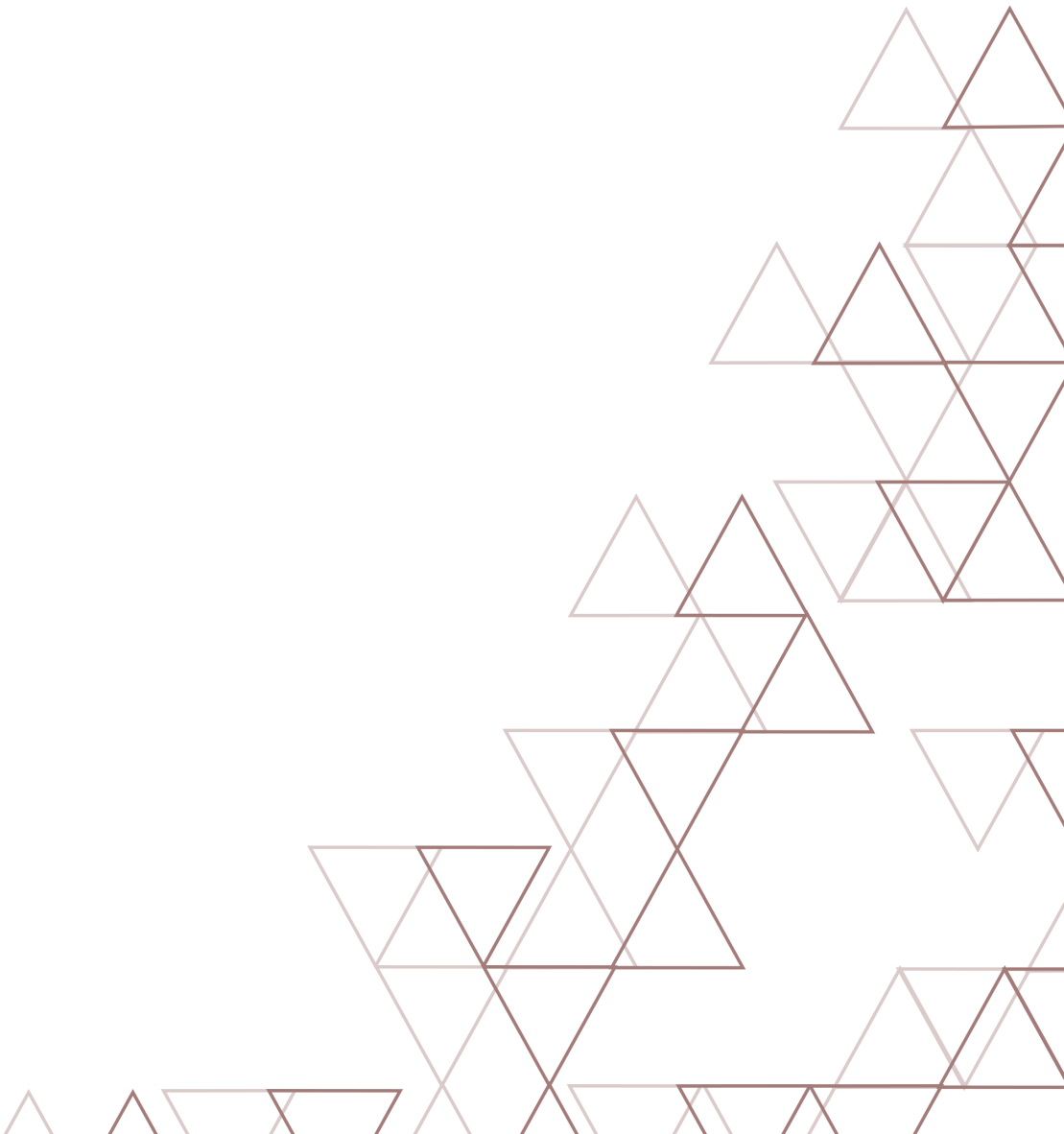
- How should the building and public space around it be organized in order to create a building which has the potential to evolve into the new center of the camp?

- How can a building system effectuate a building while taking the criteria valid in refugee camps in to account?

This book focusses on answering these individual question. First, theoretical research is used to make a well-founded ambition. This ambition is later elaborated on multiple levels. From building systems to a complete building and from this building back to the very detailing of it.

Chapter 2

Initial research



2.1 REFUGEE CRISIS

A refugee is a person who is displaced. Displaced outside of their country of origin. Refugees are people who are fleeing a conflict, persecution or affected area by natural disasters. Although this problem only seems to occur in one part of the world (middle-east) because of contemporary media, refugees are actually a problem in every part of the world. Nowadays, there are more than 20 million refugees worldwide.

Refugees come in many different kinds. There are refugees who are fully independent. They are able to afford or rent a house, managed to get a job and able to provide themselves with basic needs. This is perhaps the most beloved fugitive, because they do not require a lot of assistance and capital. When refugees do not have sufficient funds, can't find a job and can't care for themselves, they are most likely to end up in one of the refugee camps organized by UNHCR. These camps provide the refugees with basic shelter, often a tent, basic necessities and in some cases education. The third

group of refugees is also the most vulnerable one: the refugees who can't afford housing and can't stay in one of the camps because of a lack of transport or social tensions. This group of refugees is staying in Informal tented settlements. This book focusses on the last two types of refugees. The refugees living in camps and informal settlements.

The total amount of registered individuals that fled his or her residence is now being estimated at 21 million people [2]. According to this data, two percent of IDPs and refugees are living in ITS.

Although most refugees flee to areas nearby their country of origin, some refugees dare to make the step towards Europe. The effect of this refugee flow is very well noticeable the last years. The image on the right shows how and from where the refugees are coming.

[2] Figures at glance - UNHCR, 2015

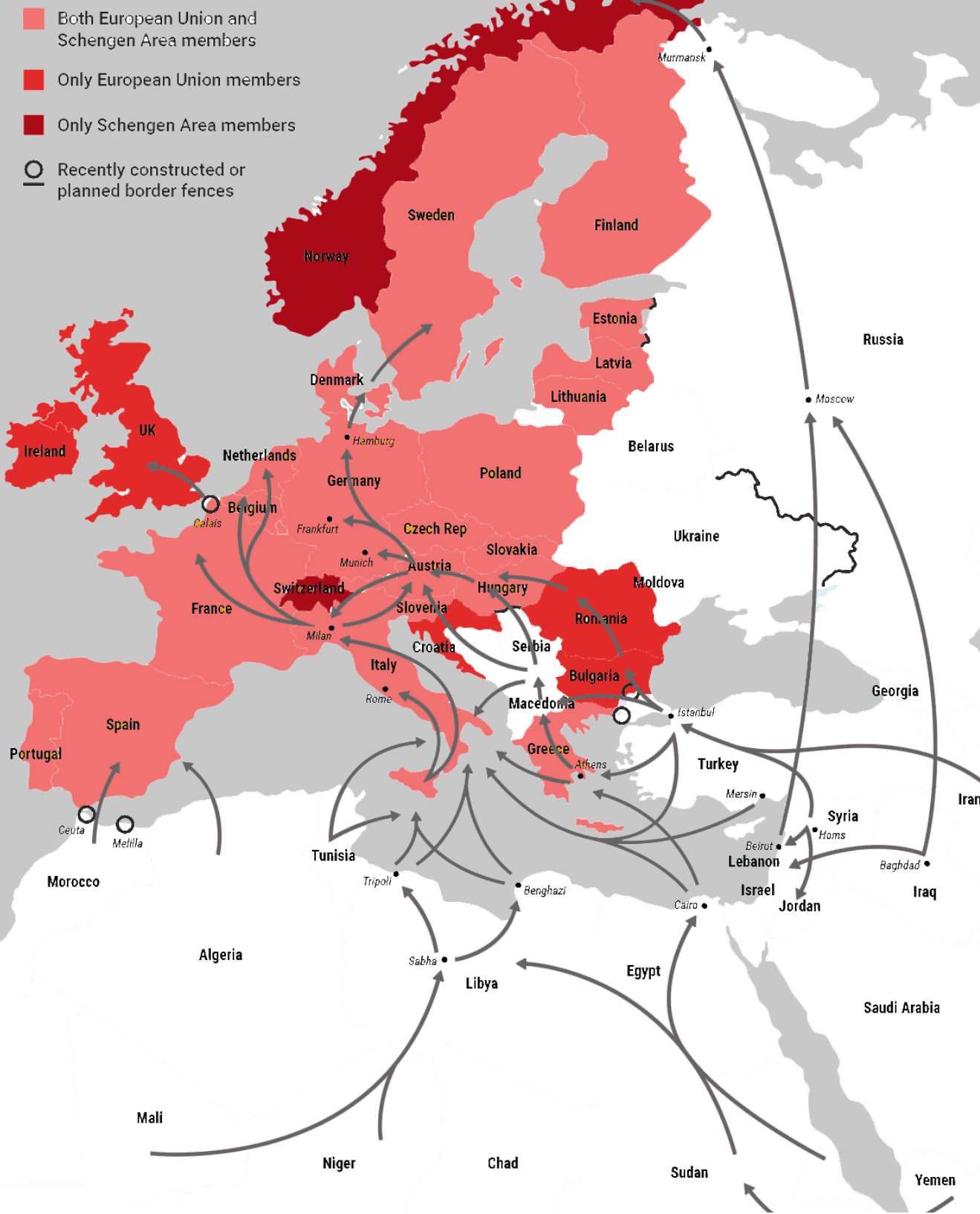


Fig 1. Map of refugee routing trough Europe - Dictionary, A public building for refugees, 2016

2.2 CAMPS AND SETTLEMENTS

At first sight, refugee camps and informal settlements have a lot in common. Probably largely because they share the same function, namely keeping refugees. Yet there are more differences between the two shelter options than there are similarities. The most characteristic differences are reflected in the following points, based on the findings by A. Schmidt[3].

1. Freedom of movement

Because of the organization and often clear boundaries of camps, freedom of movement is often more limited than in the informal settlements, where people can go wherever they want.

2. Mode of assistance

Assistance is always present in the camps. They provide medical care, basic necessities of life and organize the camps. These are often precisely the elements which are lacking in the informal settlements.

3. Population size and density

Because of the relatively good conditions in the camps, the demand for accommodations is very big. The camps take immense proportions in which

the density of people is incredibly high. This is much less the case in the informal settlements, which are often less big, less crowded and scattered around the area.

4. Location and shelter

Although the shelters in both cases, are far from ideal, residences in the informal settlements almost entirely consist of tents. In the camps you can also find dwellings of slightly better quality. Also there is often the opportunity to stay in one of the central public buildings.

Because of the differences between camps and informal settlements, there is not just one approach which is suitable for both situations. But often we see that an informal settlement over time grows into a full-fledged refugee camps. Especially in the beginning of this transition, camps do have a lot in common with informal settlements. For this reason, this thesis focusses on the context of informal settlements and new refugee camps.

[3] *Camps versus settlements* - Schmidt, A, 2005



Fig 2. Refugees in Lebanon are living in small settlement on farm land - Covenant companion, 2013



Fig 3. Zaatari refugee camp - Wikipedia, 2015

2.3 FIELD VISIT

During the graduation project, also research at location has been done. Two countries have been visited which both in their own way have to deal with the refugee problem; France and Greece. During this research all kind of refugee settlements have been seen, urban refugees, informal settlements and organized refugee camps.

In the summer of 2016, Greece was the destination. During a stay of one week we visited multiple locations affected by the refugee crisis. We have seen the city plaza hotel, a abandoned hotel which now is used by refugees. We also visited multiple refugee camps. The most interesting camp we have seen is the Elleonas camp, just outside the center of Athens. Finally we also visited an informal settlement in the old airport of Athens, whereby both inside and outside the hangars and in the surrounding stadium refugees were seen residing in tents.

The difference between the organized camps and the informal settlements is very well noticeable. Despite the fact that this specific informal settlement is supported by

humanitarian organizations, the basic qualities are much worse than in the other camps.

The situations where people stay is downright embarrassing. They stay in tents and there is no privacy what so ever.

In the refugee camps however, people stayed in relatively well constructed shelters. They even thought about adding public space to this camps in the form of a soccer field and a big canteen. There were more public facilities like medical care, schools, distribution points etc. The difference between these two kind of settlements was so confrontational that I decided to focus on informal settlements. This feeling was confirmed later that year when visiting the informal settlements of Calais.

Also here, the lack of support was clearly noticeable. There was almost no organization and rickety houses and tents were jumbled together in a giant mud pool. Public facilities were only there when it was initiated by the people themselves.



Fig 4. Elliniko ITS Athens - .Ekathimerini, 2016



Fig 5. Sylvain Mouillard, 2016



Fig 6. Elleonas refugee camp



Fig 7. City plaza hotel urban location in Athens



Fig 8. Calais refugee camp -Rachael Pells, 2016



Fig 9. Author, 2016

2.4 INFORMAL SETTLEMENTS

The crisis which Syria has long been plagued by, caused a big part of the massive amount of refugees seeking for a better live. This crisis nowadays still leads to a large increase in the number of refugees every day in neighboring countries and Europe [4]. From the outset of the refugee influx in Jordan, about five years ago, the local government has a policy whereby it is assumed that refugees are able to rent a house in one of the cities. When they are not capable, they have to reside in one of the organized camps across the country. What these government policy disregards is the fact that a large proportion of refugees are not able (due to a lack of transportation methods) or unwilling (because of intercommunity tensions) to inhabit this organized camps [5]. Because of a lack of solutions from a higher hand, refugees take matters into their own hands and search for a suitable place to stay. They end up on plots of which they have no rightful ownership and live there in tents or other ramshackle shelters. These are the so called informal tented settlements (ITS)

The official definition of an ITS is as follows: Areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally [6]. Or, as defined by the UNHCR: Unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing).

ITS differ a lot compared to each other in terms of size, composition and location. Still, most of them can be found in peri-urban and rural agricultural land. On the edge of the city, near to farmland or, in some cases, next to a formal refugee camp. The disadvantage of ITS is the fact that they are very hard to track, reach and provide with humanitarian aid. This is why refugees living in ITS are least likely to receive assistance. Things that were normally cared for by UNHCR and its partners, such as shelter and other non-food items (NFIs) are thus also sometimes lacking in the settlements. Besides this, refugees living in these settlements are not officially eligible for shelter, education, water, health or other basic social and municipal services [7]. This makes the refugees living inside them one of the most vulnerable and insecure refugee population across the countries

Location

ITS are thus often located in peri-urban and rural agricultural land in close proximity to the hosting community. Although sometimes the locations for these ITS seems random, in practice there are deeper lying reasons why they arise on sudden locations [8]. The most influential reasons are listed below:

Safety

Safety above all, this is also the case for refugees. People are leaving their country seeking for a safer and better place to stay. The locations where ITS arise are thus chosen because they are able to provide shelter for the future inhabitants.

Economy

[4] Syrian arab republic - UNHCR, 2015

[5] Syrian refugees in ITS in Jordan - UNHCR, 2014

[6] Definition informal settlements - OECD, 2015



Fig 10. Calais camp location - Author (2016) / BBC (2015)

Different than in the refugee camps, inhabitants of ITS are not assisted by NGO's. For this reason, they are often relatively economically active. ITS often are located on places that provide good economic opportunities. In practice this often means on the edge of big cities. This makes it easier for the inhabitants of the ITS to find a job.

Resources

There are different kinds of ITS. The conditions can vary considerably and they differ a lot in terms of organization. Yet in both situations there is the need for resources. Some settlements arise close to water, food or even wood (for making a shelter) where other settlements arise close to villages or cities so that the inhabitants are able to buy their resources in stores.

Transport

Last but not least, transport. In the life of a refugee transport plays an important role. The accessibility and need for transport determines in many cases the place for refugees to stay. Because of a lack of transport, refugees are often forced to camp on the location where they left behind.

Strategic location

In other situations, refugee settlements arise in areas with an ideal location, as is the case with Calais, shown in Figure 4. Here refugees gather who want to make the crossing from France to England.

[7] *Syrian Refugees Staying in Informal Tented Settlements in Jordan*, REACH / UNICEF, 2014

[8] *Mapping the process of informal city making* - Samper, J, 2015

Necessities of life

When a resident of an ITS is not fully able to care for himself or is not self-sufficient, the lack of assistance in the form of humanitarian aid can ensure that problems arise in obtaining the basic necessities of life. The REACH program, founded by UNHCR to analyze and map information about ITS, also did research in this settlements in terms of this basic necessities. This research shows that 59% of the assessed households living in ITS where food insecure. Almost 80% relies on WFP (Water-food program) assistance that they only barely get. Things like fish, vegetables and other healthy resources are obviously almost never present in ITS; only 1.1% weekly eating sea food and 10.2% a form of fruit [5].

Besides food, also water is lacking. Only 8,6% is relying on municipal connections. Most of the households, 56.6% to be precise, reported private vendors as their primary source of cooking, drinking and washing water [5]. Because of this scarcity, households are often dealing with water shortages and are forced to borrow water from friends or family.

Physical shelters for refugees are often substandard. The majority of households reside

in tents (90.7%) or “makeshift shelters”, constructed of tarpaulin, plastic sheeting and corrugated or scrap metal. The location on which they reside is often private land, which brings insecurities due to the fear of acute eviction by the landowners. This forces the refugees in a more nomadic lifestyle. When there is a tendency in which refugees can stay longer in one location, generally also higher living standards are measurable. The refugees often seek illegal ways to provide themselves with electricity and water, but also ways to improve their shelter.

Facilities

Of course, it is not possible to relate ITS with every thinkable facility. For this reason, only the three most important are mentioned: Sanitary, Education and Livelihoods.

A lot of the ITS across the country of Jordan have a serious lack of sanitation. In many cases, the households do not have access to either private or communal latrine infrastructure [5]. The capacity to dispose of human waste in a sanitary way appears to be extremely limited in ITS, which provides a fertile breeding ground for the transmission of disease-causing organisms [5].

Another major shortcoming is the lack of education in ITS. The analysis by the REACH program shows that only 3.5% of school aged children were actually attending school. This mainly caused by the lack of funds and distance to the schools. What is really striking is the fact that 41.4% of all school aged children have never been to school in their lives. This is an indirect result of the low educational levels of the parents residing in ITS. Most of them had only access to primary education and a big proportion did not attend to school at all. A logical consequence is the fact that it is relatively difficult to find jobs for this population. Because of this they are found to be drawn from the poorest socio-economic strata of Syrian society [5]. Only 19.8% of people living in ITS had access to a job

[5] *Syrian refugees in ITS in Jordan - UNHCR, 2014*

for one or two days a week. The big proportion of this percentage consist of children. Because they have no school to attend in, children are often used as a generator of income. Because children are very cheap to hire, it is also very interesting for local employers to have a child in service [5].

Conclusion

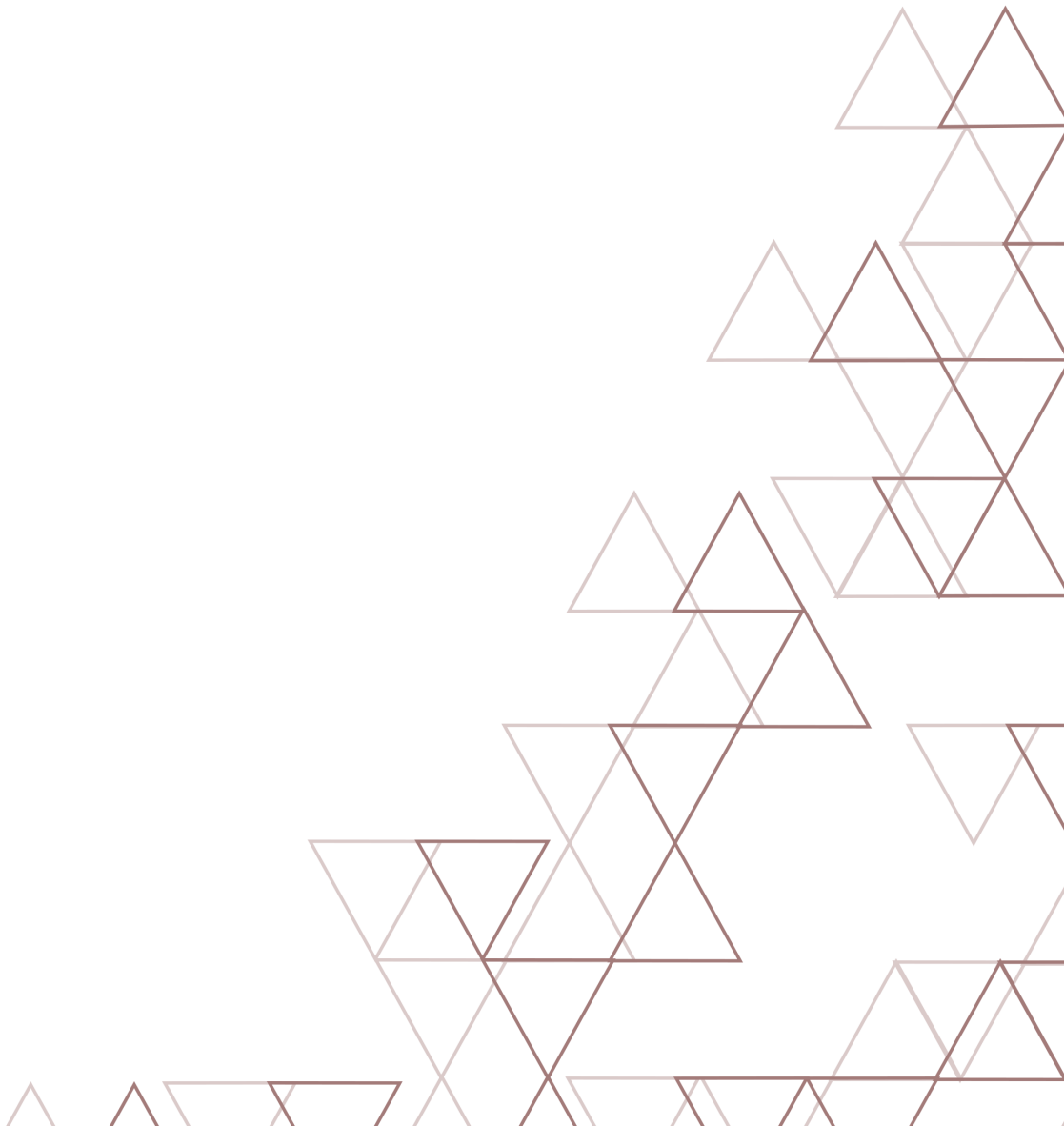
The growing number of refugees creates one of the ITS ended ensure that this problem is growing and extremely topical. People staying in these circumstances are scaled tot the most vulnerable group of refugees. To improve the situation of these people humanitarian aid is needed in an effective way and performed in a coordinated manner. The following intervention priorities are established on the basis of the examination of the UNHCR REACH program:

- Because of the high percentage of children in ITS, incorporating the specific needs of children in any common response strategy is vital.
- Education and post-basic training schemes should be devised and offered to school-aged children and adults.
- The poor health conditions and lack of vaccination should be compensated.
- A solution is needed for the lack of proper sanitation in order to prevent further deteriorations in health and hygiene outcomes.
- A durable solution should be provided in order to improve livelihoods.
- Besides agriculture there should also be alternatives in case of failed harvesting. The degree to which people are self-reliant should be improved.

The results of this study and the UNHCR

recommendations will be considered in further research. In order to stimulate the transformation it is obviously of great importance to take the wishes and needs of the people into account.

Chapter 3
Goal



3.1 MAIN GOAL

The complexity of the problem concerning refugees ensures that even after years, the conditions in a lot of tented settlements have not improved. It looks like the disaster, war or natural, which forced them to flee could have happen just months ago. There are millions of people living in situations like this. A life in which they constantly have to worry about food, water and medical help.

However, a change that is visible, is that refugees take matters into their own hand to improve their living conditions in the tented settlements. The temporary shelters are sometimes taking forms of permanent living places. This sign of preparedness to develop is a very positive sign. In the history of Europe, a lot of settlements have transformed this way. Temporary shelters have been transformed into districts and have become a part of the city. Every early inhabited area begins with an appropriation of land. The approach of this investigation is to consider the tent camps as a new urban district in development which should be incorporated into instead

of being regarded as an illegal settlement to be deconstructed.

Instead of moving against them help them to help themselves. Provide them in their needs and give them space and facilities to develop themselves and their environment. In other words: it has to be a building wherein emergency facilities and development possibilities are united by means of a temporary structure that can become a permanent public building. A public building can be a catalyst for the development of tented settlements to a permanent district. The community building can be a center that drives self-reliance, a building that grows and stimulates growth that way.

3.2 CATALYST

As mentioned before, the main aim is to improve the circumstances in informal settlements or new refugee camps. In other words, by creating a public building the context of the settlement should transform from emergency situation into areas of development. When a building has the purpose to improve its environment, we call this catalyzation.

The term catalyst is obviously originally no urban or architectural expression. The name is borrowed from chemical disciplines. In chemistry, this phenomenon is a well-known and often used method. The literal definition of a catalyst, such as described by the chemist is as follows: *"a substance that enables a chemical reaction to proceed at a usually faster rate or under different conditions (as at a lower temperature) than otherwise possible [9]"*. Despite its origin, the term begins gradually to penetrate the architecture and urbanism.

The main difference between catalyzation in science and in urbanism, besides the context, is the predictability. In a laboratory a chemist adds a number of ingredients according to a proven

formula, knowing what the result will be. In urbanism, there is both no proven formula and no predictable outcome. This doesn't mean that urban chemistry is entirely indeterminate and unpredictable, but to a lesser degree than in a controlled environment such as a laboratory. An urban process is not proceeding chronologically from A to B and in subsequent steps from C to D. As Wayne Attoe says it: *"A catalytic process might bounce around in a looser (though not random) fashion before achieving a desired end"*[10].

Still, there are some similarities between catalysts in chemistry and catalyst in Urbanism. In both processes, catalysis involves the introduction of an element or ingredient to change or modify others. During this process, the catalytic element itself often remains intact, but can also be modified and incorporated in its environment. In chemistry, this catalyst is a substance and in urbanism, this catalyst can be architecture.

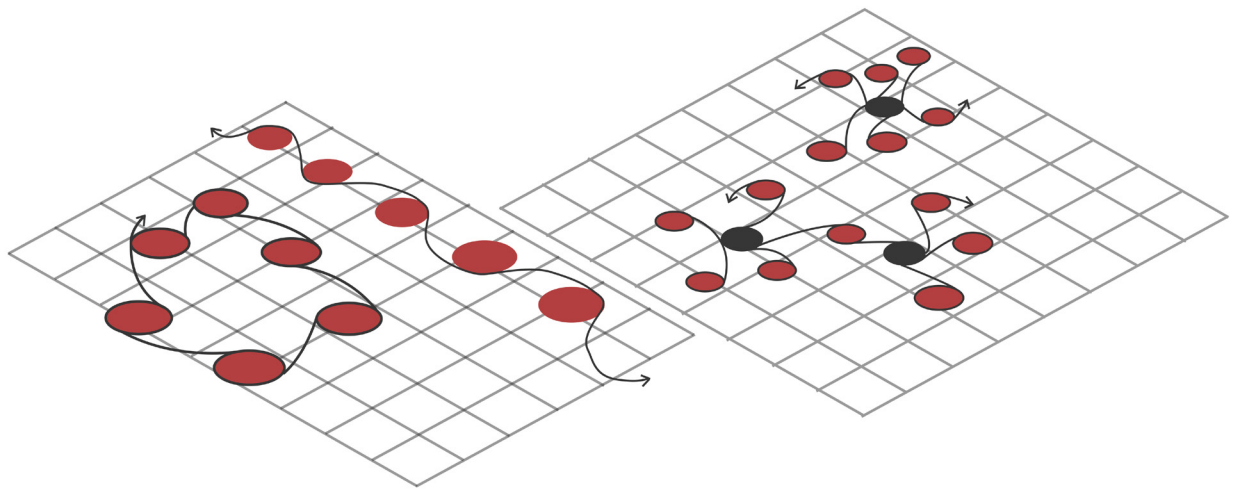
The catalyzation theory in urban design is not an alternative to known existing theories, but rather subsumes them [10]. In contrast to these existing theories, the theory of urban catalyst does that one thing that existing theories fail to do: describe how to get from goals to implementation.

An urban catalyst has a greater purpose than to solve a functional problem, create an investment or provide an amenity. A catalyst is an urban element that is shaped by the environment and then, in turn, shapes its context. Its purpose is to incremental, continuous regeneration of the urban fabric [10].

A catalyst design is thus never an end product, but an element that is able to stimulate and guide further development. *Urban catalysts are able of molding a city in any of several ways, none of them dictated by a single-minded vision [10].* Although the theory is nowadays starting to take its general membership in architecture and

[9] Definition catalyst - Mariam Webster, 2016

[10] Catalysts in the design of cities - Attoe, 1989



Catalyze type 1
catalyst as serial succession

Catalyze type 2
catalyst as acupuncture

Fig 12. Catalyzation types - Author / [10]

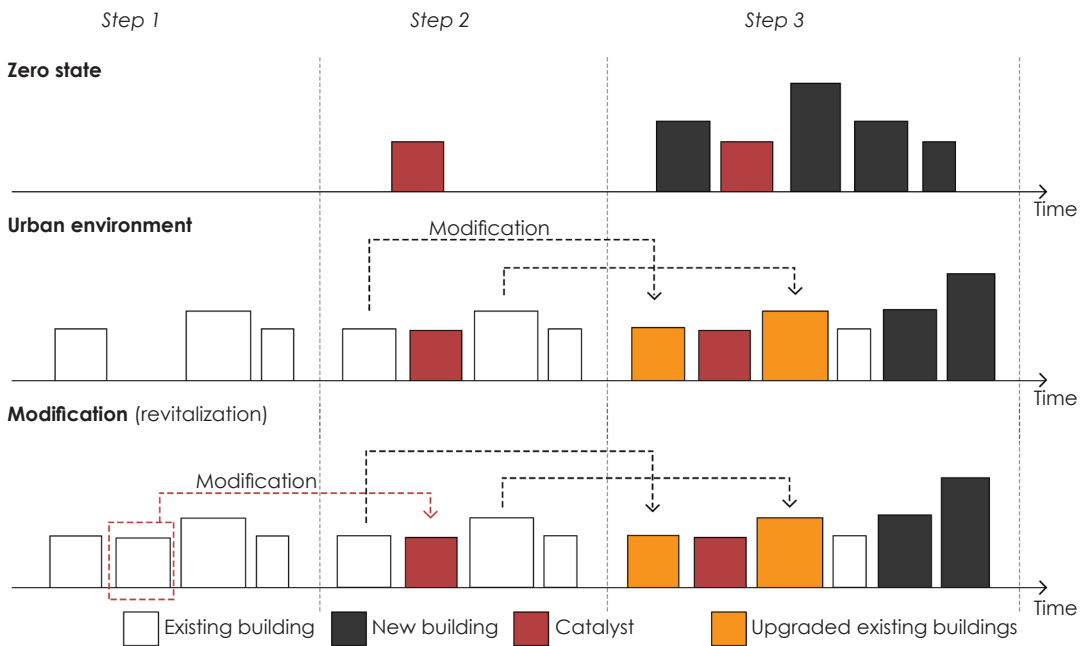


Fig 13. Phases in catalyst progress - Author / [10]

urban planning, the theory has been around much longer. The original concept of urban catalysts was defined by eight factors[10]:

1. New elements modifies the elements around it.
 - The potential of a building to influence its environment and guide future development is enormous.
2. Existing elements are enhanced or transformed in positive ways.
3. The catalytic reaction does not damage its context.
 - To unleash a force is not enough. It must be channeled.
4. A positive catalytic reaction requires an understanding of the context.
5. Not all catalytic reactions are the same.
6. Catalytic design strategic.
 - Change occurs not from a single simple intervention, but through careful calculation to influence future urban form step by step.
7. A product better than the sum of the ingredients.
8. The catalyst needs to remain identifiable.
 - Its identity need not to be sacrificed when it becomes part of a larger whole.

Despite these clear ground rules, it is impossible to set a design standard which would have effect in any situation. In one city a catalyst might be

a shopping complex, in another a hotel and in a third a transportation hub. It could be a building block, open space, an architectural element or even a playground. The common mistake people make is to think of catalyst as super developments like for example sports arenas or airports. It is way more accurate to describe an urban catalyst as a smaller element, a building and the space around it, which will kick-start redevelopment activities in its environment [11]. The emphasis in catalytic design is more on the program than to design itself. It works from a master program instead of a master plan, whereas a masterplan is more specifying an end condition in the future and a master program sets objectives and ways to reach them depending on the circumstances.

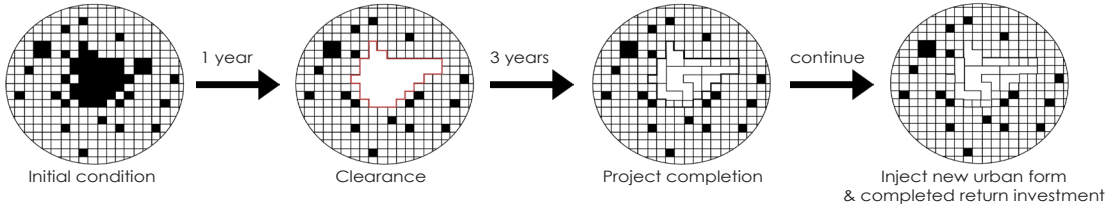
As existing “normal” urban theories, the catalyst theory is also not without any risks. There is a danger of failing to have the desired impact or inhibiting development. But the positive thing about it is that a negative catalyst also brings possibilities. *A development can act like a sponge in soaking up resources and activity, depriving adjacent areas. It can fail to inspire responses. Failure to light a spark can discourage others from investing time, effort, and financial resources. Programs, strategies, and designs need to be properly conceived if dynamic, productive catalysis is to happen*[10]. The real driving force of making a city, camp or settlement become vibrant, alive and economically feasible rests in establishing in the collective mind of the people what the area can become [11].

The method of catalysts

Now we know what an urban catalyst is, it is now important to find out what can make such an element to success. Despite the fact that it is not possible to define an unambiguous design which could be used anywhere, it is possible to establish guidelines on the basis of success in the past. As Lynell Bohannon listed in his study of catalyst, success depends on a series of factors which can be divided into

[11] *The urban Catalyst concept - Bohannon, 2004*

Traditional redevelopment strategy



Urban catalyst strategy

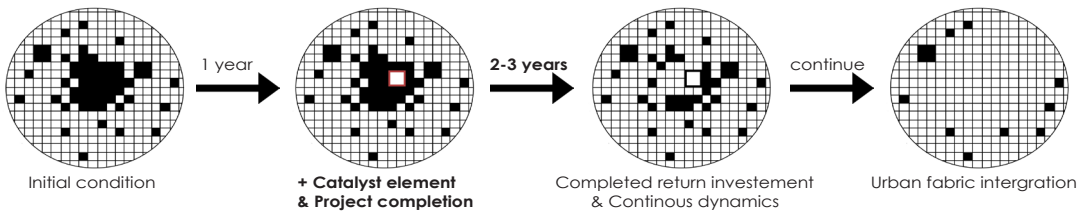


Fig 14. Traditional redevelopment strategy vs. urban catalyst strategy - Author / [10]

specific themes: Spatial conditions, Morphological factors, Perceptual factors, social factors, visual factors, functional factors and temporal factors.

- Visual factors
- Visual and kinesthetic.
- Visual awareness
- Provide movement cues for users

Spatial conditions

- Near commercial activity
- For an urban catalyst to be successful, the catalyst must not be a stand-alone element, but rather an element within a framework that guides future development [12].
- Pedestrian flow

- Functional factors**
- Respond to basic needs people seek to satisfy in urban space: comfort, relaxation, passive and active engagement and discovery.

Morphological factors

- Awareness of morphological characteristics of the context
- A range of block sizes, determined by local context, provides best opportunities.

- Temporal factors**
- Mix-used activities should be related to the time

Perceptual factors

- Perceived by its users
- Image ability recognize in tissue

This theory about catalyzation is off course initially not intended to be used in refugee camps. But there are a lots of examples showing how the use of public buildings can actually catalyze development in refugee camps or informal settlements. Because of the absence of qualities that are taken for granted in most

Social factors

- Shaping built environment influences patterns of human activity
- Strategically plan activities and arrangement

[12] What makes buildings catalyc? - Steenberg, 2002

cities, a public building in the context of a refugee camp or settlement can have a much greater impact than a public building in a normal city. To prove this effect, below several examples are presented which are showing the stimulating effect of public building in refugee camps.

Context-related reference

When schools in its urban context are examined, a clear relation can be found between the school as an element of urban infrastructure and urban development itself. A clear example of this is for instance, a neighborhood where a lot of new housing has been build will often result in the construction of new schools. However, what is often forgotten is that this also works in a reverse way. A good school will attract families, which need new housing. Schools can thus indirectly increase the demand for residential space. So besides their educational function, they can also act as an urban catalyzer. This phenomenon not only occurs in cities, but is also applicable in camps or informal settlements.

The perfect example, as presented in the book from camps to city, was in the camp near Smara, the school called 27 February. Initially, this was

not a camp. It was a boarding school situated in sub urban environment. The school was founded as an adult education center, teaching woman vocational knowledge and specific crafts [13]. Because of its function, this school started to attract families from out the region. This started with just a few small tents and huts. Over time, more and more households joined around this school. People started to make this place their permanent home. Slowly but surely, the tents were replaced by better-structured shelters. Later it became much more than just a school. The settlement itself began to take life. There were facilities such as shops, markets and other issues, and the population increased steadily. Today, this settlement is a refugee camp. A refugee camp with electricity, air-conditioning systems, ongoing assistance and much more. The school here has thus ensured that a sub-urban location was transformed into well-functioning and structured refugee camp. And this is not the only example of the generational power of schools.

CONCLUSION

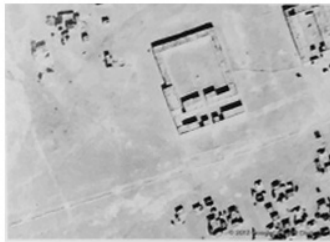
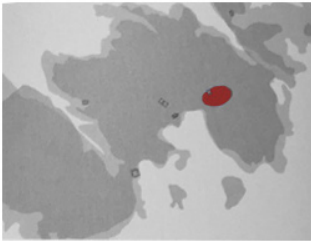
The use of a building as a catalytic element can be very effective in the circumstances of a refugee camp. However, the approach has to be way different then in a “normal” city. For example, a hotel will not have the desired impact, because it simple doesn’t suites the needs of the refugees. But based on the factors listed by Bahonnan in the book “ the urban catalyst concept”, basic principles can be extracted which can be useful for making a design.

As it turns out, the placement of the building in the environment is of great importance for the effectiveness. The building has to be located strategically with the eye on future development of the area and should be arranged on the basis of the framework of this area. At its location, the building has to be noticeable for its nearby environment. This visual awareness is very important for

[13] From camp to city - Herz, 2013

De marzo primary school

commercial and institutional densification



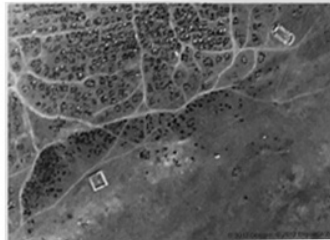
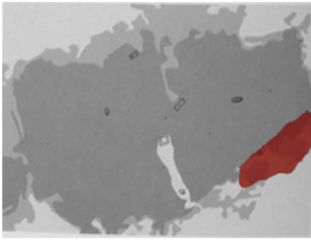
2003



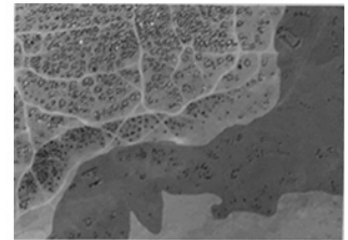
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MMD primary school

Development of peripheral zone



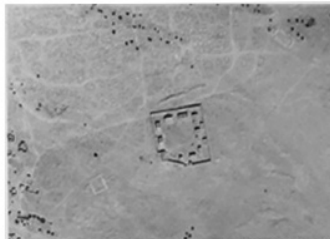
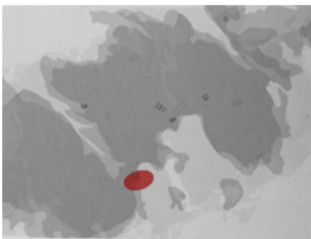
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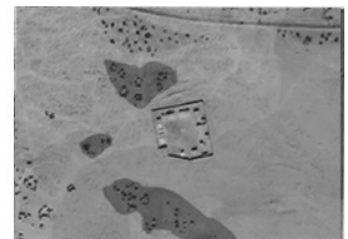
2010

Umdraiga primary school

Residential growth around a school



2003



2010

Fig 15. Examples of urban catalysts in the context of refugee settlements - from camp to city, 2013

the attraction to its surroundings. But also the separation of busy areas and the more quiet zones appears to be an important factor in designing a catalytic building.

But besides all these design elements, there is one extremely important aspect; the program. The program has to fit its environment perfectly. It has to be a mix of public and private functions which provide space for carrying out activities required by the residents of the area, or in this case the refugees.

The needs in refugee settlements are way different than in normal circumstances. Even between

different settlements the needs of the residents can be quite different, because one camp will have already been more civilized than the other. For this reason this project doesn't have a fixed program, but a program that responds to different phases in a refugee camp, as defined by UNHCR: the emergency phase, the development phase and the release phase.

3.3 EMERGENCY

There is always a cause which forces people to become refugees. This can be a natural disaster, social political conflict or a war situation. When a conflict like this happens, measures are being taken to support the people in these situations; refugee settlements arise, some formal, some informal. When new settlements arise, measures are being taken to help the refugees fast and efficiently, which result in quick low tech solutions without considering long term quality.

There are three phases in refugee settlements: emergency, development and release phase, based on the findings by Eefje Hendriks. The emergency phase is thus the first phase in which the refugees reside. This first phase is all about priorities. The priority to give shelter to refugees, provide them with clothes and give them access to sanitation. Because of the fact that this project should be suitable in multiple locations, it is important that the spaces are not being assted to only one function. The needs in different situations can vary considerably. This asks for certain flexibility in this emergency phase.

To fulfill the needs in the emergency phase, a space will thus be provided in which three functions can be situated; a distribution center, health care and emergency sanitation. The distribution center will distribute shelter (tents), food and clothes. The health center should be able to provide vaccination and basic care (based on the findings and recommendations in chapter 2.3) and the sanitation consist out of showers and toilets for both man and woman. How big the functions are related to each other can be determined by the needs in of the local situation. For example, after a natural disaster, the need for health care will be much greater than after a political conflict or war. And also the demography in different situation can vary a lot.

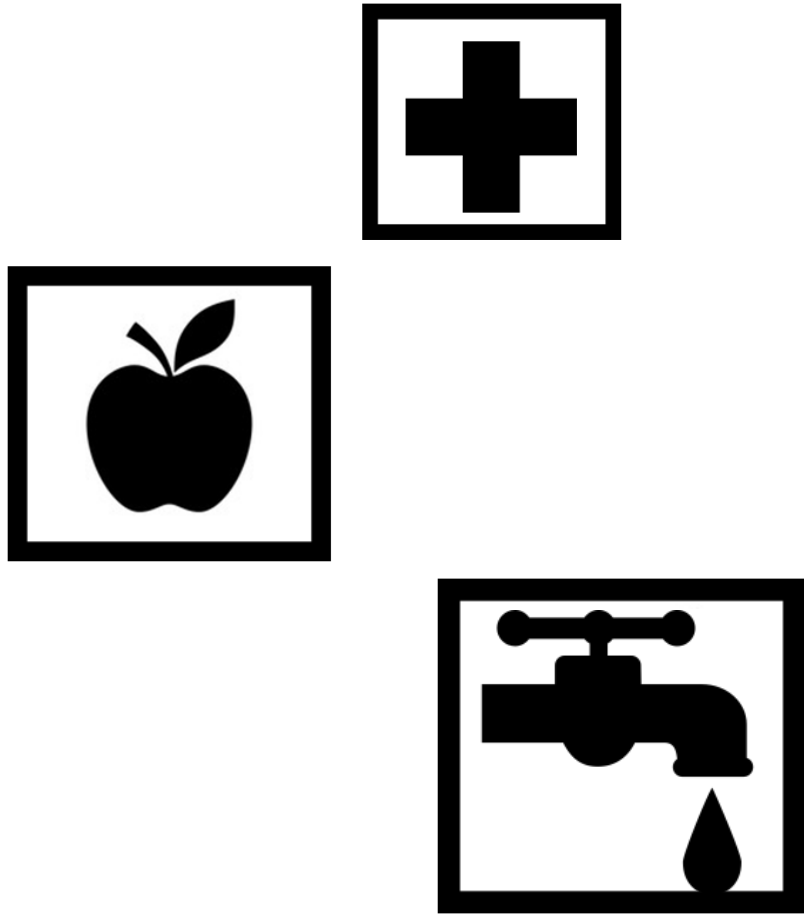


Fig 16. The needs in the emergency phase explained in symbols

3.4 DEVELOP

The development phase is the second phase in which refugees reside. In this phase, refugees develop or try to develop themselves and their environment. The theory of Maslow confirms that when people are provided in their basic needs, security and social aspects, development of themselves is the next step to take. Although in some cases, like for example in Za'atari, this development is clearly visible, in other cases the development phase is never reached and refugees get stuck in emergency situations.

Another name for the development phase is the transitional phase. With this the transition from emergency situation to more developed environment is meant. An important aspect of this transitional phase is that not only the environment (shelters and public buildings) develop, but also the people using this environment, the refugees. In order to give this refugee the opportunity to develop themselves, a couple of aspects have to be addressed. First, the social cultural aspect. According to the earlier mentioned Maslow pyramid, it is impossible for

refugees to develop when they are not provided in their social or cultural/religious needs. To provide in this need, the building should contain places for people to socialize and to loosen. For this reason, a ceremony center and communal spaces have to be part of the design. Another part of development is education. Education off course comes in many forms. But the main division can be made between self-education and joint education. The building should give the people the change to do both. For this reason, a library with educational program has to be part of the design. This gives the refugees the possibility to read books, but also to join in lectures or training programs. This combination of functions is in the remainder of this booklet described as "knowledge center". A positive side issue is that education seems to be one of the best suitable functions to catalyze development in an area, as explained in chapter 3.1



Fig 17. The needs in the development phase explained in symbols

3.4 RELEASE

The release phase is the desired phase, but in practice almost never reached phase. In the release phase people can care for themselves and do not rely on assistance from NGO's or other organization anymore. They make their own living and have a proper future perspective.

In the release phase the aim is thus to make refugees independent. So the functions related to this phase should contribute in the process towards independency. One of the functions which does this is off course education. Developed and educated people do have more change to integrate in local societies. They are more likely to get a job than non-educated refugees and having a job is off course necessary if you want to become independent.

Another way to strive for independency is to create a platform on which people can sell their skills or products. This is thus basically something like a market. A market in a camp has many positive effects. People can sell their homemade products to make money and in making these products they turn their boredom in to usefulness.

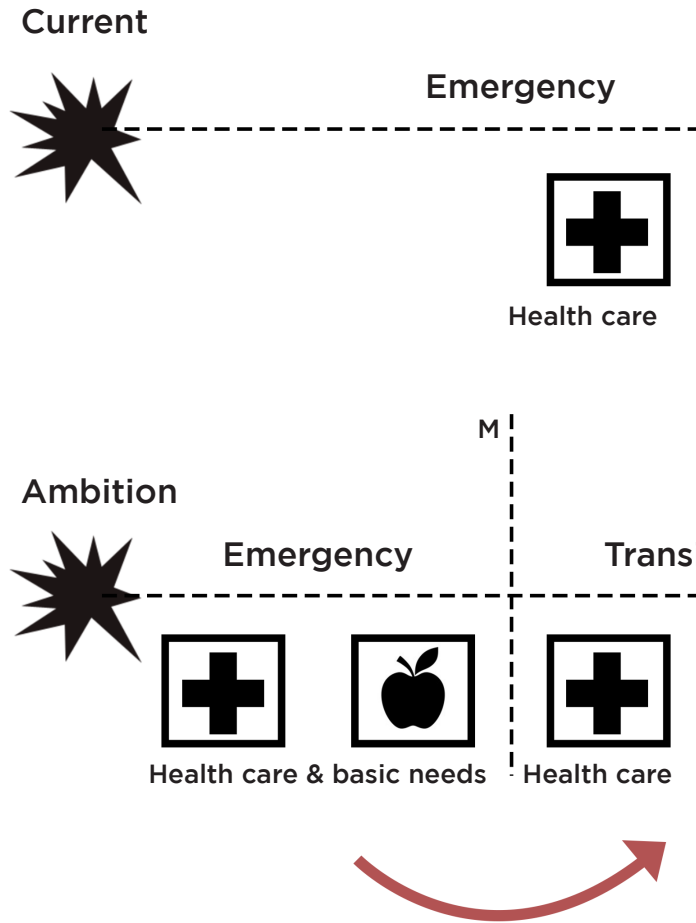
The release phase however is a phase that is far away from informal settlements or new refugee camps. In these kind of settlements people concern more about basic needs like food, hygiene, shelter etc. Before a settlement like this can reach the release phase, they first have to make the step away from the emergency situations in which they reside. For this reason, this project only focusses on the transformation from phase 1 (emergency) to phase 2 (development).



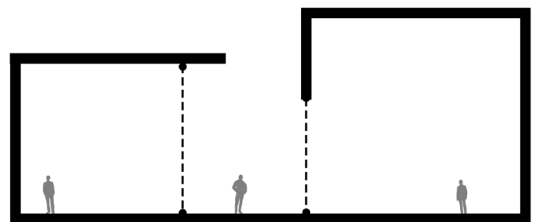
Fig 18. The needs in the release phase explained in symbols

3.5 PHASES

As a short recap, this page shows how the ideas about catalyzation and transformation through the phases are translated into a concept for the building program. Summarized this concept can be described as an evolving building program, which consolidates and grows over time. It starts as an empty flexible space in which basic functions such as sanitation, health care and distribution are located. When time passes by, the building grows internally. New levels arise and thus more space to add new functions. The functions which are added in this second phase are: ceremony center, communal space and a knowledge center.

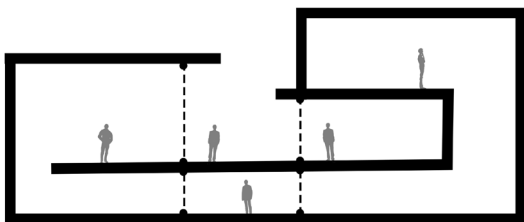
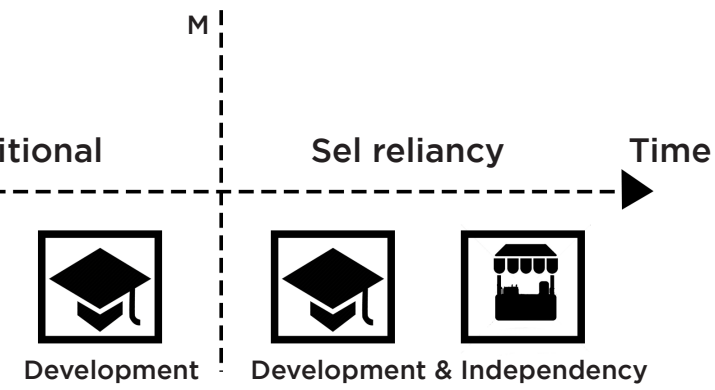
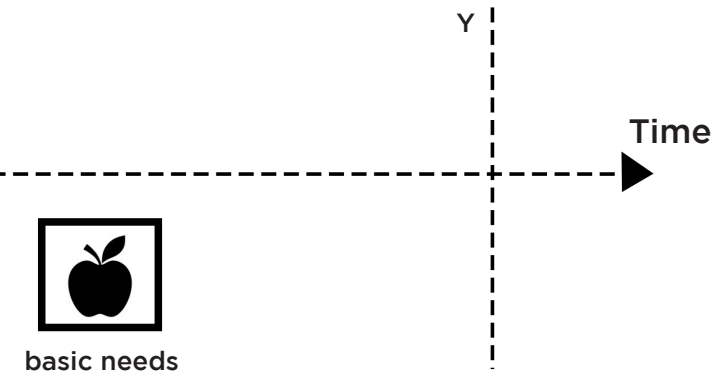


FUNCTIONS AT ORIGIN
 HEALTH CARE
 FOOD DISTRIBUTION
 SHELTER DISTRIBUTION
 SANITATION



FASE 1

Fig 19. Explanation of progress through the phases



FASE 2

- FUNCTIONS ADDED IN FASE 2**
- KNOWLEDGE CENTER
 - COMMUNAL SPACE
 - CEREMONY HALL
 - PUBLIC SPACE

Chapter 4
Context



4.1 NO CONTEXT

There are a lot of refugee camps and informal settlements around the world. One building is of course not going to solve this huge problem, but the impact should be as large as possible. Because of this the idea was to design a building which can operate in multiple locations. Whether this is in the forests of Calais, the desert of Za'atari, the snowy mountains of Bekaa valley or the dry lands of Dadaab. But in practice, the demands in the different locations in terms of building technique seems so different, that there is chosen to elaborate the building more specific for one location. So although there is a building concept developed in this project that can serve in more than one newly established camp or informal settlements, the building in the configuration as shown in this booklet is especially designed for Calais. This thus can be seen as the main case study. Calais is chosen because the camp represents a lot of other informal settlements and camps in terms of its dynamics, demography, conditions and organization. Calais is also a camp on which a lot of research has been done. So a lot of information is available,

such as maps, images, reports and statistics. This information ensures a better foundation of the project.

In chapter 9 of this book some measures are presented with which the building can be used in different locations and circumstances.



Fig 20. Calais refugee camp - ANP, 2015



Fig 21. Za'atari - Getty images, 2013



Fig 22. Bekaa Valley - BBC, 2013



Fig 23 Domiz tented settlement - Mohamad Mohamad, 2015



Fig 24. Tented settlement Lebanon - UNHCR



Fig 25. Tented settlements of Dadaab - The Uchaguzi, 2016

4.2 CALAIS

Calais is one the most mentioned refugee settlements of the last years. Besides the fact that it is one of the biggest camps in Europe, it is also an illegal camp. Because it is illegal, humanitarian aid is scarce. This in turn result in conditions so bad that the camp got the nickname “the jungle”. Because of the bad conditions inside the camp, it’s been an eyesore for the French government for years. This government has tried multiple times to completely evacuate the whole camp, which was often associated with big riots and violence.

Calais is thus on of the earlier mentioned “informal settlements” (chapter 2). De location of the camp ensures its appeal for refugees. It is situated next to the highway which runs through the Eurotunnel, the connection between France

and England, which make this camp the perfect area to stay for refugees who want to go to England. These refugees are jumping on trucks in the night so they can make the crossing unseen. For this reason, the French government started building a separation wall between the highway and the camp in the third quartile of 2016.

The Calais refugee camp has a brief history. A history associated with enormous growth of the camp, interspersed with evacuation of the camp. Since 1999 refugees are present in the area willing to make the cross to England. Since 2008 this number has grown explosively. Since then, the French government has tried multiple times to destruct the camp, but the refugees kept coming back. In 2016 the French government started with the most recent evacuation. In February the south part of Calais was demolished. In October, the north part of Calais was destructed (not the container area). Attempts are undertaken daily by refugees to return to camp. They hide in the forest areas and hope to stay there. This continues tension between the refugees and the French government nowadays still leads to a lot of problems in the area.

The image on the right shows the map Calais. The red line in the middle separates the north side and the south side, the so called jungle. Above this line, the situation is displayed as it was in the summer of 2016. By this time, the south part was completely evacuated. This project is based on this situation. The camp as it was before the evacuation can be seen on the following pages with accompanying analysis.

Fig 26. Calais refugee camp section - Catalogue, public building for refugees, 2016

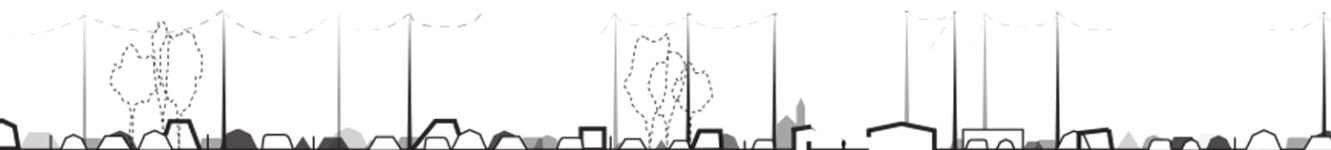
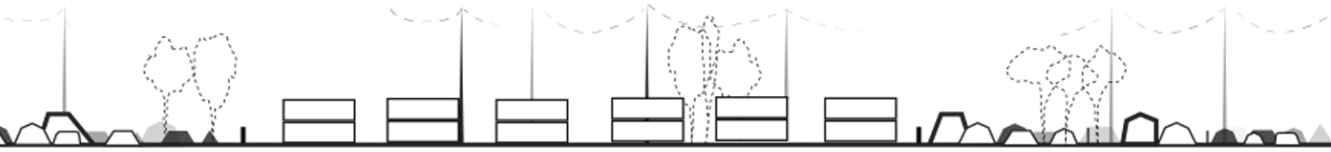




Fig 27. Calais refugee camp situation



TERRITORY

--- BORDER

LANDSCAPE

● WATER RIVER / LAKE / SEA
 2000 M TOPOGRAPHY
 1000 M
 0 M ALTITUDE (ABOVE SEA LEVEL)
 -200 m



NEIGHBOURING SETTLEMENTS

— MAIN ROAD
 — SECONDARY ROAD
 - - DIRT ROAD
 ● > 500,000 INHABITANTS
 ○ 100,000 - 500,000 INHABITANTS
 ○ 50,000 - 100,000 INHABITANTS
 ○ < 50,000 INHABITANTS

TRANSPORT HUBS



Fig 28. Calais refugee camp - Catalogue, public building for refugees, 2016

Calais jungle - camp scale

FACILITIES

- MARKET (STRIP) PRIMARY AXIS
- COMMUNITY DAY CENTRE
- HEALTH HEALTH CENTER
- EDUCATION PRIMARY AND SECONDARY SCHOOL
- TECHNICAL SERVICES BIKE REPAIR
- RELIGION CHURCH, MOSQUE
- SERVICES TOILETS/SHOWERS, BARBER SHOP
- EXTRA SERVICES SHOP, CAFE, CLUB

INFRASTRUCTURE

- SECURED BORDER
- MAIN ROAD
- ENTRANCE
- SECONDARY ROAD

DENSITY

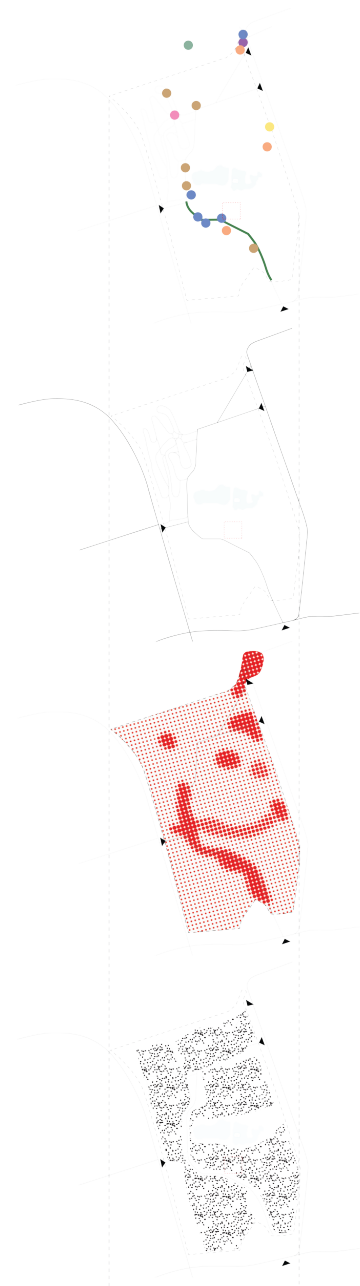
- + + + + SPACES OF EXCHANGE, MEETING AREAS
- + + + AROUND FACILITIES
- + + ESSENTIALS: SHOWER, TOILET & KITCHEN
- + RESIDENTIAL AREAS

URBAN FABRIC

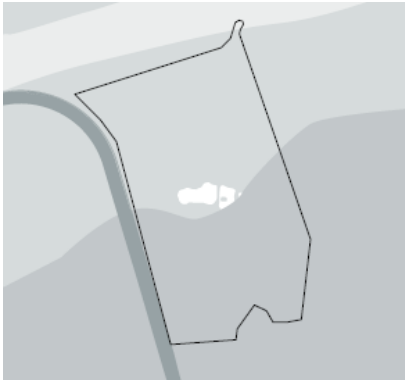
- SOLID BUILT AREAS
- VOID UNBUILT AREAS

SATELLITE MAP

- FRAGMENT BORDER



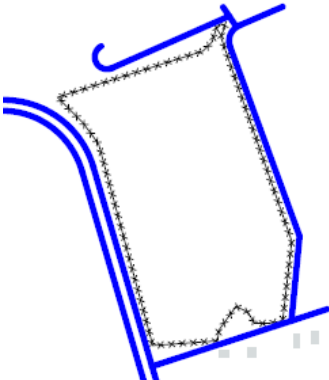
Terrain



LEGEND

- CAMP BORDER
- ALTITUDE

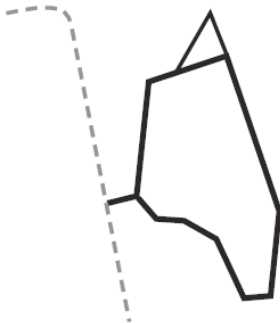
Constraining elements



LEGEND

- CAMP BORDER
- INFRASTRUCTURAL CONSTRAINTS
- ***** PLOT CONSTRAINTS (POLITICAL, ECONOMIC, ETC.)
- NEIGHBOURING BUILDINGS

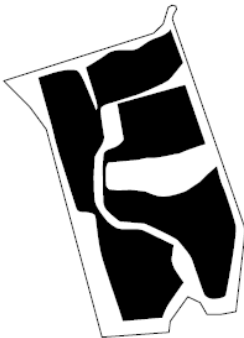
Infrastructure



LEGEND

- MAIN ROADS
- SECONDARY ROADS
- - - - BORDER

Urbanfabric

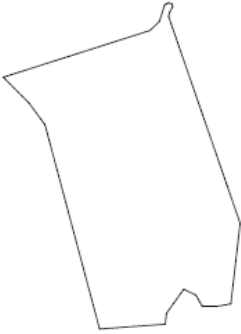


LEGEND

- SOLID
- VOID
- BORDER

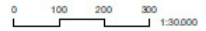
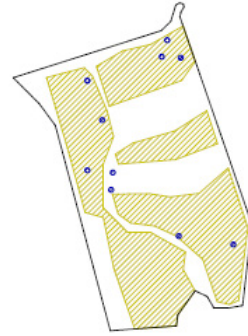
Fig 29. Calais analysis- Catalogue, public building for refugees, 2016

Strenghts



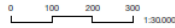
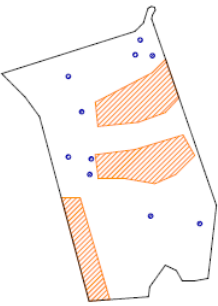
□ None

Weaknesses



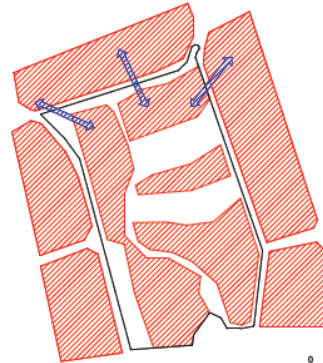
- Home built, low quality tents by refugees
- Primitive and poor quality of water supply, shower and sanitation

Oppertunities



- Enough area for further development oppertunities
- Improve water supply, shower and sanitation points

Threats



- Continued plot development and camp expansion with high density
- Flooding

Fig 30. Calais SWOT analysis - Catalogue, public building for refugees, 2016

4.2 SITE

The main street of Calais used to run through the whole camp. From the northside along the west side of the water to the south bending to the east. When the south part of Calais was deconstructed in 2015, half of this main street is demolished. The red line in the drawing on the right indicates the point until where the camp was deconstructed. Everything underneath this line was removed, with exception for two important locations; two small public centers. Two centers which are being used a lot by the inhabitants of the camp. One of

these centers lies in the heart of the old south part, as shown in the drawing on the right. The other center is located in the east side of the old south part. The point where the connection roads of these three locations (the main street and the two centers) meet, is the location where the building will be placed.

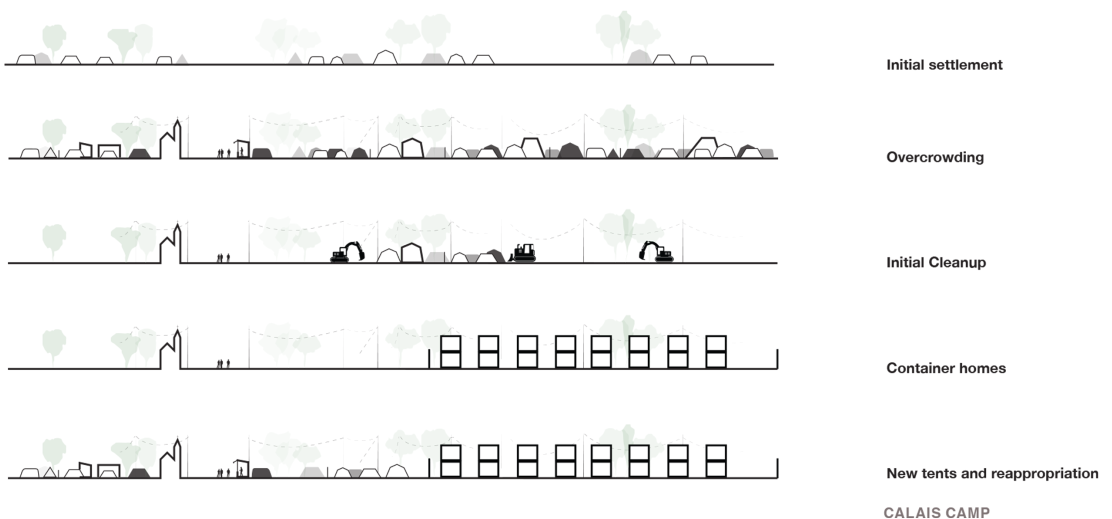


Fig 31. Calais development - Catalogue, public building for refugees, 2016

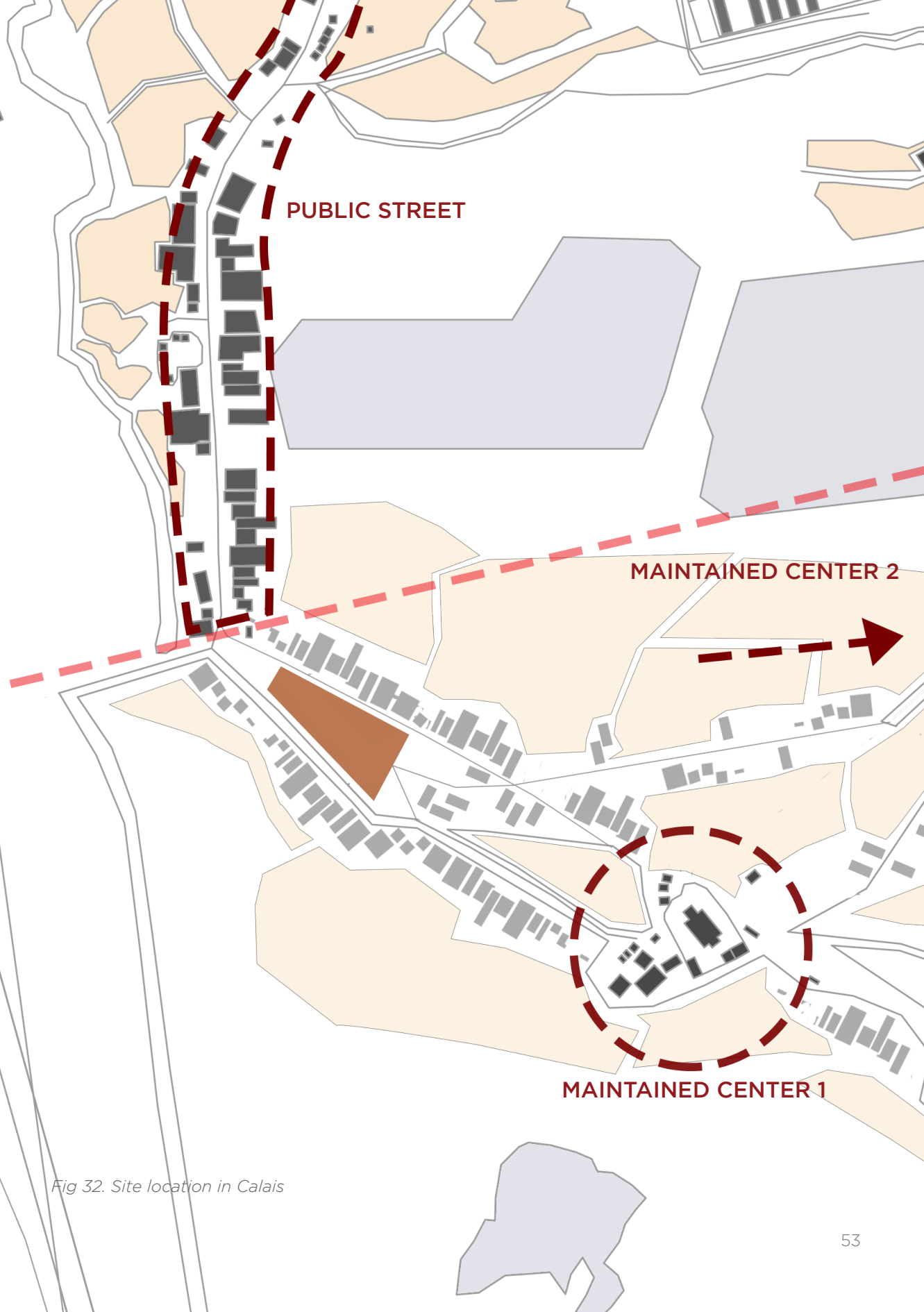


Fig 32. Site location in Calais

Chapter 5

Building method



5.1 TRIFOLD

By way of a Wochenaufgabe during the research phase we were asked to think about a new, innovative building system which is suitable for crisis situations. Hereby different aspects or criteria are essential.

First of all is transportation an important aspect. During the developing we assumed that the building system should be able to transport compact in containers. In addition, construction time is obviously a very important aspect. In crisis situations, it is necessary to keep the construction time as short as possible.

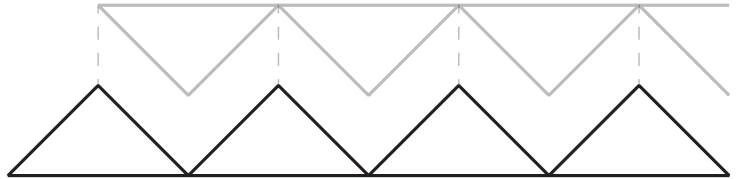
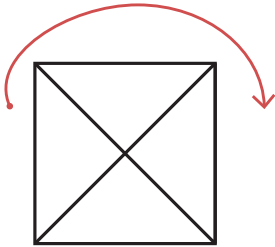
Finally, the possibility of building without much specific knowledge is an advantage. In this way, local people can help in the reconstruction or construction of their environment. This is in addition to practical reasons also an ethical issue. They can literally make their contribution.

Based on these criteria the Trifold Building System is formed. A system which is based on a series of folding triangles which can be manufactured in various constructional building

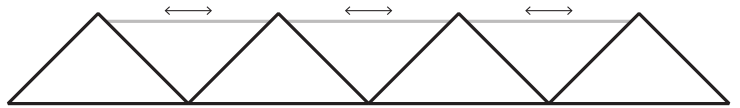
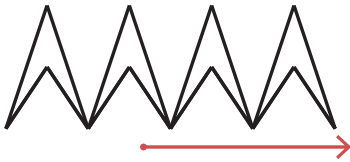
elements. With this system a foundation can be realized that is able to support the entire building. In addition, trusses can be made which can reach spans up to 15 meters, and which at the same time also form the basis of the floors.

And finally, with the building system can also be made facade elements that are decisive for the architecture. The building system offers a lot of freedom and represents his own architectural language.

The idea of Trifold started with a wooden square consisting of four triangles which was able to form a small beam (figure 33.1). However, only four of triangles brought many restrictions along with it. This is why each triangle was made foldable (figure 33.2). As a result, it was possible getting larger spans. Finally, by constructive reasons the steel tie rods were replaced by foldable wooden sides which forms the current (temporary) status of the build system (figure 33.3).



Concept 1: Foldable squares that can be stacked into trusses



Concept 2: A serie of connected triangles that can be unfolded into trusses with loose tie rods for stability



Concept 3: A serie of connected triangles that can be unfolded into trusses

Fig 33. The emergence of trifold building system

5.2 FOUNDATION

As has already been said, the entire structure of the building is made with the trifold building system, and therefore also the foundation. For the foundation principle, the construction system is used as accompaniment of the sand, which ultimately will absorb the vertical loads of the building. The function of the foundation within the building is very important. It ensures that the forces will be evenly distributed on the ground surface and prevents subsidence by loos sand.

But besides this structural value, the foundation also ensures that the building will be disconnected from the soil. By placing the foundation elements partly above the ground level, a plateau will be created on which the floor beams can be placed. This ensures that the building levitates above the ground. This avoids problems such as: inequality in the ground level, vermin, sand spraying and of course humidity. Because of the fact that the building system is executed in wood, this latter is of great importance.

In line with the vision of the system, creating the foundation is very easy and fast. The work needed to make this foundation consists of three main steps; digging trenches, unfolding the elements and replete the sand.

First, at the location where the foundation will be situated, trenches have to be made at the correct depth and the soil have to be equalized and tamped. On this hard base the trifold elements can be placed. These elements, which arrive in a see container, have to be sorted and unfolded. After this, these elements have to be placed in the trenches and positioned at the the right place. The last step of laying the foundation consists of the filling. The excavated sand should now be thrown back in to the triangular openings and the edges along the foundation elements. This should create a solid base for the rest of the building.

However, in some locations the soil will be very muddy, like for example in Calais. In order to prevent this foundation to sink in this mud, a layer should be made out of concrete slabs (Telcon plates). The foundation elements can be placed on top of these plates. The spaces in between have to be filled with sand at the proper height.

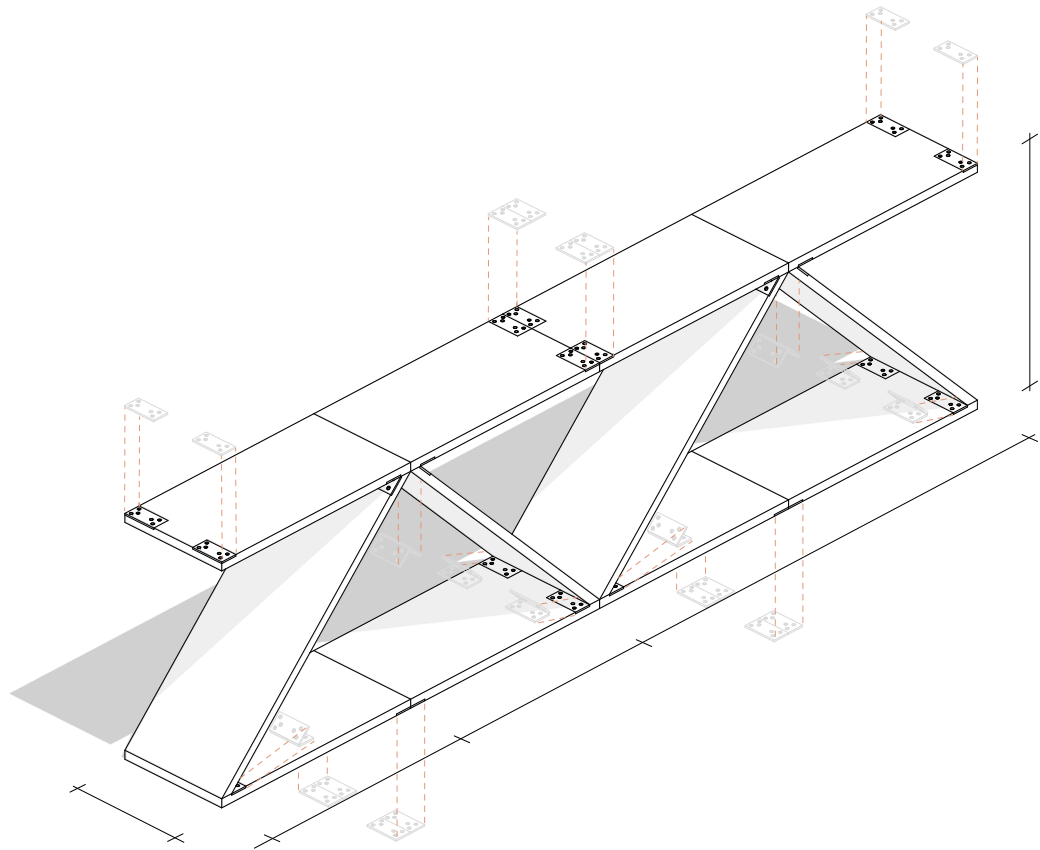
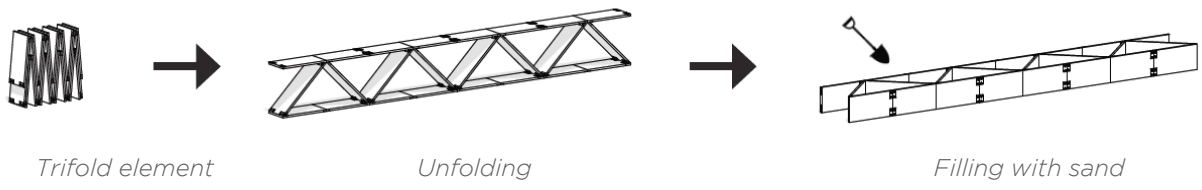


Fig 34. Trifold foundation principle

5.3 TRUSSES

The portals are the key element of the system and are designed for making distant spans and achieving great heights. Although constructive portals are normally meant for the acquisition of roofs and facades, the portals of trifold also offer a solution for the floors.

By designing the system like a cocoon, wherein the skin is composed of the foldable-structure elements, the system is in fact an all in one solution. The trifold portals are finished on the outside with selected facade panels, elaborated in chapter 8.2. The portals are coupled with each other to achieve structural stiffness. On the lower parts of the portals, floor elements are assembled to create the ground floor. As already mentioned in the chapter " foundation ", the portals as a whole will be placed on top of the foundation beams, whereby these portals become detached from the ground surface.

Also, the portals can be made without a lot of prior knowledge and expertise. The making of the gantry construction consists, overall, of 4 steps; unfold, pair, lift and connect.

After arrival at the location, the system is taken out of the shipping containers. The right portal combinations should be sorted together. These combinations consist generally out of a single floor truss, two gable trusses and a roof truss. These loose trusses are to be deployed on a liberalized surface and can then be linked to each other. The coupling of the individual elements takes place with dedicated connectors, which are made in advance in the right angle. When all parts are coupled of a portal, the whole can be lifted up and be positioned in the right place. This sequence is repeated several times, until there series of portals arised. Last but not least, these portals mutually brought into communication with each other in order to be able to guide the power flow through the structure.

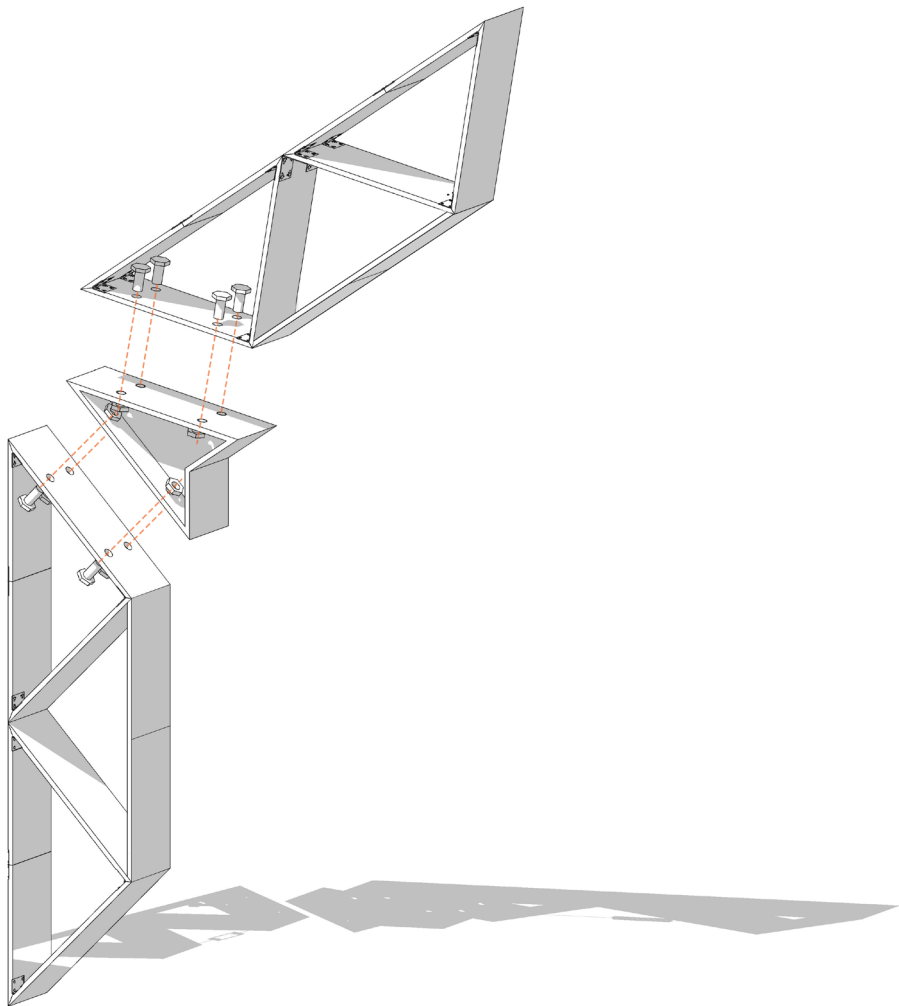
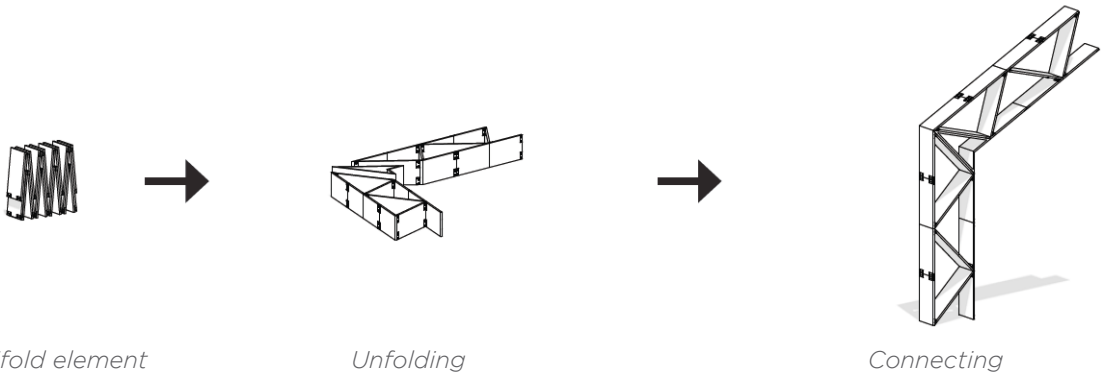


Fig 35. Trifold truss principle

5.4 FACADE ELEMENT

Because the structure of the building is acquired with portals, it is a linear system. And as with any linear system, the building is terminated with a cup wall on either side. In many situations, these walls are solved with a different system. With the trifold building system, it is possible to carry out this cup walls with the same system with which the portals, foundations and floors can be made.

Due to a change in the rotation direction of the triangular elements, entirely new possibilities with the system arise, like for example making facade elements. By connecting eight of these triangles with each other, as shown in the figure, a square element with several openings can be created. These openings can be filled with siding, translucent panels or even glass.

The making of the wall panels has many similarities with the making of the portals themselves. However, the making of the facade elements has more steps. First, the facade elements have to be sorted, unfolded and coupled so that

the correct form is created. Because these wall elements will also incorporate the necessary vertical forces, the most crucial points will be reinforced with prefab elements as shown in figure 36. The last step in making the facade elements is placing the panels, siding or glass in the triangular openings.

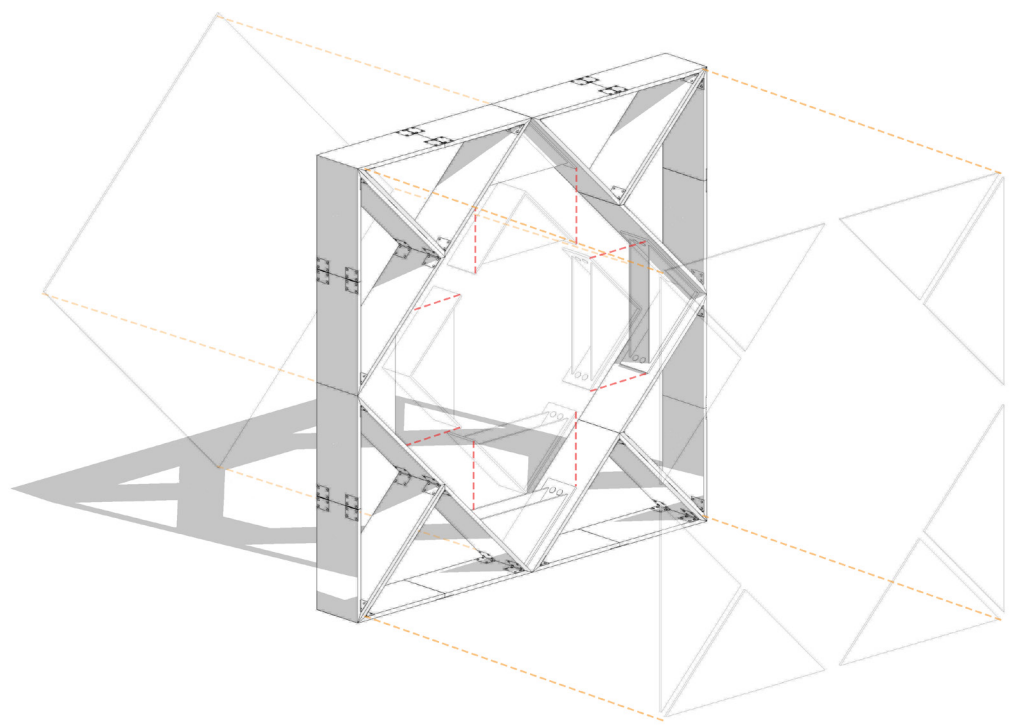
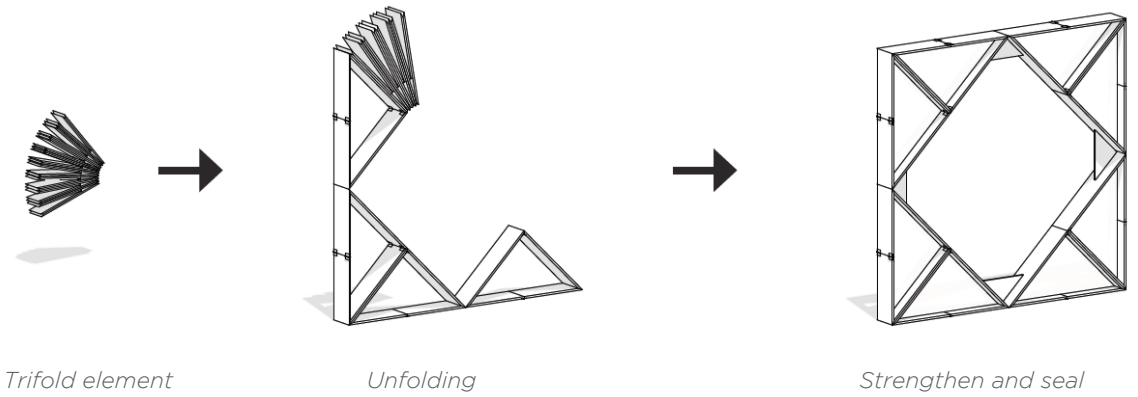


Fig 36. Trifold facade principle

5.5 POSSIBILITIES

Besides the fact that the building system is excellent for creating large open spaces where height and width are the main aim, the system can also be used in a complete different way to create a total different architecture. An architecture that combines multiple foldable elements to provide special spaces with a unique design language.

When the structural components and the corresponding finishes, floor or facade, shall be regarded as a sandwich panel, this provides a certain freedom. This freedom provides a great diversity of section slices wherein spaces always be related with each other in a different way. This experimenting with this principle can be seen in figure 37, where a selection of different possibilities is displaced.

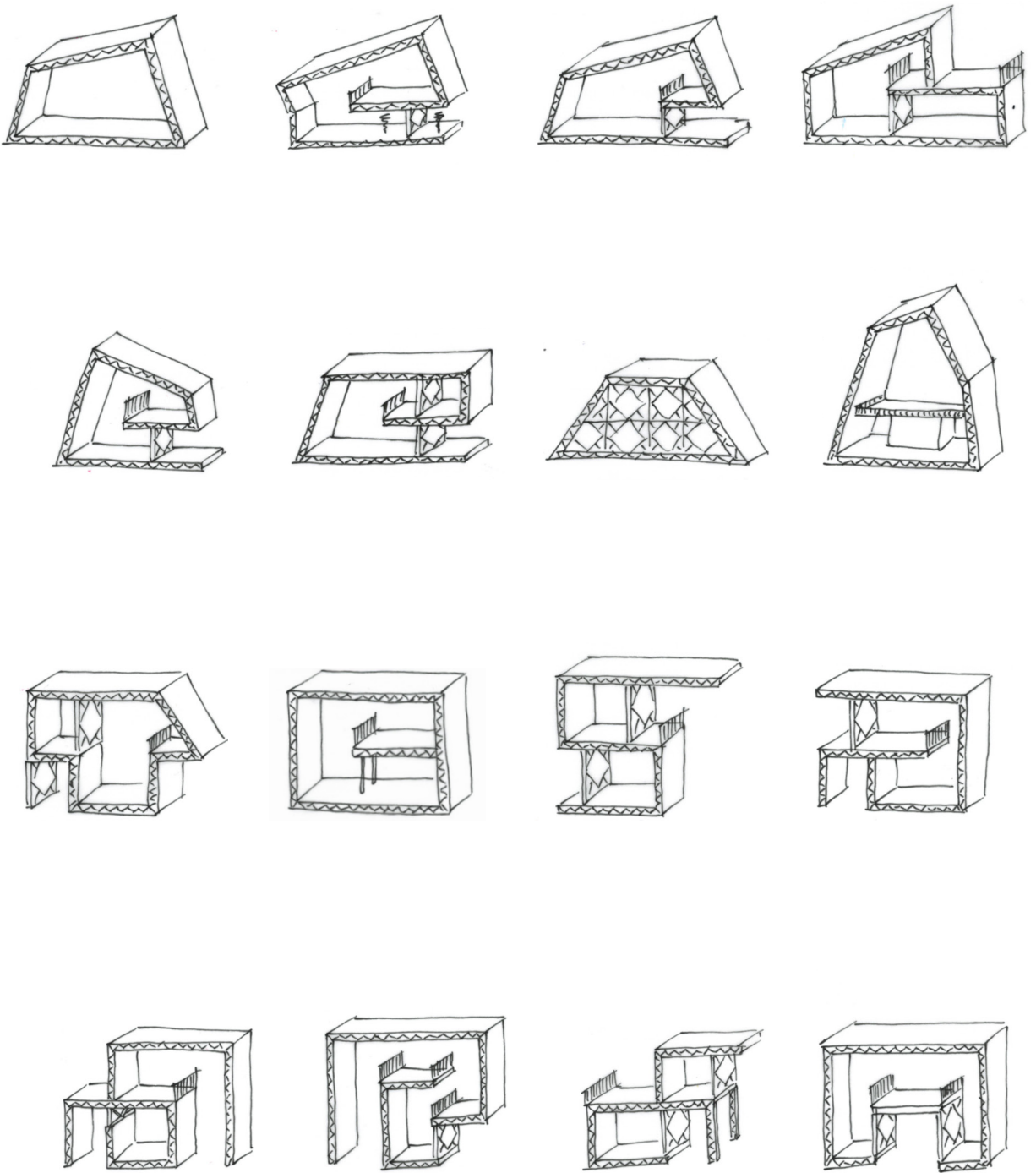


Fig 37. Trifold sliced interpretation

With the possibilities in mind, a wide diversity of designs can be made. Trifold building system is pre-eminently suited for making large and high areas. For this reason, there is chosen to test this building system by designing multiple ceremonial spaces. The designs differ in complexity, organization and additional functions. Eventually, all findings from these design where combined to create one main final design; the dutch design week design.

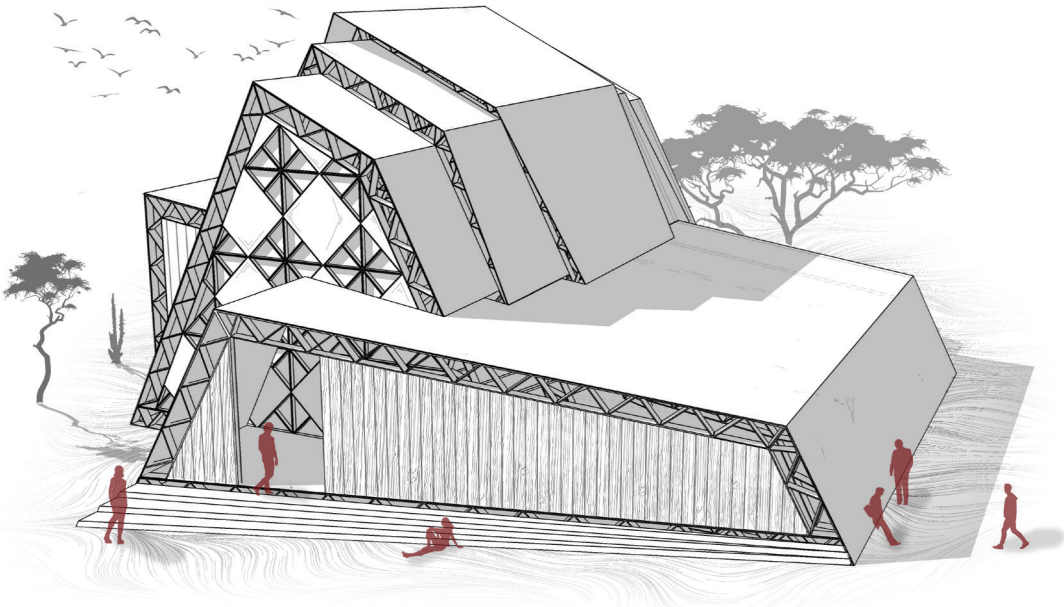


Fig 38. Trifold ceremony hall in Elleonas concept 3

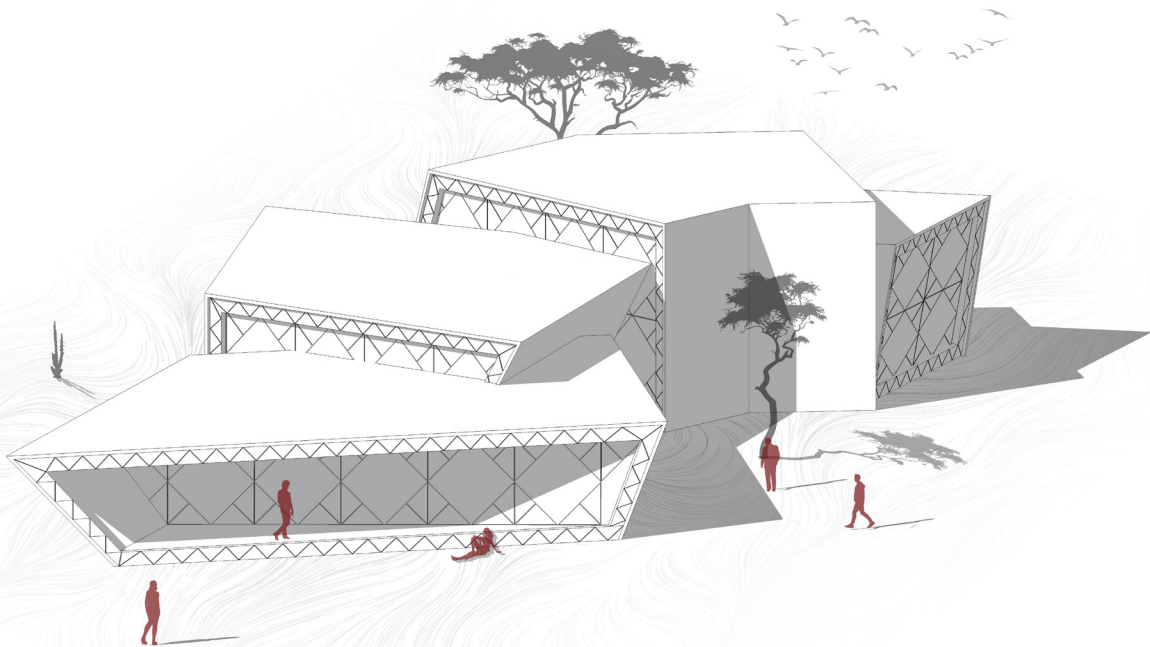


Fig 39. Trifold ceremony hall in Elleonas concept 1

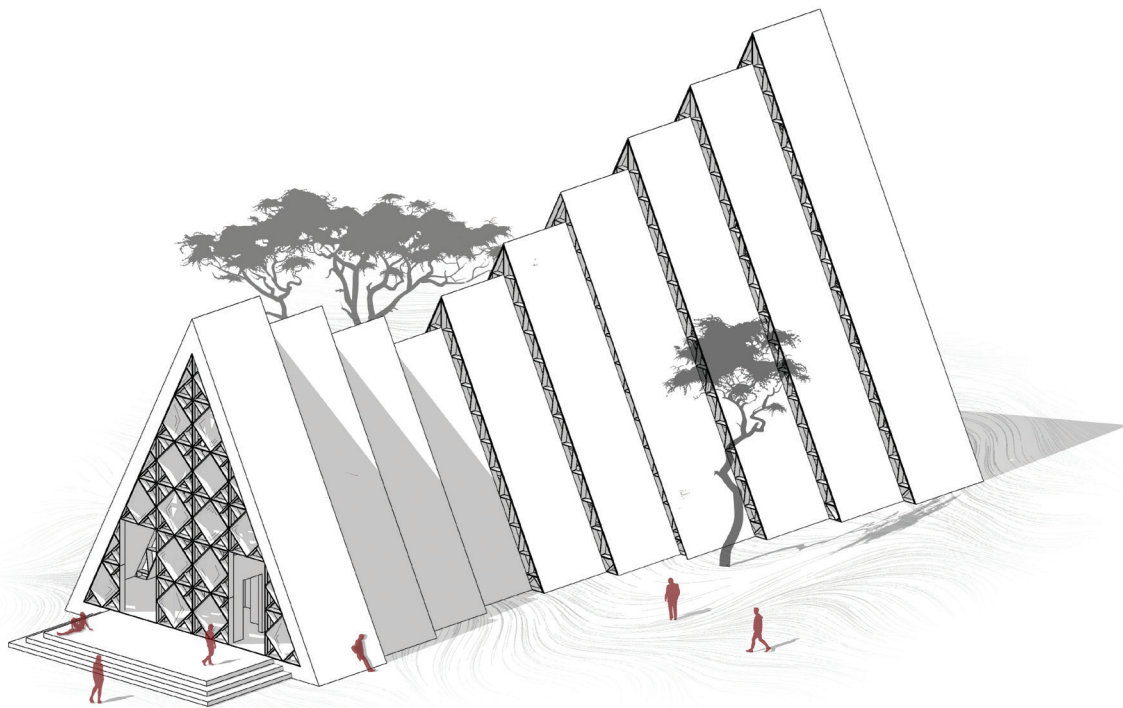


Fig 40. Trifold ceremony hall in Elleonas concept 2

5.4 DDW

On 22th of October 2016 the Dutch design week was held in Eindhoven. For this year's edition of the DDW, we as a graduation where ask to prepare an exhibition. As an important component of this exhibition, the progress of the building system was presented.

It has been decided to create one last design to present at the DDW which shows the possibilities of the system. This design is shown below. The design consist of one

main ceremony hall wherein a component is been placed made out of see containers. This component contains a bar, toilets, dressing rooms and creates an extra level in the building. The idea behind the design was to create one sculptural volume with small differences in slice shape to allow daylight to enter the building, and larger differences to highlight the entrances of the building. The building can be used for ceremonies like weddings, baptizing, funerals, birthdays or other events. When there is no event taking place in the building, it is being used as public space by the residents of the camp to gather.

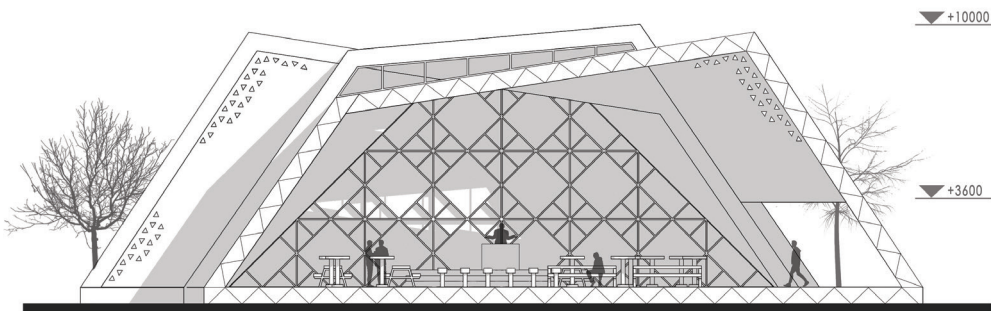


Fig 41. Dutch design week model, section

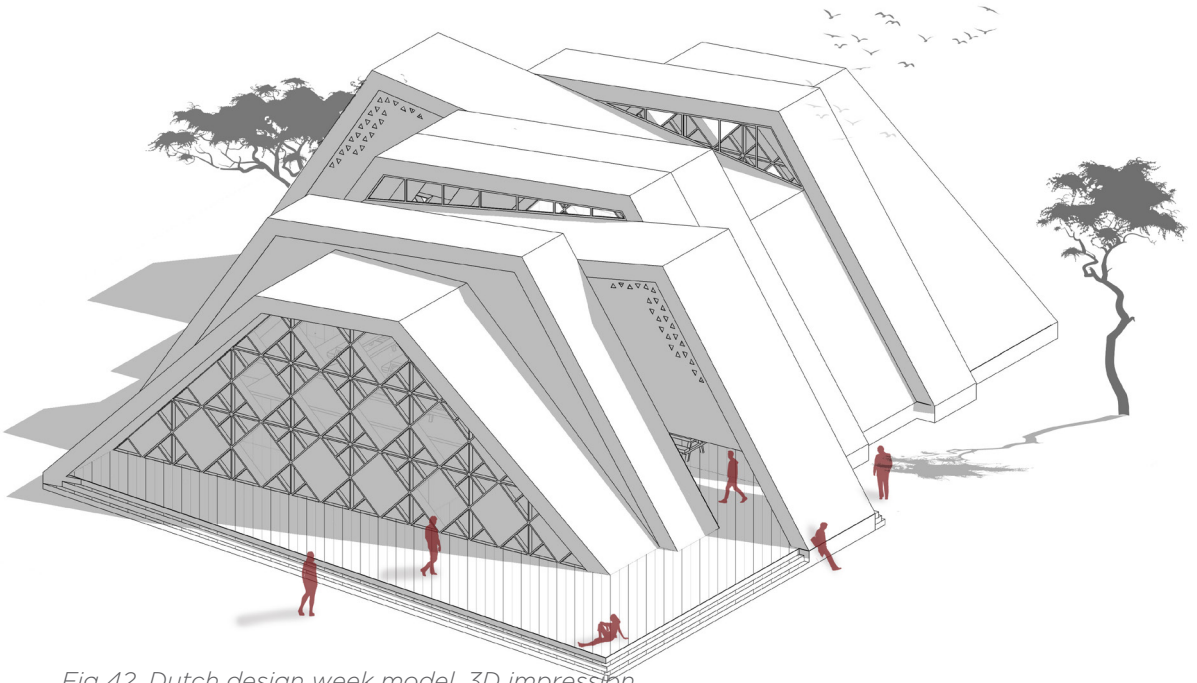


Fig 42. Dutch design week model, 3D impression

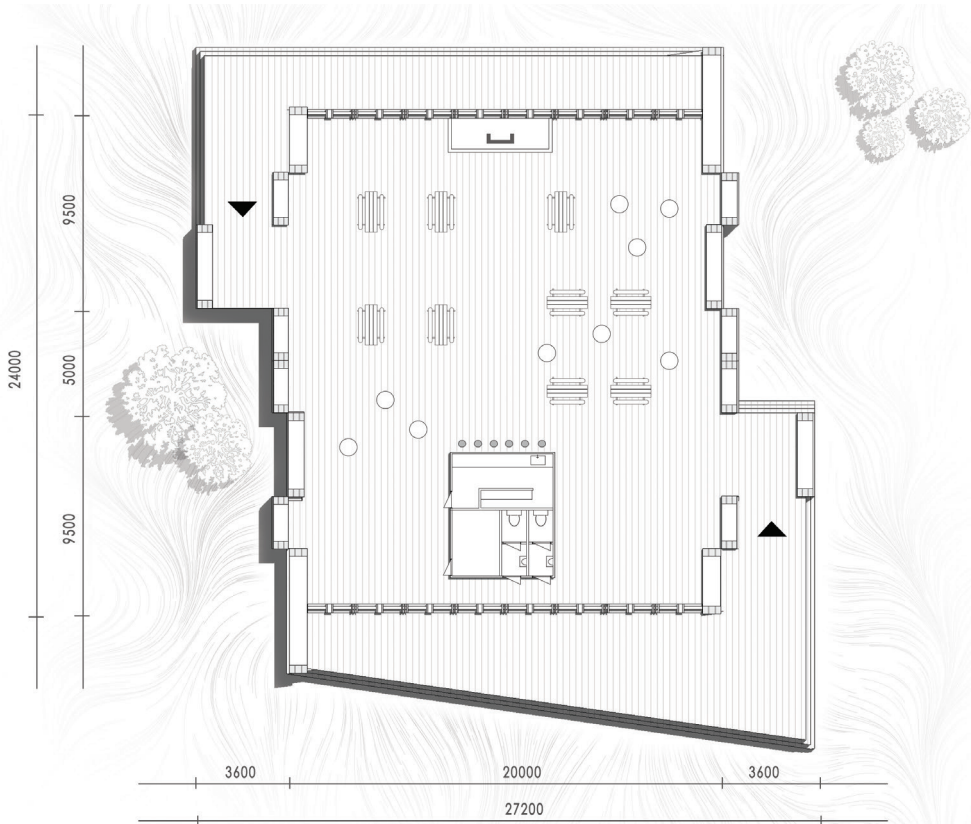


Fig 43. Dutch design week model, floor plan

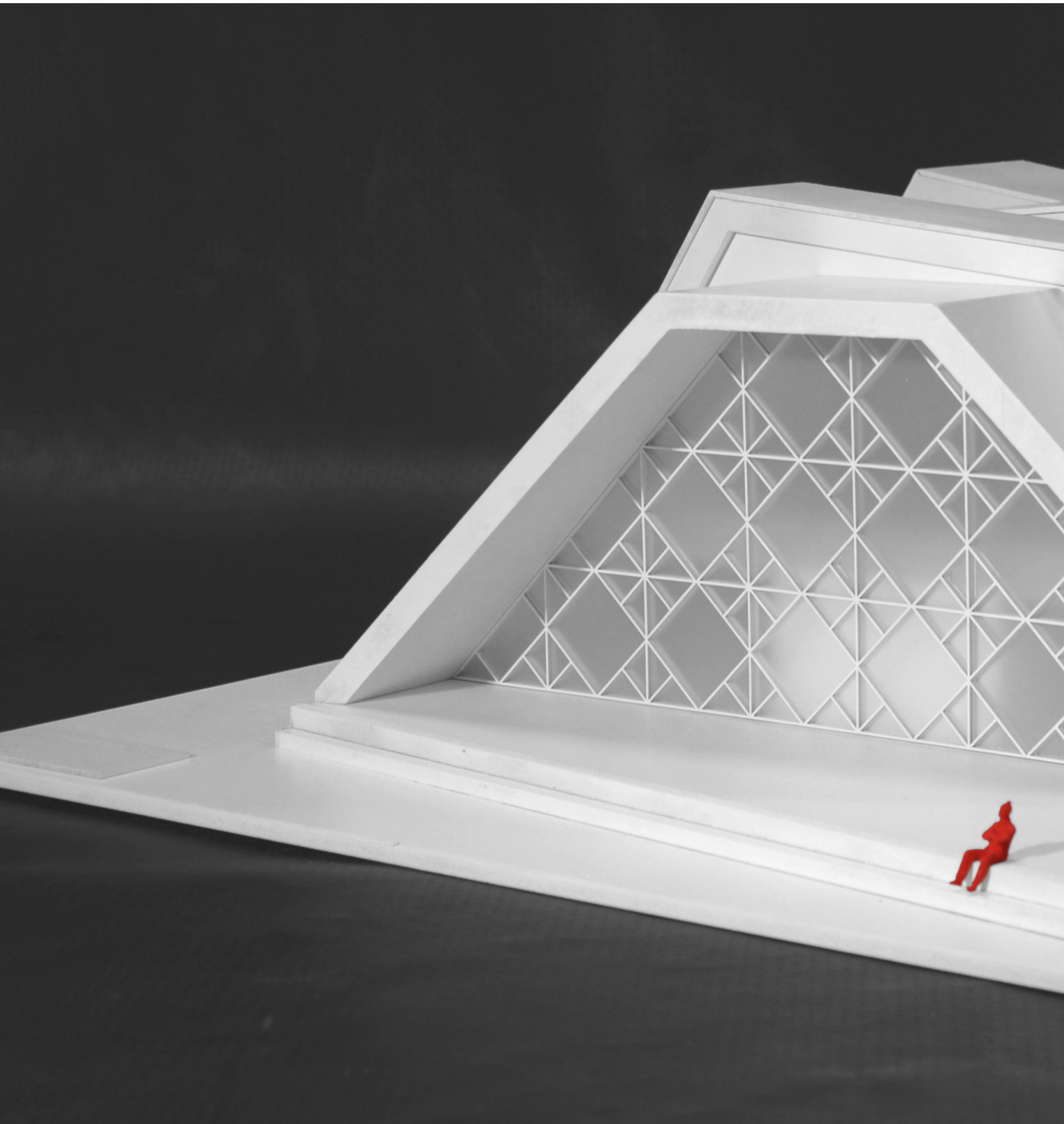
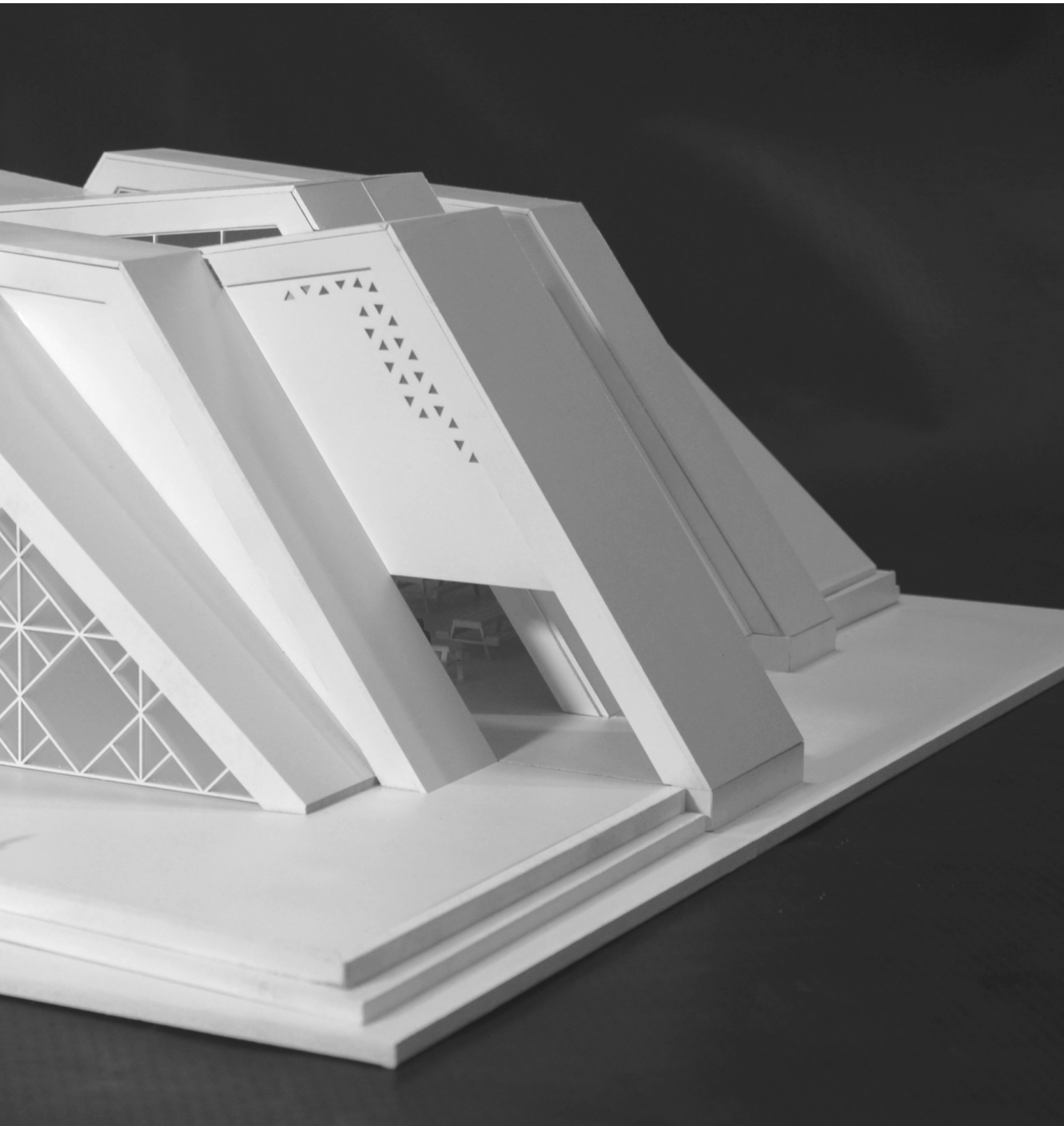


Fig 44. Dutch design week model



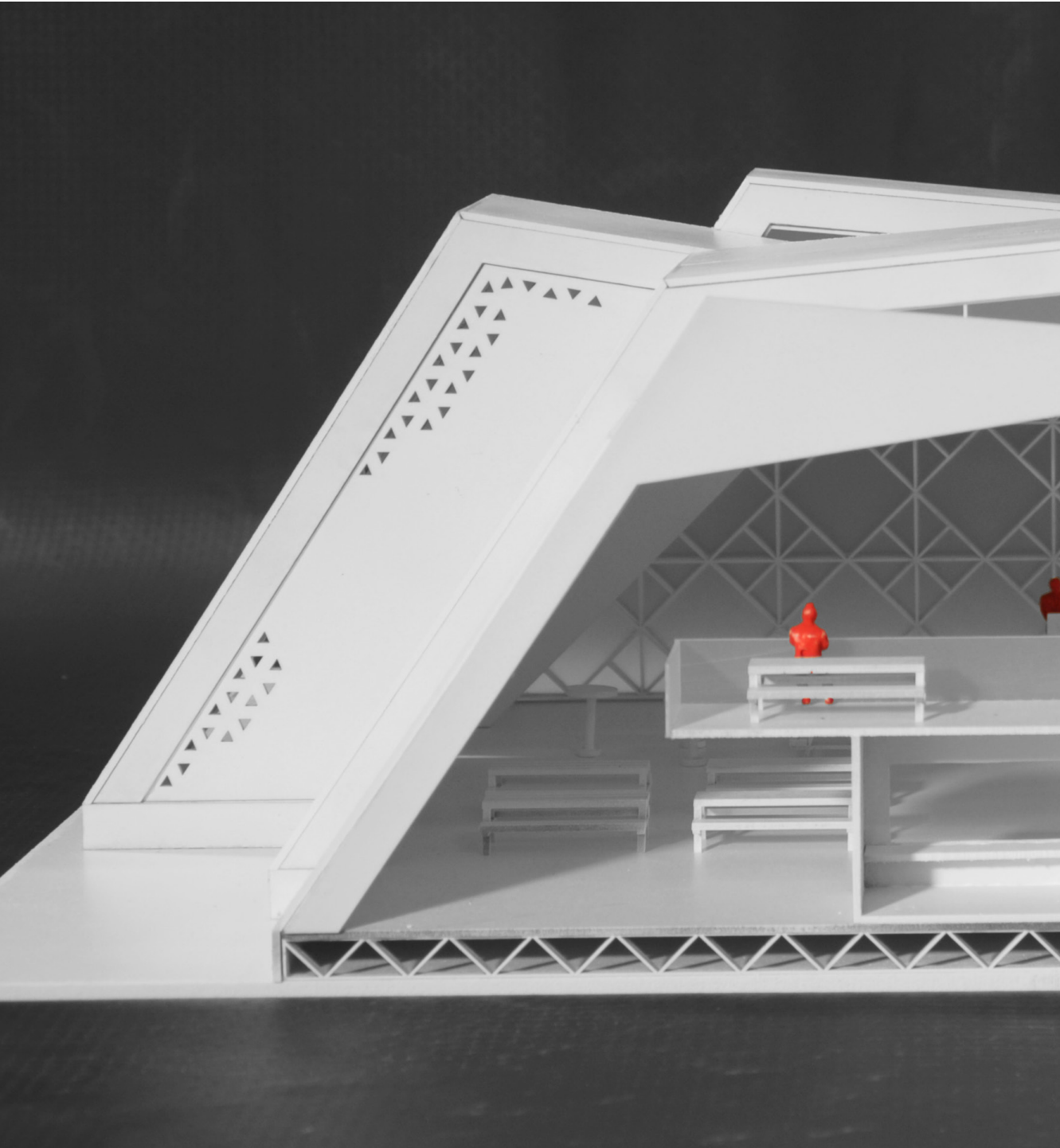
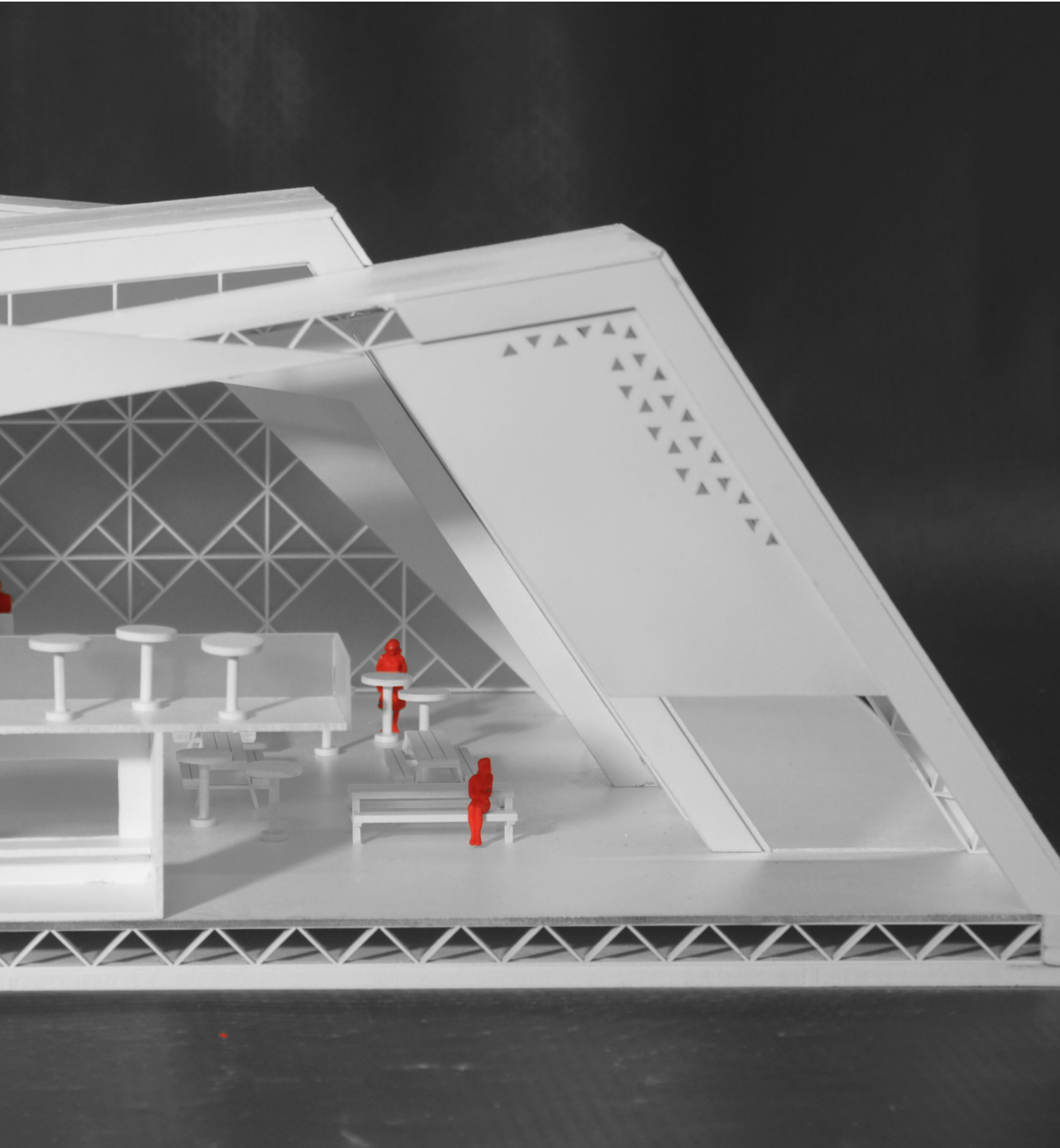
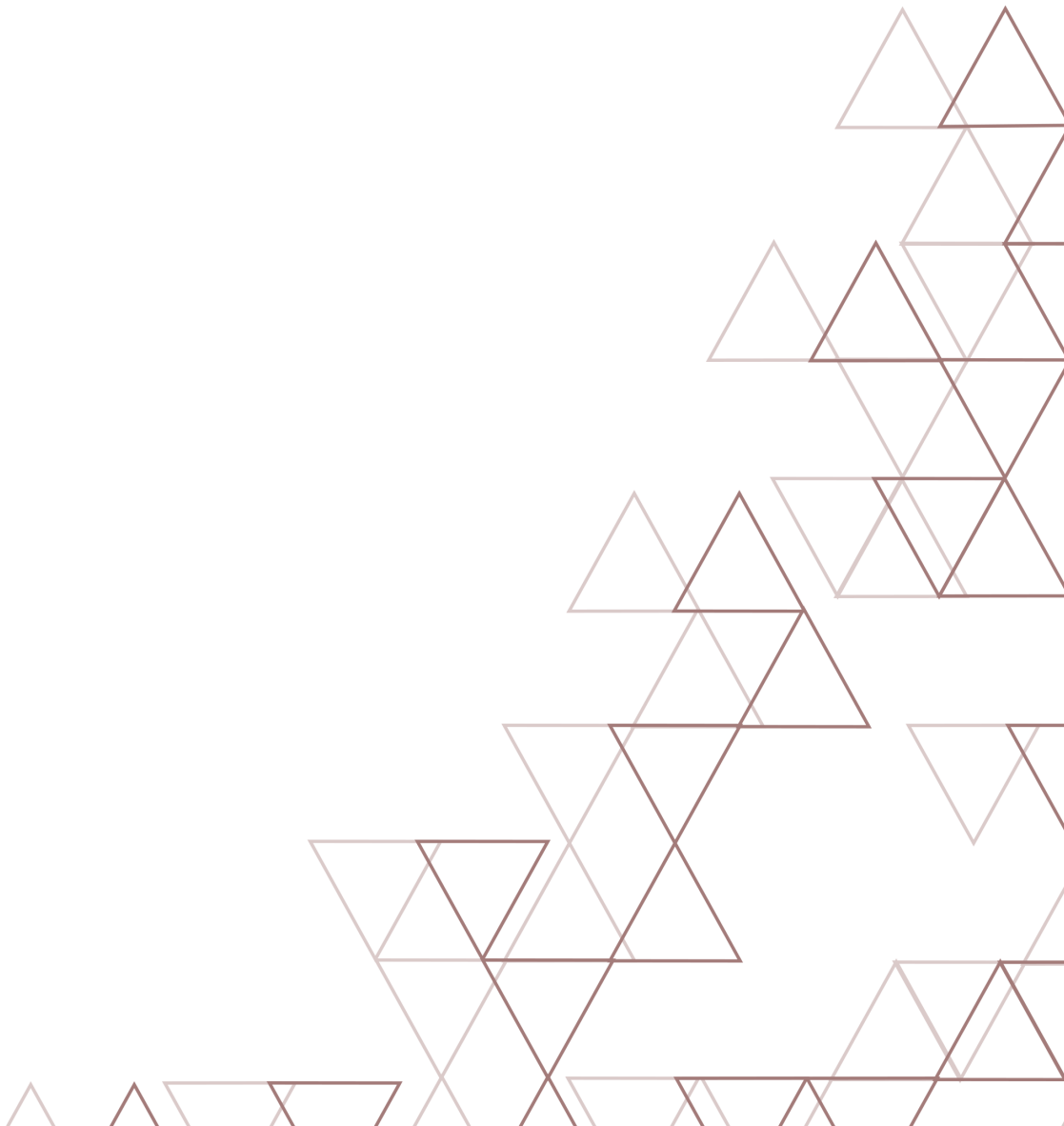


Fig 45. Dutch design week model



Chapter 6

Building concept



6.1 AMBITION

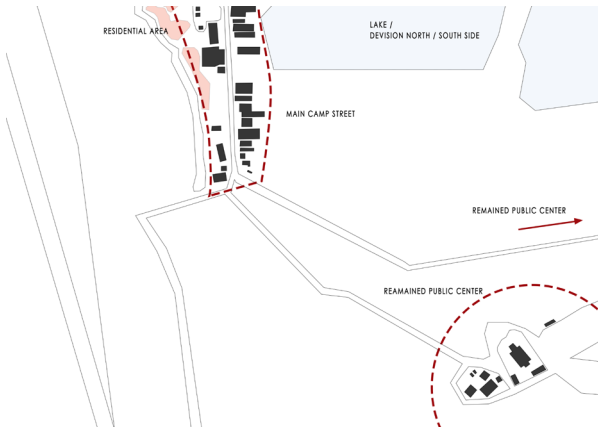
As already mentioned in chapter 3, the main aim is to improve the quality of life for refugees in informal settlements or new camps. In practice, this thus involves the transition from emergency situation into a situation in development. With this project the ambition is thus greater than just creating a nice building. This building has to activate a process. A process in which refugees can be helped to help themselves. This building must therefore be a so-called catalyst for its environment.

In previous chapters the functionality of an urban catalyst is being explained by a couple of design aspects. One of the most important design aspects is the placement of the building in its environment. For this reason, the location of the building is carefully chosen. In figure 46.1 we can see that the desired plot is located south of the remained part of the refugee settlement (north part). The site is located at an intersection of three important elements; the main street of Calais and two small remained centers where people gather to read, learn, go to the church or eat

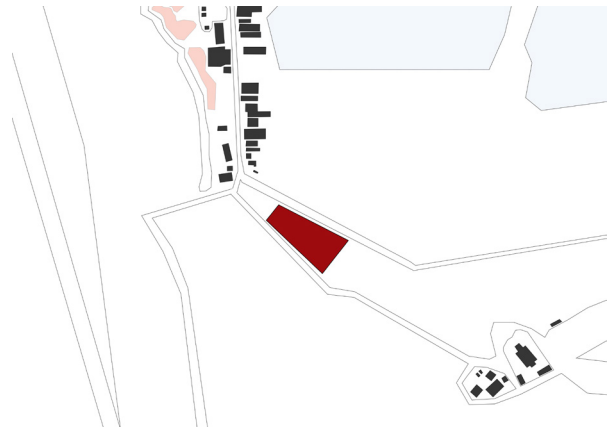
together. The building volume is placed on top of this intersection, as shown in fig. 46.2. The future development of the camp is already taken into account when placing this building at its location. Because it is placed almost exactly in the heart of the settlement, in between multiple smaller public centers, the building has to potential to grow into the new center of the camp.

This location, at the end of the main street of Calais, gives the opportunity to pull the public road through the building, as shown in figure 46.3. By situating public functions on this street, it is assured that it will be widely used by the people in the area.

The educational program has already proved to be able to attract people from the region (Chapter 3.2). The public functions and space ensures that people will stay or hang around the area. It allows them to escape from everyday worries and give them some peace and comfort. The functions such as food distribution and health care ensure that the building is useful and will be used throughout the whole day. This combination of the location, volume, program and the public space which it creates are the ultimate ingredients to create a new camp center. Off course this scenario is based on assumptions and it is impossible to predict whether it will be true or not, the signs and previously observed results indicate that this can be a likely outcome. An outcome that would look something like Figure 46.4.



1. Strategic location



2. Building volum shaped by site



3. public street trough building



4. Evolved into new camp center

Fig 46. Building urban concept

6.2 CONCEPT

The design concept of the building is simple but effective. It starts with a building volume, which is literally the site's circumference pulled up. At one side of this building volume there is the main street, on the other side a branch which connects a remained center of Calais with the main street. The building is thus placed on an intersection (chapter 6.1). This building volume is three layers high. Each layer has its own group of functions, which are divided by their intro- or extroversion. This is in line with the findings of Chapter 3.2. The more introvert or private functions are located on the ground floor. The middle layer is the connection layer. It connects not only the top layer with the bottom layer, but this is also the layer where people will pass who don't need to enter the building. This layer can thus be seen as an extension of the public street. On this layer more public functions are located which must be in strong connection to public space. The top layer also contains more public functions (figure 47.2).

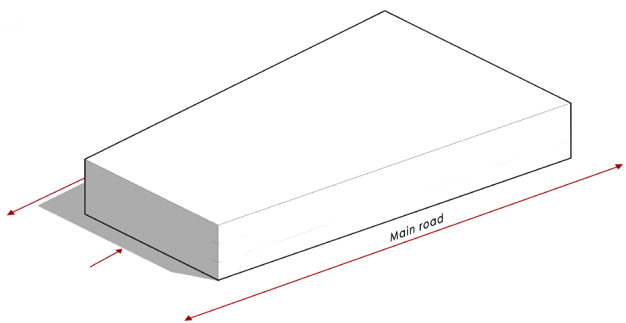
Figure 47.3 shows how the public street, which abuts the front side of the building, literally cuts through the volume until the first floor. The public street will thus lie on top of this layer. Applying

a heightened public street in the building is not without any reason. It gives the refugees a chance to loosen up both mentally and physically from the ground level which is topped by problems and mess. Besides this, having a heightened public street also offers an extra space underneath this street which can be used for more private functions or activities. This thus involves the separation of the private with the public.

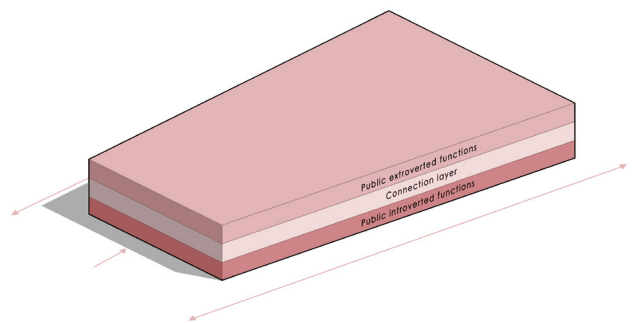
Above this public street, a connection is made between the two sides of the building. In this way, people are able to cross from one public function to another, without having to go outside. This connection is presented in figure 47.4. The next image shows how the public spaces are related to the area around the building. The public street is lowered at the end, making it so slowly being absorbed into the ground level. At the south side of the building the connection between the covered public space and the main road is being made.

Figure 47.6 shows all the floors in the building. As shown, there are a lot of mezzanines in between the levels. These lowered or heightened parts are designed to create enough light in the public space underneath the street. These height differences also divide different spaces from each other without using walls. All this different levels are connected with each other through the "stair zones", shown in figure 47.7. These are zones of 1500mm wide at the inside of each volume in which all the connecting stairs are located.

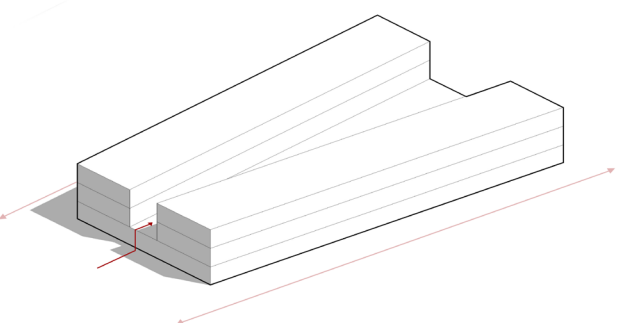
The last image on the right page shows an important design element; the ceremonial point. This part of the building is heightened and widens due to create a visual impact on its environment. Chapter 3.2 tells that it is very important to create visual awareness of the building in order to make it catalyzer. The highest point is about 20 meters high. This ensures that it can be seen from a big distance. In this way, the building can become the icon of the refugee settlement.



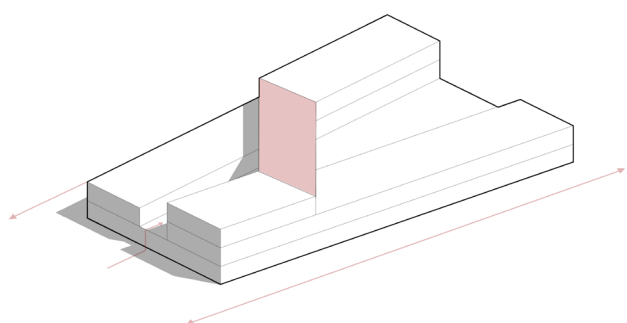
1. Shape devined by building plot



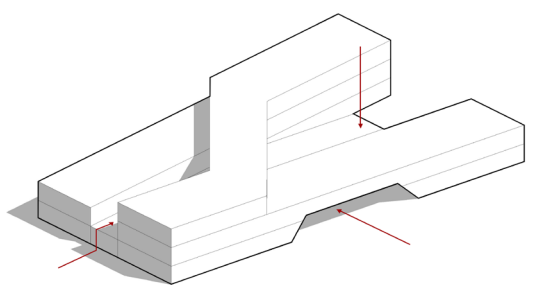
2. Devision in layers (Extrovert / introvert)



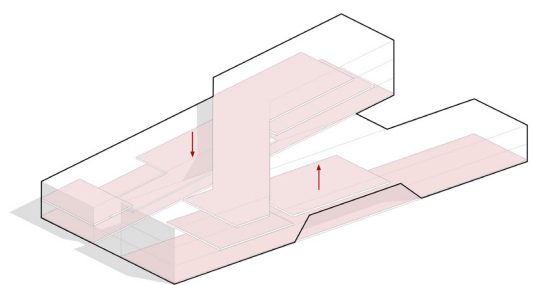
3. Public street trough building



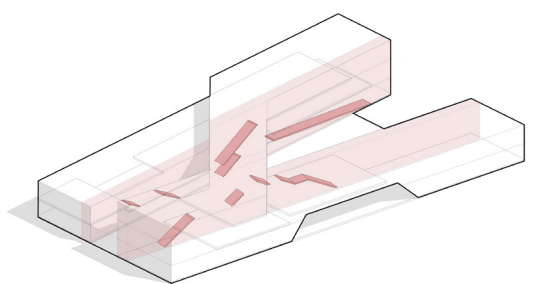
4. Connecting the volumes above the street



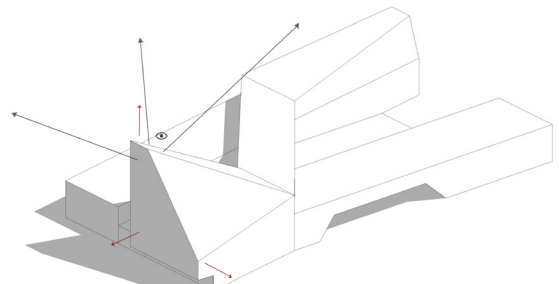
5. Connect with the surrounding ground level



6. Height differences in floors for more daylight



7. "Stair zones" at the inside of the volumes



8. Building as an icon for the settlement

Fig 47. Building shape concept

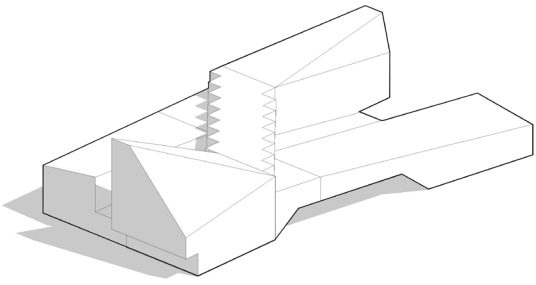
6.3 PROGRAM

To create a urban (or camp) catalyst, it is necessary to design a multifunctional building which provides in the need of the inhabitants of the camp, according to chapter 3.2. This is exactly what is being pursued with this program.

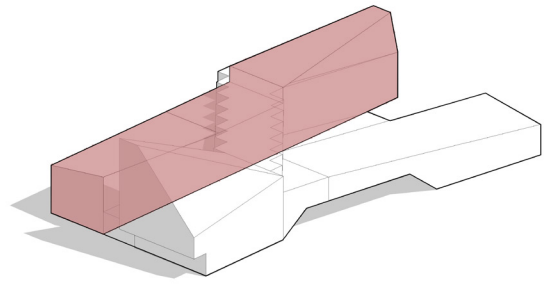
There is searched for the combination of functions which can accomplish their own goals related to different phases (chapter 3). These goals range from providing in basic necessities to helping the refugees to develop themselves.

All functions are linked to a public space. There are two main public spaces in the building; the public street and the space underneath it. All intimate and introvert functions are linked to this space underneath. All extrovert public functions are linked to the public street itself.

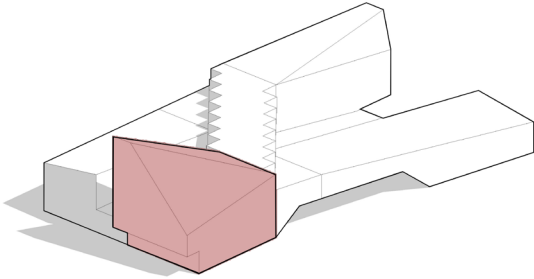
Thus in essence an introvert building is created which concentrates itself to the public spaces. This should give the user the feeling of protection and loosen them from the daily problems related to the camp they stay in.



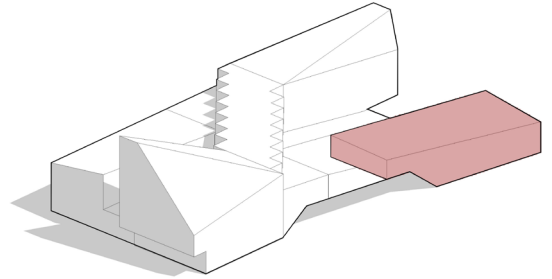
1. Building overview



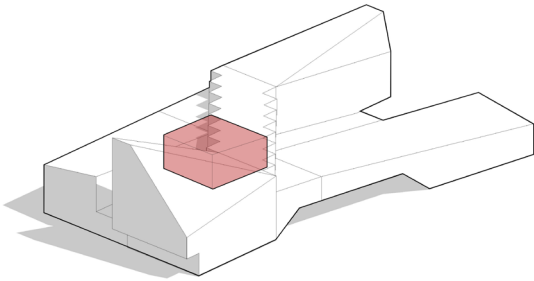
2. Knowledge center



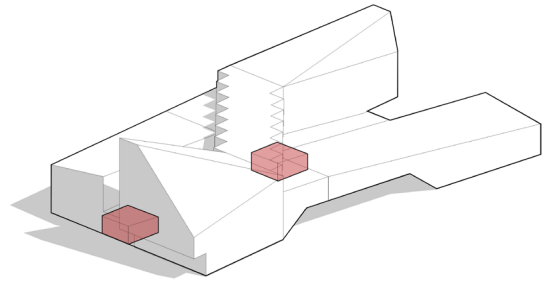
3. Ceremony space



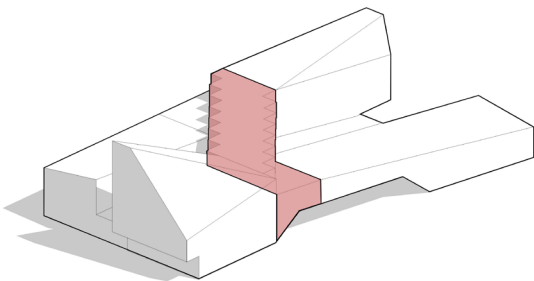
4. Health center



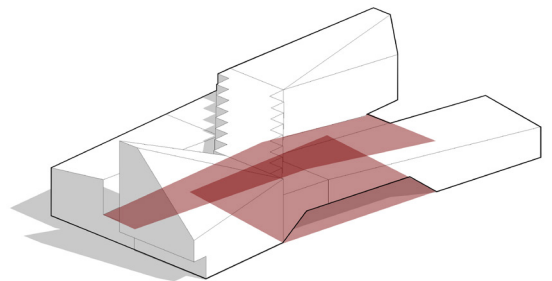
5. Distribution point



6. Sanitation



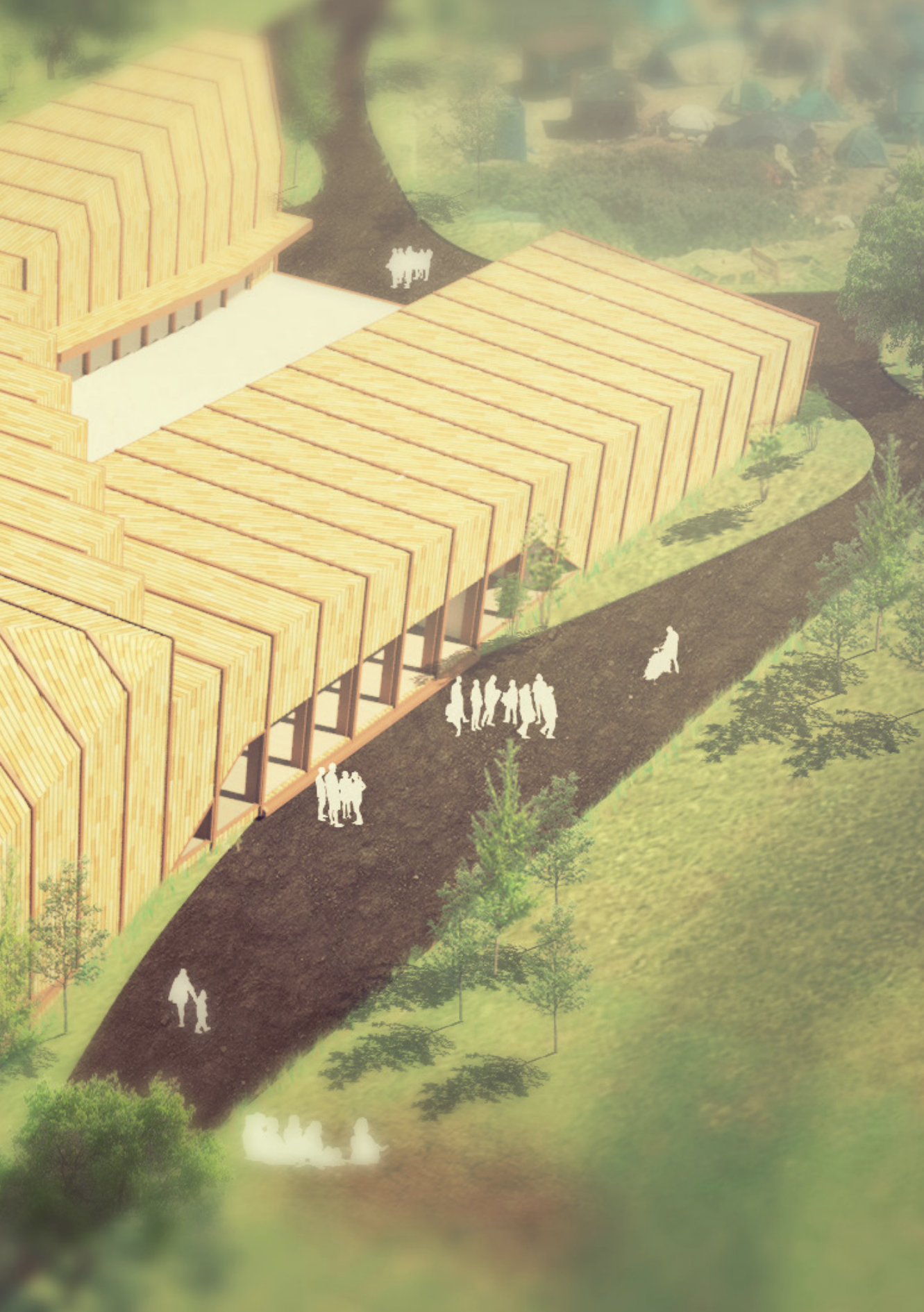
7. Communal space



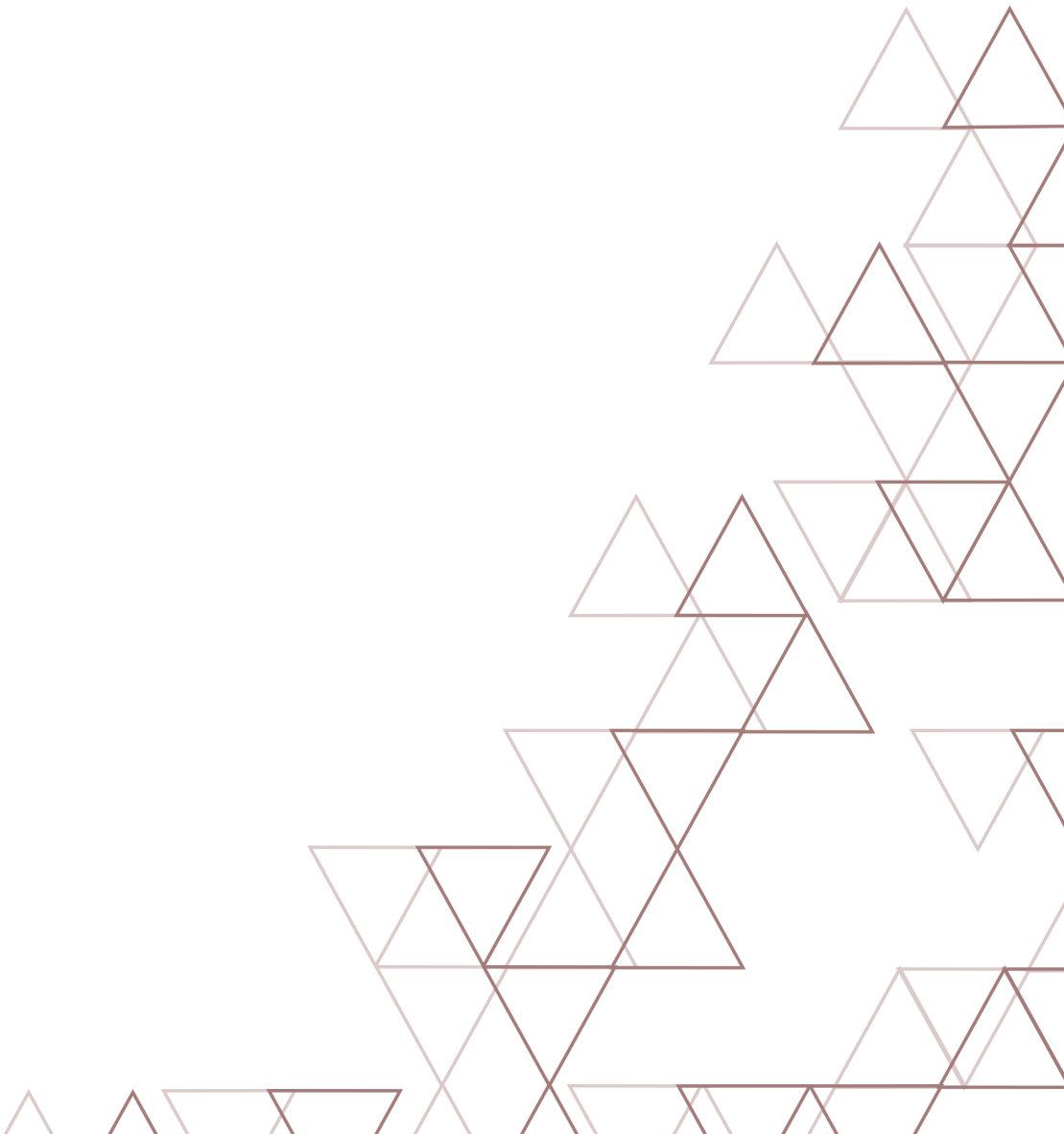
8. Public space

Fig 48. Building program division





Chapter 7
Design



7.1 PROGRAM

Figure 50 shows how the building program concept is translated into a division of spaces.

Layer one is characterized by the introvert public space with its adjacent introvert public functions. Layer 2 is characterized by the public street with the adjacent extrovert public functions and the top layer is the connection layer between the north nave and the south nave of the building.

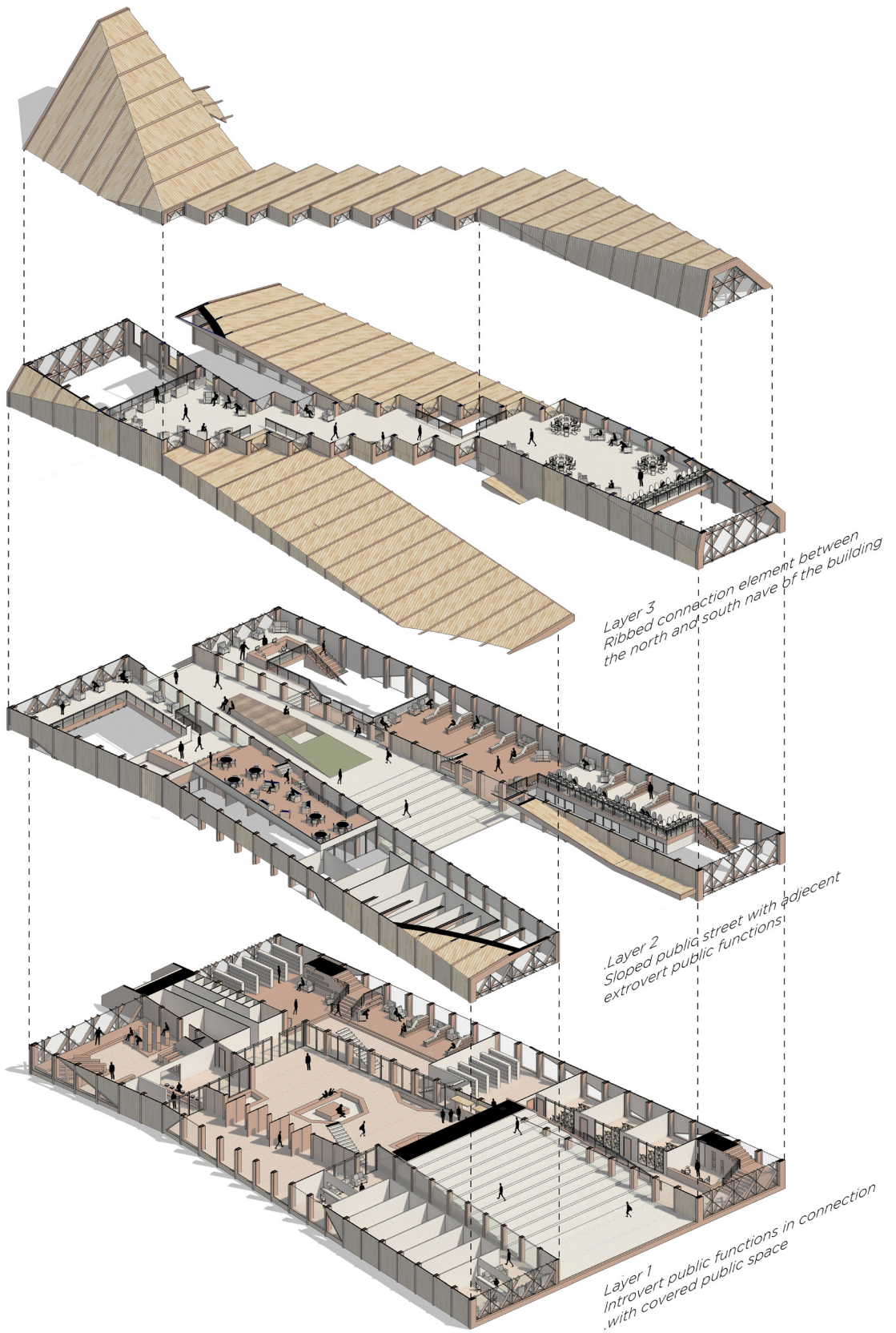


Fig 50. Axonometric view of the building

GROUND FLOOR

The ground floor has the greatest diversity of functions. Around the central public space the distribution center, knowledge center, sanitation, health center and ceremony space are situated. This concerns the more introvert parts of these functions. The central area contains conversations pits where people can sit around, charge their phone and wait for their food or other items. This space can thus be seen as a covered public space, where people are protected from the elements and detach themselves from the daily problems in the camp.

The north nave of the building is assigned to the knowledge center. Also in this nave is the distribution center, which splits this knowledge center in two parts. The left part is the reading area. This is a relative quiet zone wherein bookshelves and seating areas are created. These areas can be recognized from the heightened floor parts, which also divide the occupied zone from the movement area. The right side of the knowledge center is the public entrance at ground level. In this area some rooms are situated meant for lectures or reading session.

The distribution center itself is very simple. It contains storage space, a large door through which the goods come in and a counter on the inside where the goods are handed to the refugees. Refugees that need to wait for their food, clothes or shelter can do this in the central public space.

The south nave of the building contains the ceremony space and health center. The ceremony space is located at the left. This space consists of a bar, wardrobe, main ceremony hall, small chapel for intimate session and a dressing room. The health center is located at the right. This center has two entrances. The left entrance is meant for people who must undergo treatment. These are generally spaces that are directed inwards, and therefore it is adjacent to the inner central square. The right entrance of this health center is meant especially for the pharmacy. This is during the day a coming and going of people, and therefore it is situated on the public street.

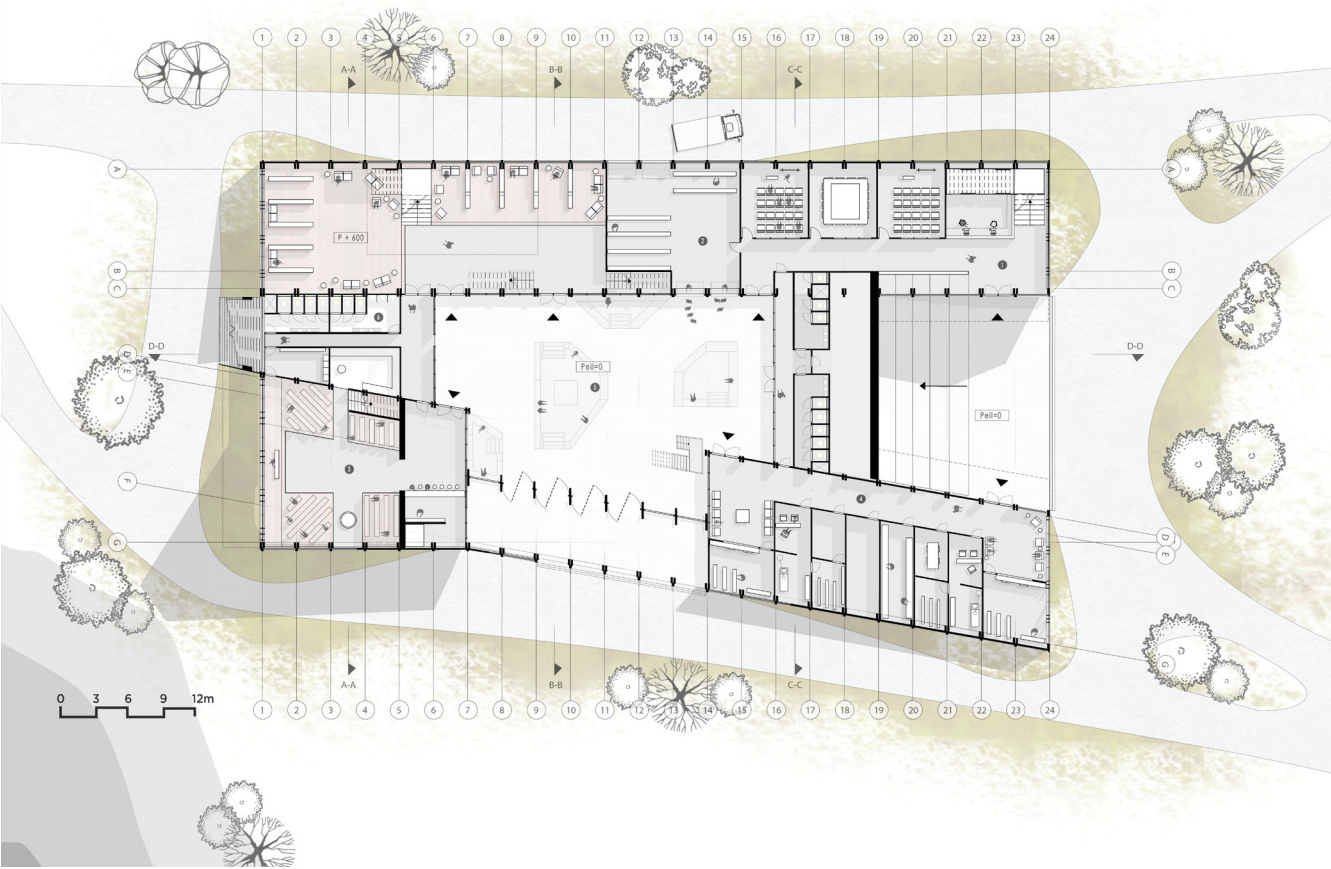


Fig 60. Ground floor plan

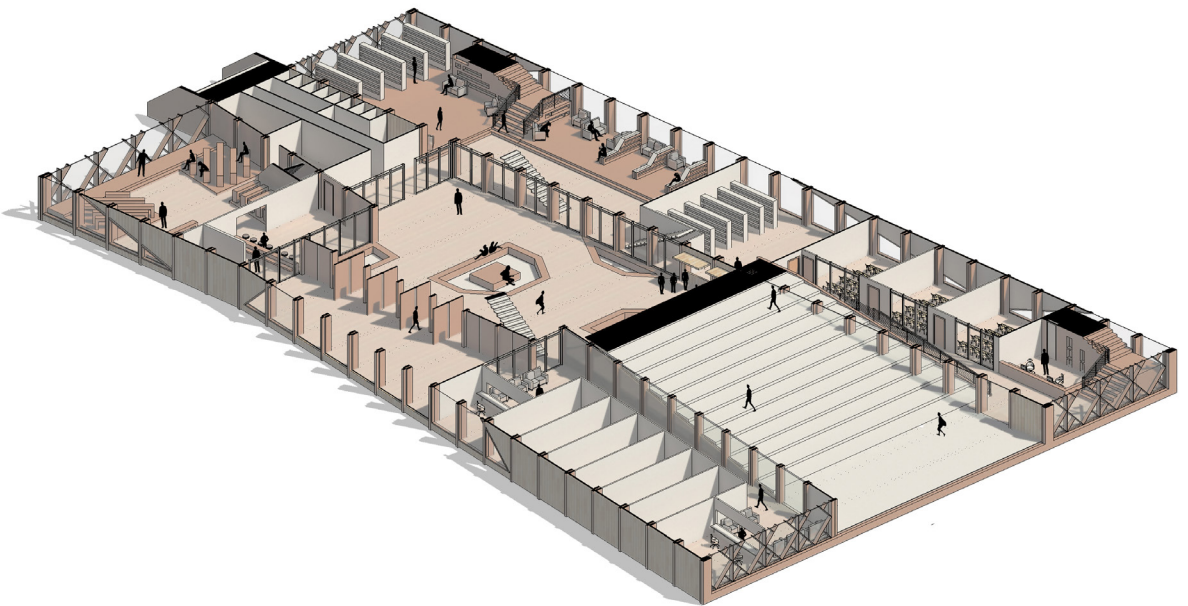
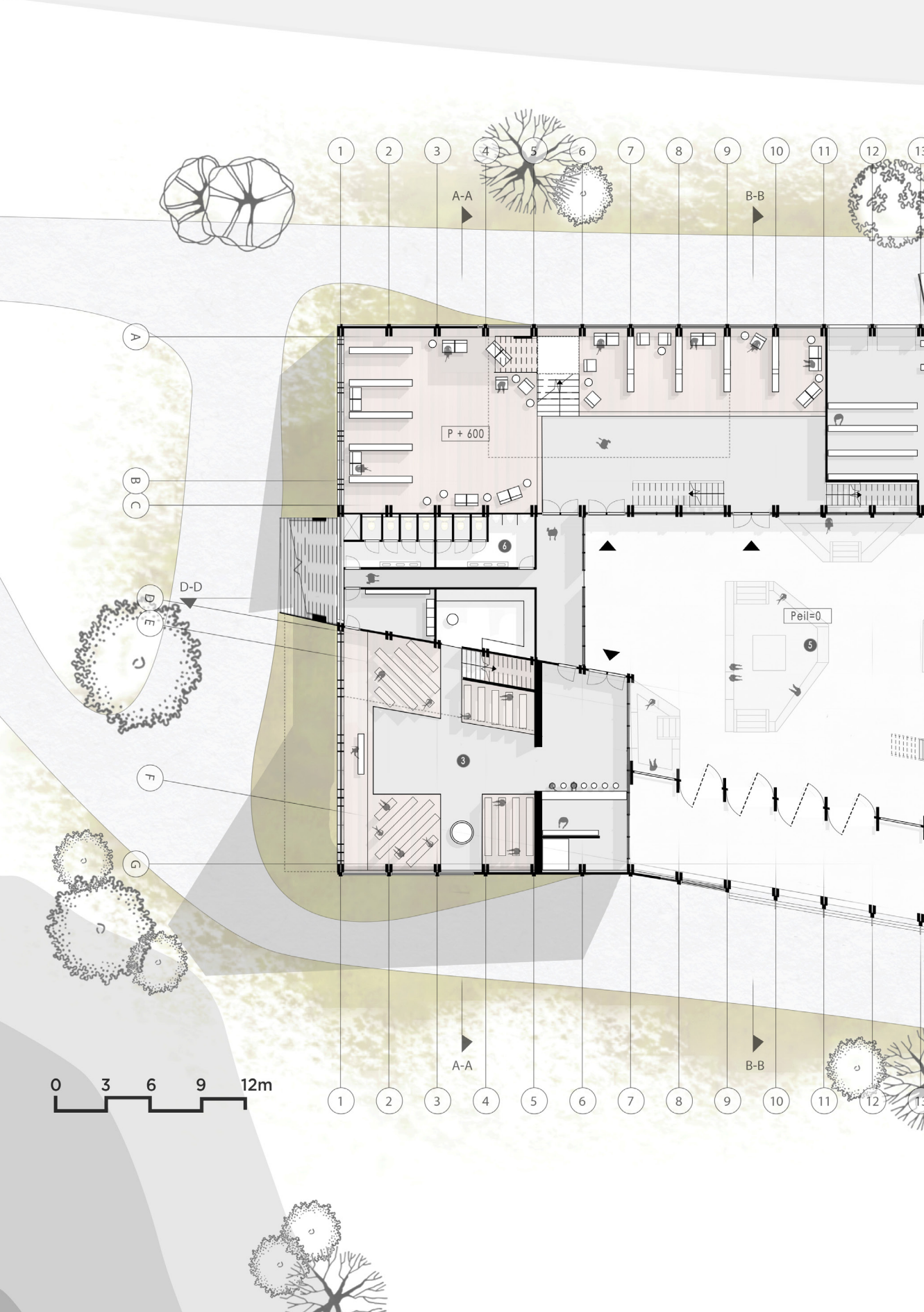


Fig 61. Ground floor axonometric view



0 3 6 9 12m

1 2 3 4 5 6 7 8 9 10 11 12 13

A

B
C

D
E

F

A-A

B-B

D-D

A-A

B-B

P + 600

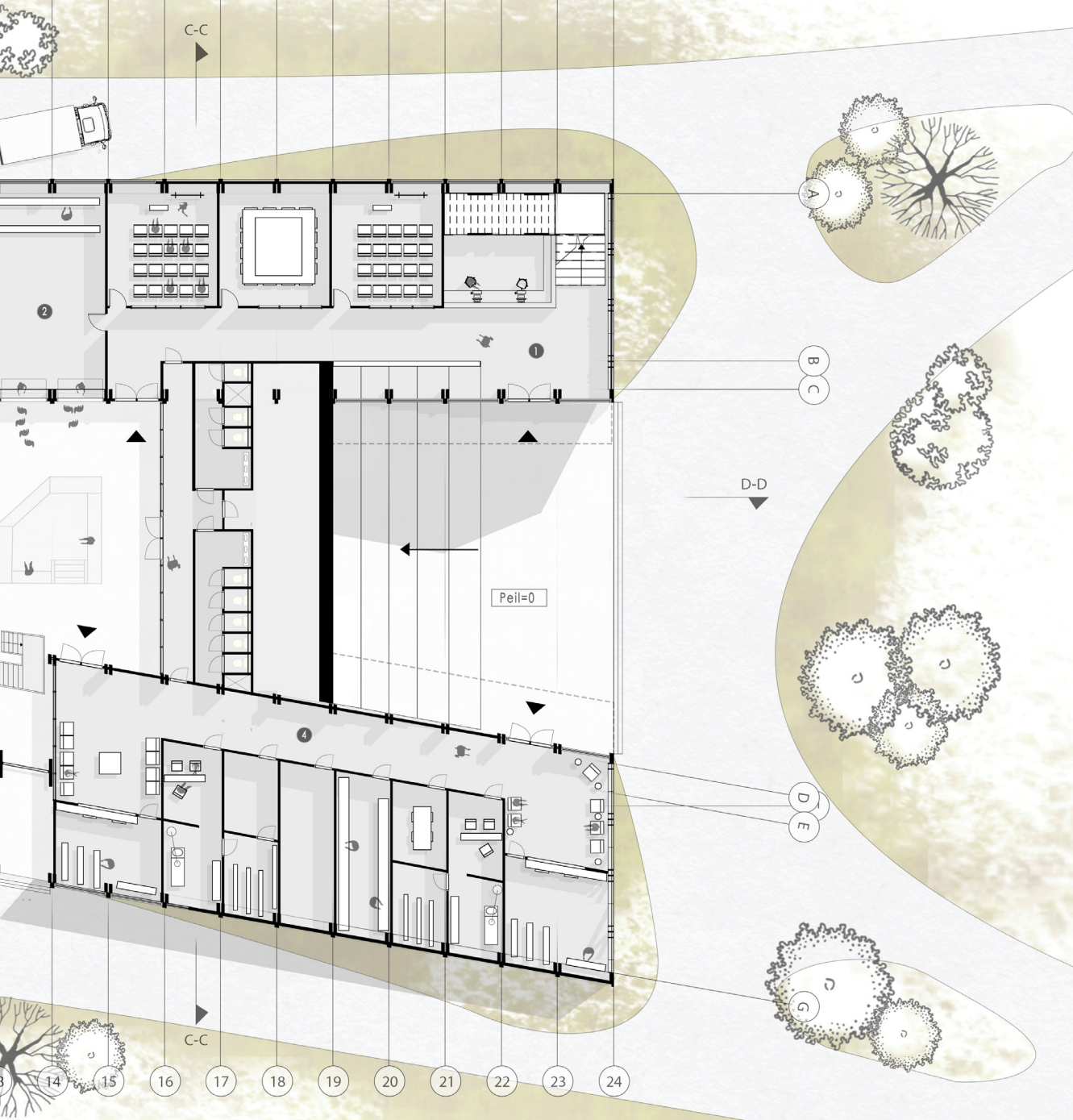
Peil=0

3

6

5

14 15 16 17 18 19 20 21 22 23 24



C-C

Peil=0

D-D

C-C

14 15 16 17 18 19 20 21 22 23 24

A

B
C

D
E

G

LEVEL 1

The most important part of this plan is the public street. This street is an extension of the main street of Calais and therefore all public extrovert functions are adjacent to this street.

The north nave is assigned to the knowledge center over the whole length. The entrance for this function is located at the left side (flat part) of the public street. In the middle of this level, the floor is lowered with the aim to allow more daylight into to public square underneath this public street. This lowered part is used to place bookshelves and seating areas. The right part of the knowledge center is intended for making working places. Here the refugees can use computers.

The south nave is all community space. The left side of this space connects to the ceremony hall. It acts as a kind of balcony where people can attend the event held in the ceremony space. Behind the seperating wall, there is a bar where people can get drinks or small foods. Adjacent to this bar, at the right side, there is a heightened area where seating areas are organized to create a space where people can come together. This space can thus be used by the refugees for appointments or just to come together.

The public street itself also consist of two part; a flat part at the left and a sloped part at the right. This sloped part is made out a series of steps. At the left part, there is a seating element placed in the middle of the street. The sides of this seating element are executed transparent, so more daylight can enter the space underneath. For this reason, there is also a big void integrated in this element as shown on the images on the right. Furthermore, this street is marked by strips which are integrated in the floor. This strips can be made of grass, can be transparent or can be raised to create seats.

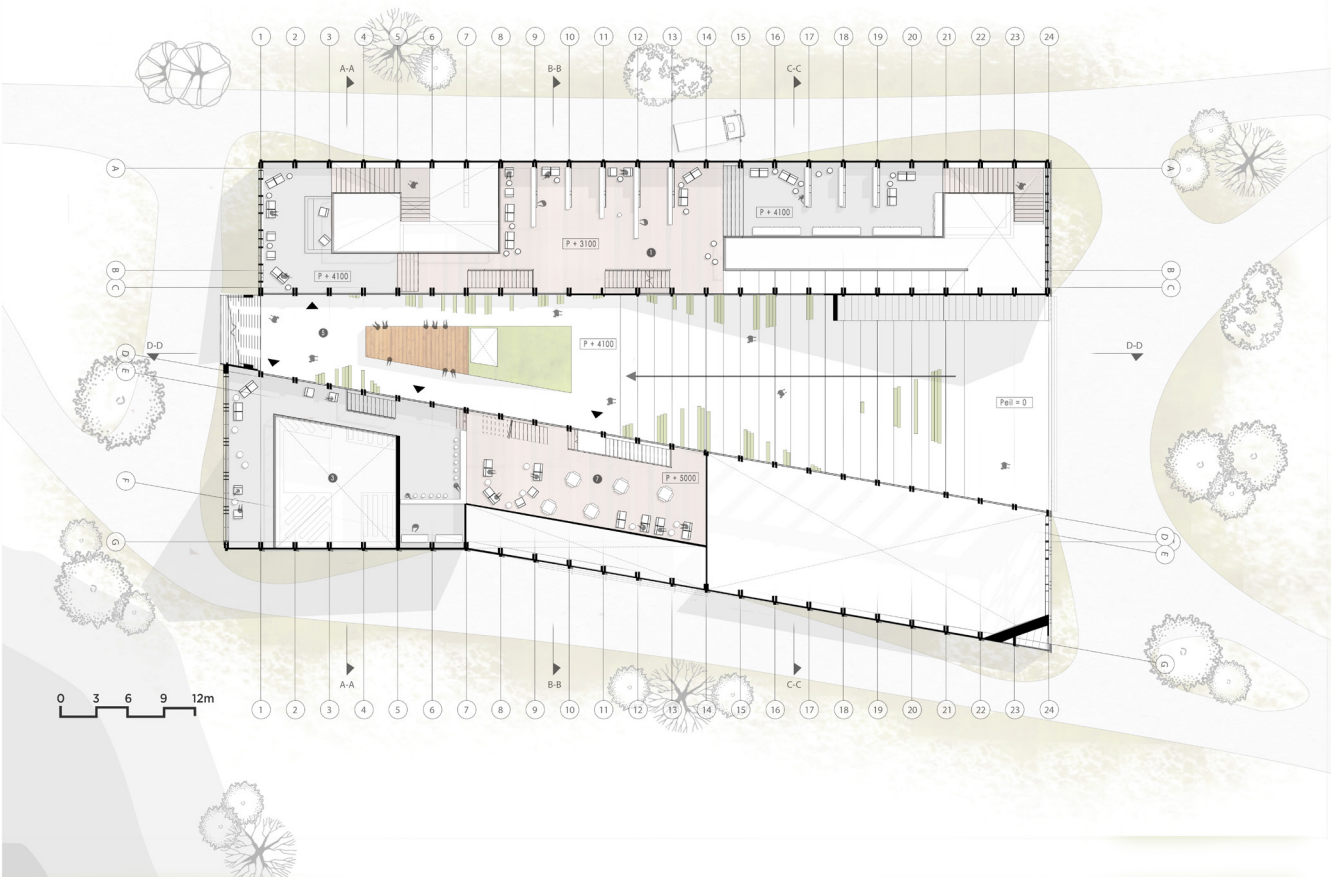


Fig 63. Level 1 floor plan

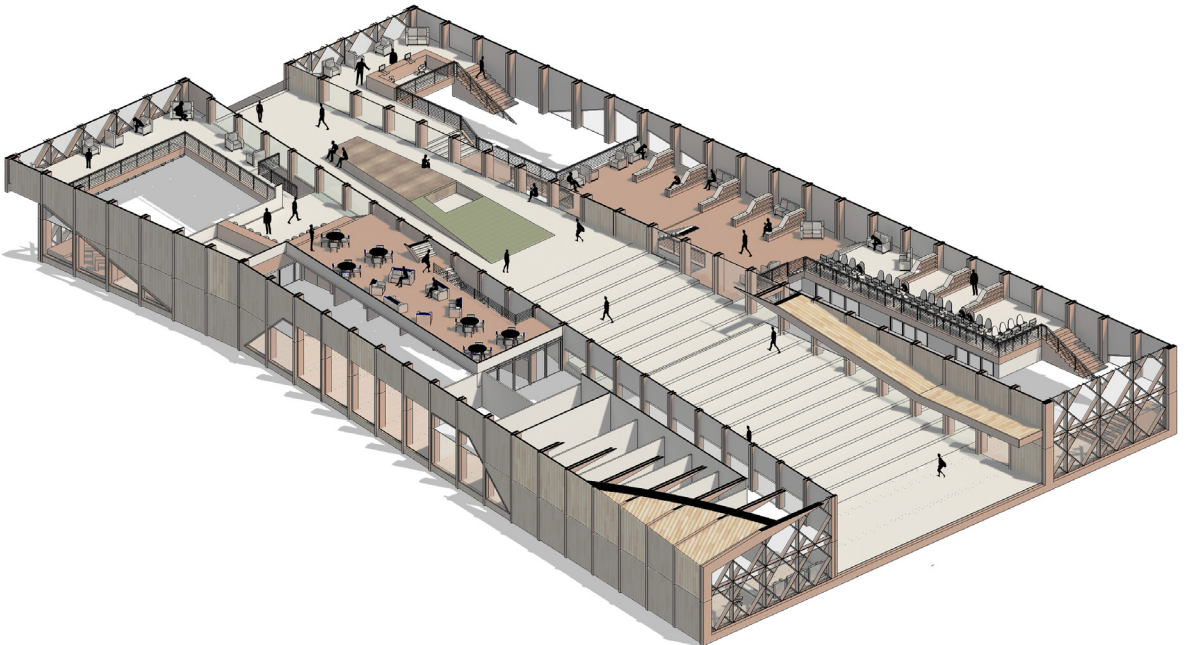
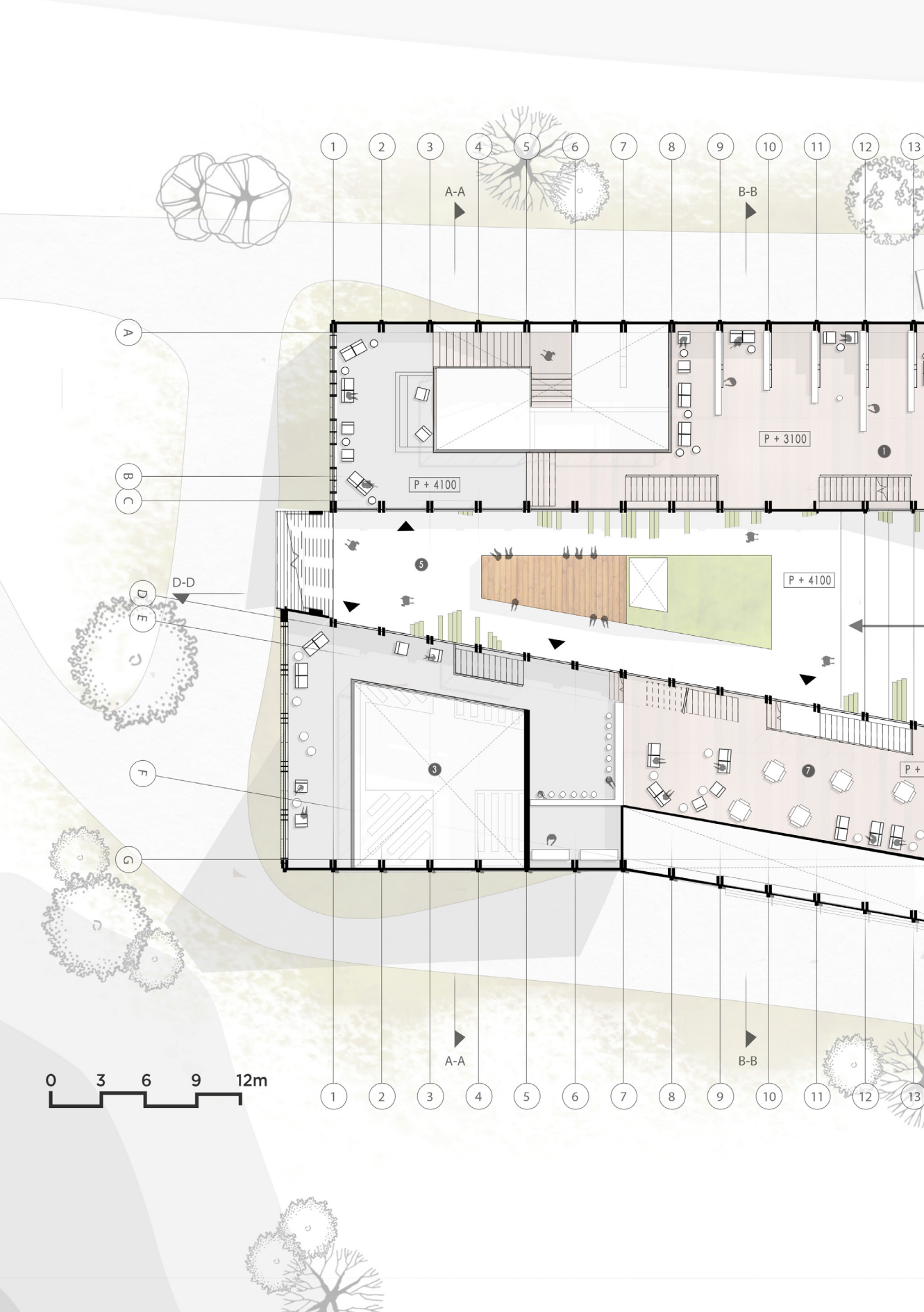
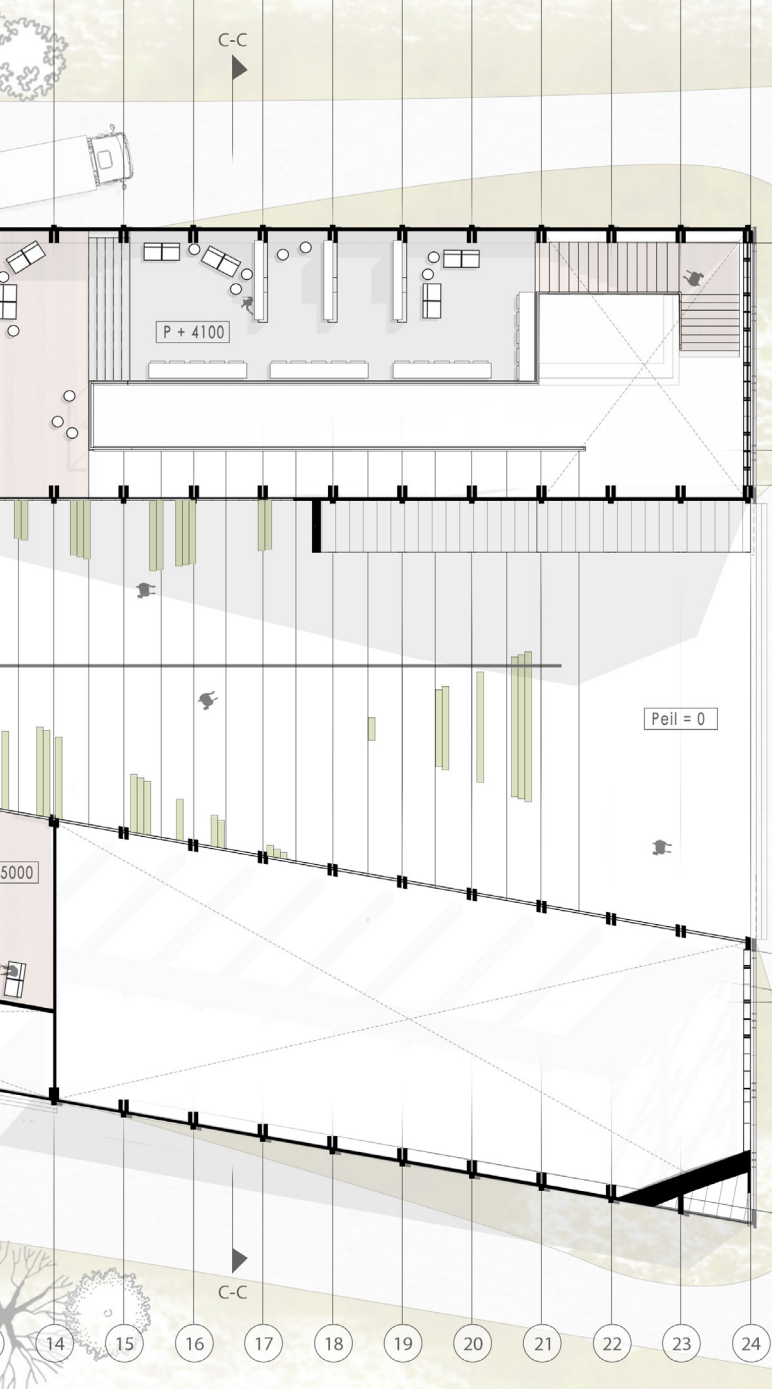


Fig 64. Level 1 axonometric view



14 15 16 17 18 19 20 21 22 23 24



A

B
C

D
E

G

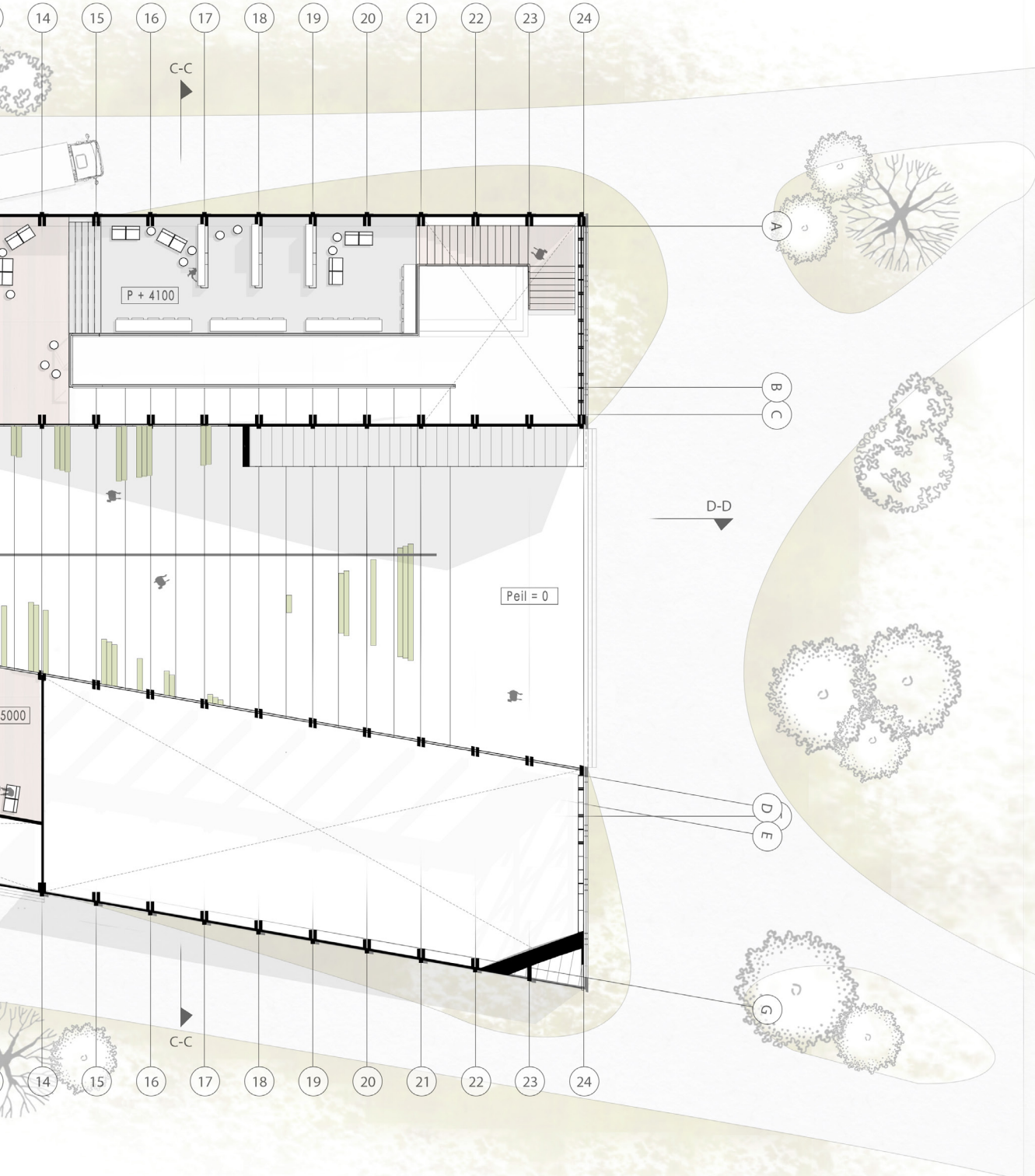
D-D

C-C

C-C

Peil = 0

5000



LEVEL 2

The top layer of the building is mostly meant to make the connection between the north and south nave of the building. This connection is situated above the public street. The ribbed design comes from the building system and is used to achieve the desired architectonic expression (7.2 exterior).

At the bottom left of the floor plan, a big void is visible. This void is adjacent to the ceremony space on the ground floor. The area around the void is meant for people who want to attend in the event going on in the ceremony space. Besides this, the space can also be used as communal area.

The top right of the plan shows the top floor of the knowledge center. This part of the knowledge center is designed to create workspaces for the users.

The ribbed part of the plan, in between those two zones, is literally the connection zone. When people pass from one side to another, they get an overview over the public street, because the sides of the ribbed parts are executed with trifold facade elements in the same way as the gable ends of the facade.



Fig 66. Level 2 floor plan

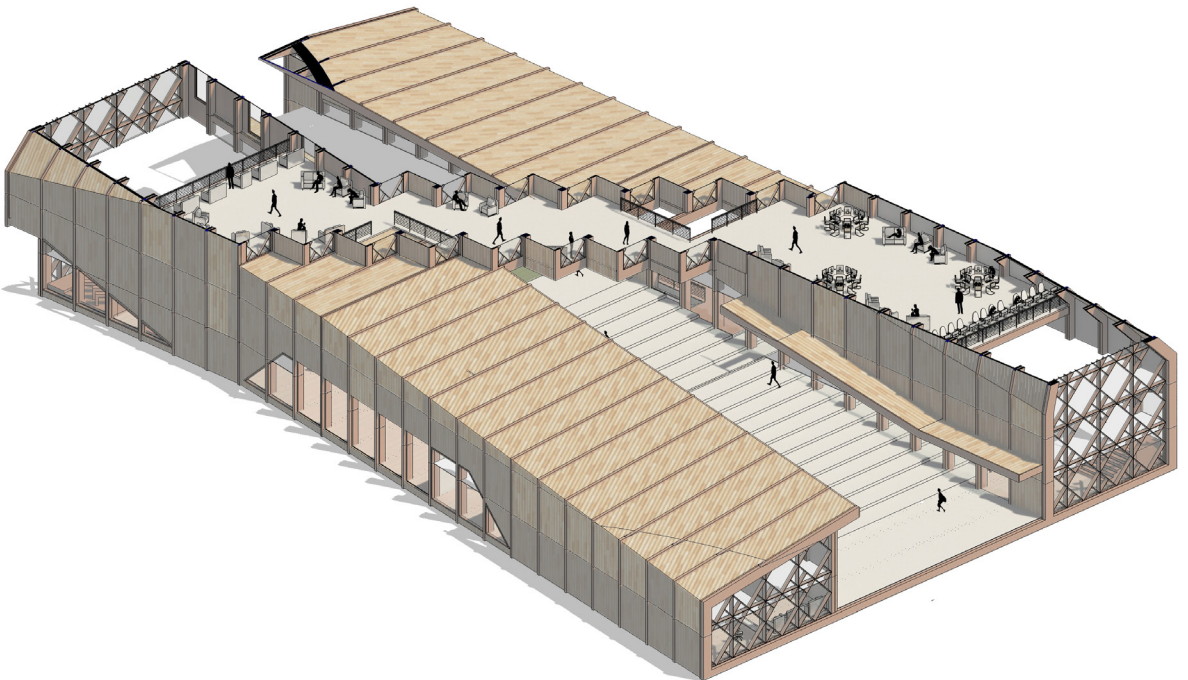
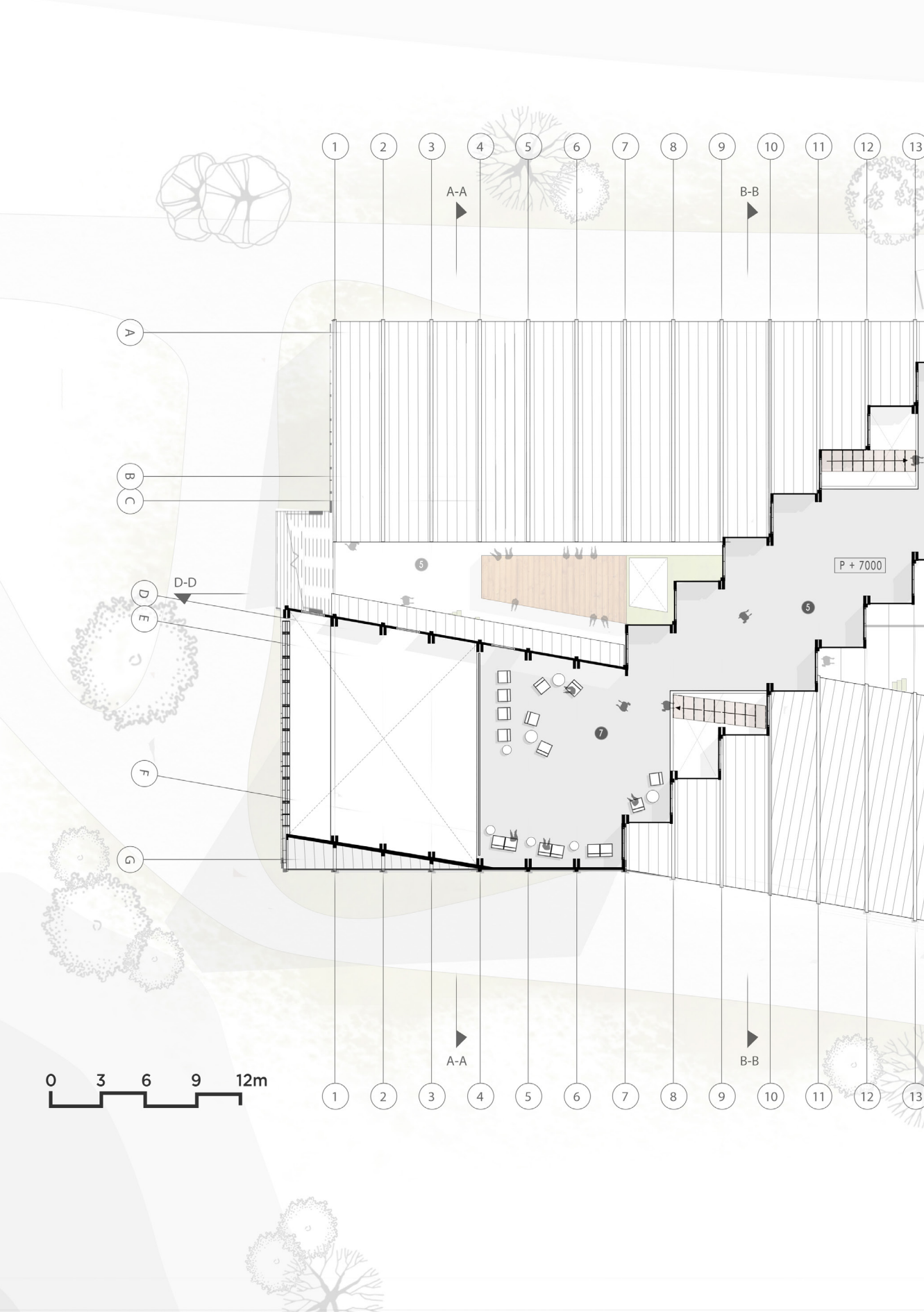


Fig 67. Level 2 axonometric view





A

B
C

D
E

G



7.2 EXTERIOR

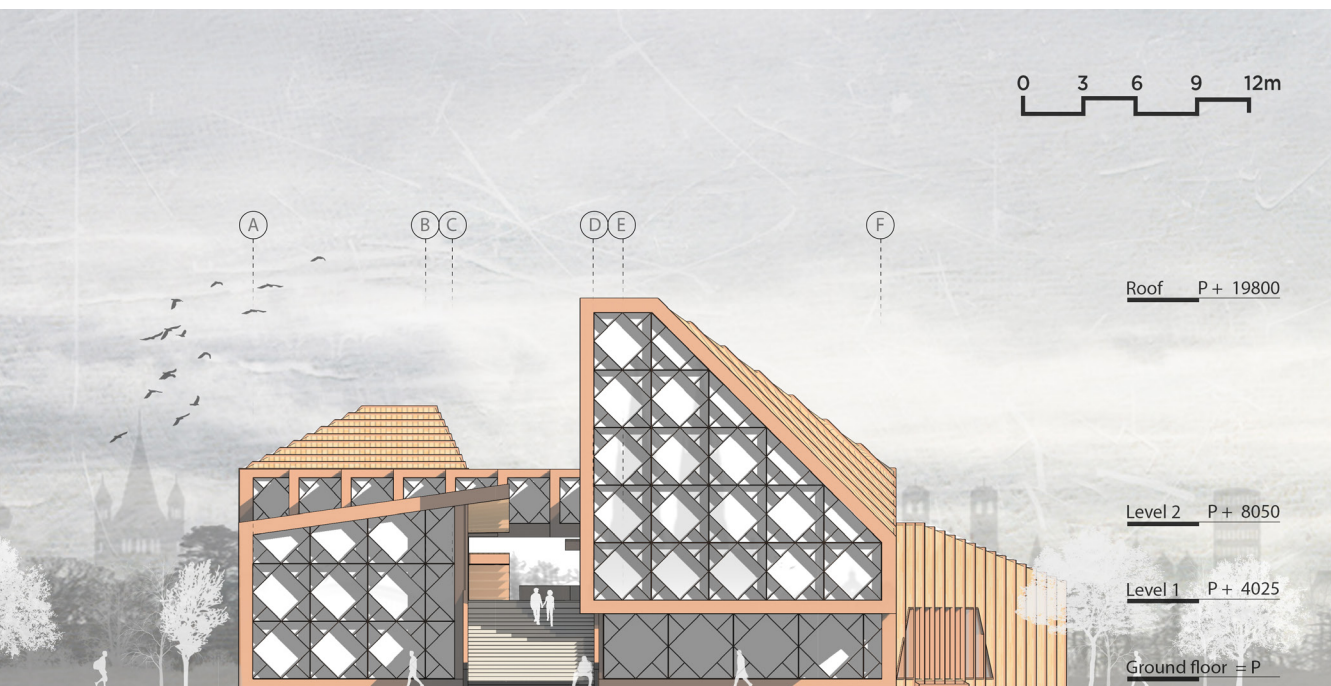
EAST & WEST ELEVATION

Both gable ends of this building are characterized by the trifold building system. The trifold facade elements are stacked and connected to create this facade pattern. The shape of these gable ends arose from the interior. First, the correct expression for the pertaining space is determined. This shape is then afterwards slightly adjusted so that it matches the pattern of the facade system. These facades

are being framed by a thick edge of 600mm thick. These edges are executed in wood in pallisander color, same as the trifold system itself. The height of the east facade ensures the visual awareness of the building in its environment, so it can become an icon of the settlements.

Between the two volumes there is the public street. Above this public street spans the connector between the two volumes. This connector is designed in a staggered manner, as shown in the west elevation. In this way the building is conceived as two separate volumes with a piece that connects them with each other instead of one big volume with two cut outs. This highlights the accessibility

Fig 69. West elevation



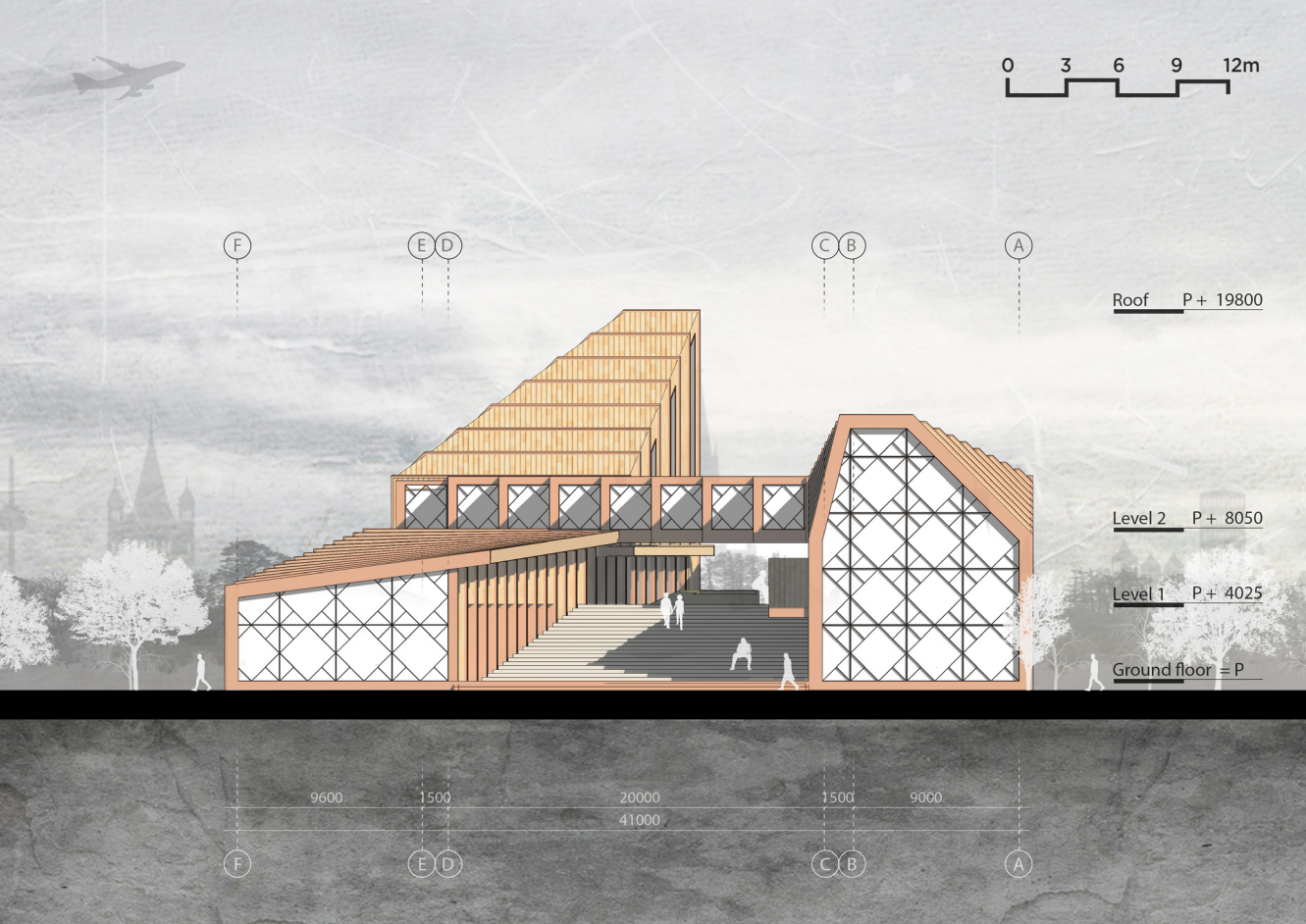


Fig 70. East elevation

of the public space in between the two volumes. The roofs of the building are never directed to the inside, but are neutral or inclined towards the outside. In this way rainwater, rain, or sand which ends up on the roof can never fall on the public street between the volumes, but is neatly conveyed towards the outside of the building.

NORTH & SOUTH ELEVATION

The north and south facades are the longer ones. The south facade borders the main street of Calais, and thus there is the entrance for the public space underneath the public street. This entrance is an important factor in the facade picture on this south side and is designed and aligned on the other facade openings of the building. These openings are determined by the interior demand for daylight. Some

spaces need a lot of light, like for example the knowledge center, other need less light, like for example the distribution center. These peaks and troughs in the facade are connected with each other and in this way the lines in the facade arose.

The materialization of the facade is for the biggest part out of wood. The facade panels, which are mounted to the trifold portals at the inside, are covered with cedar wooden slats. The dominating lines on the facade arose from the interconnecting between those panels, as shown in chapter 8. These lines are executed in the same material and color as the edges of the gable facades.

Fig 71. North elevation

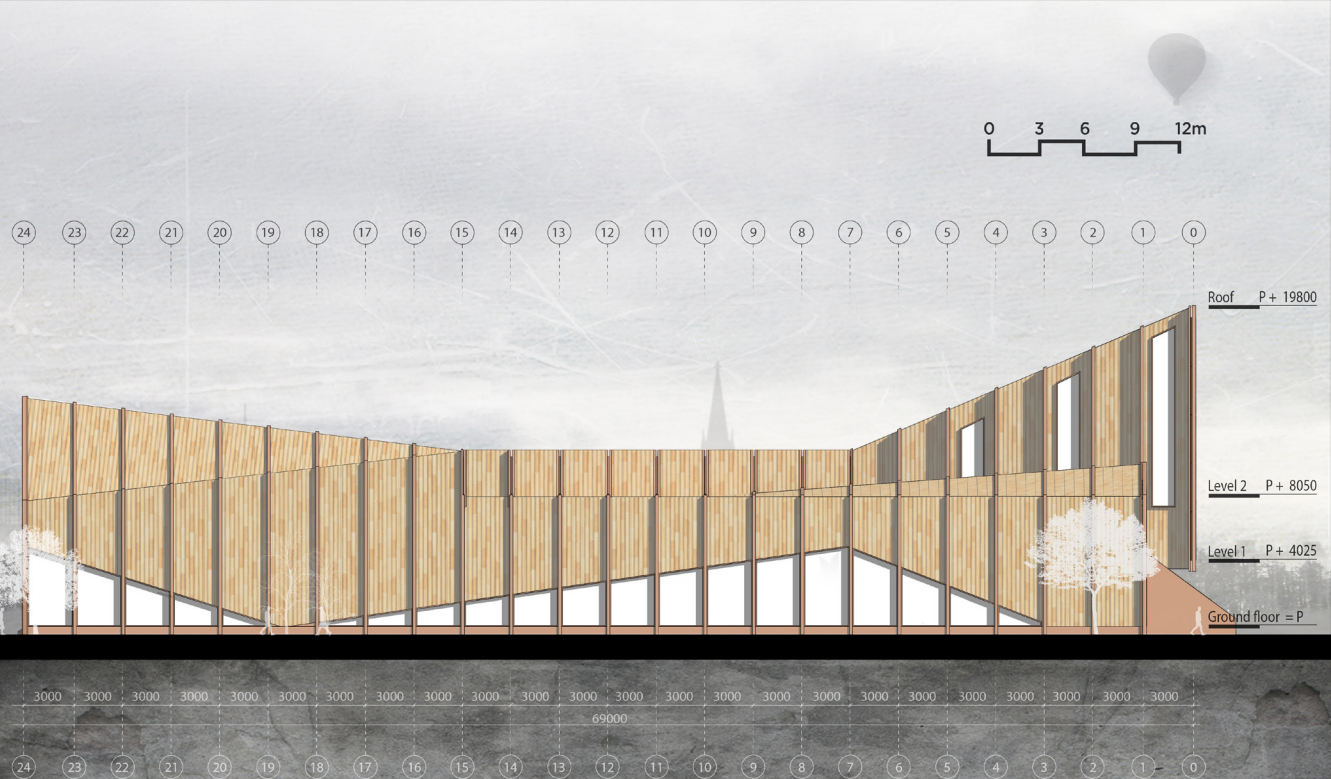




Fig 72. South elevation



Fig 73. Used materials

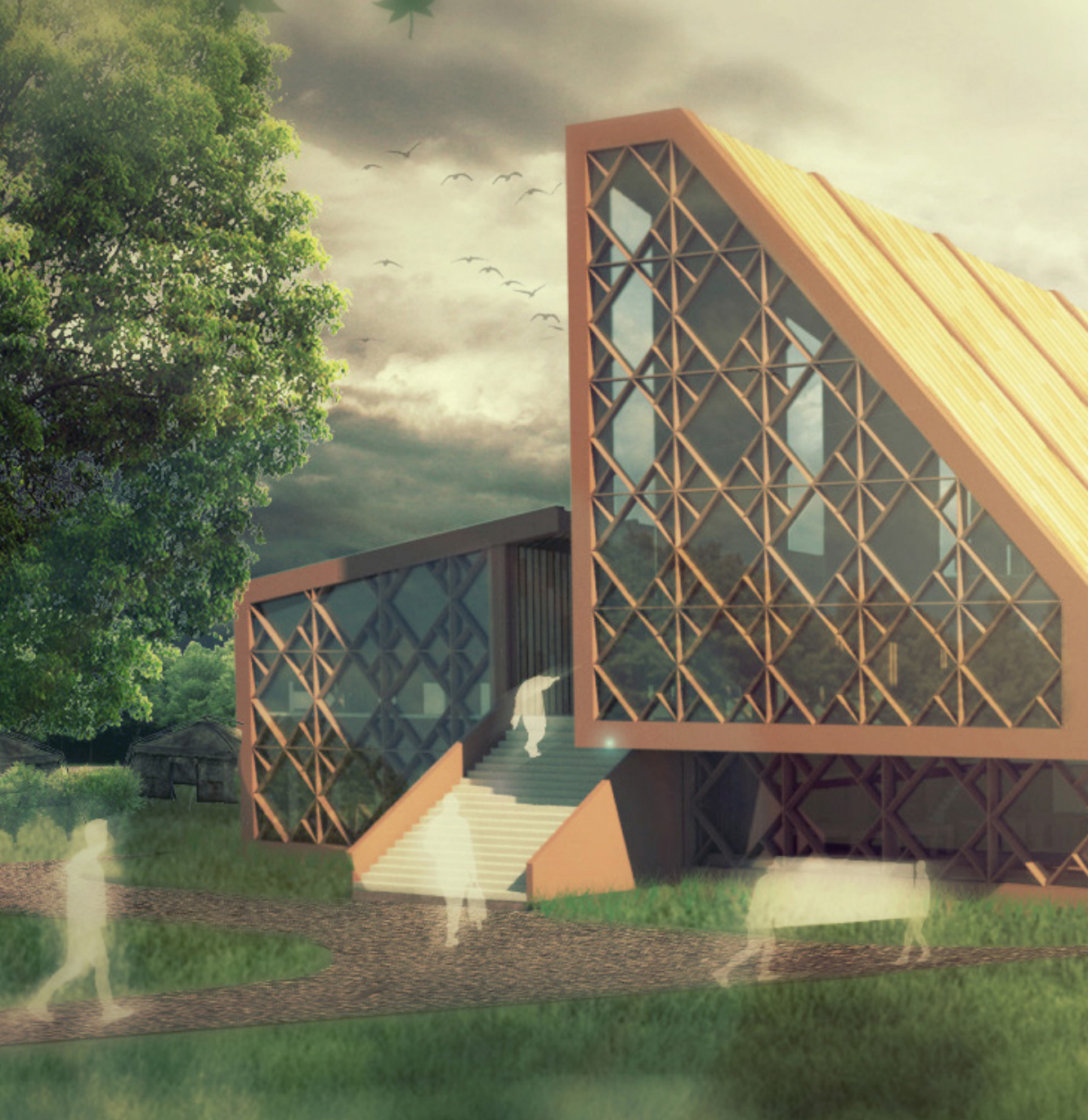


Fig 74. South-west impression

As is clearly visible in figure 74, the connecting lines of the facade panels are very determinative for the expression of the building. Because the gable and facade edges are executed in the same material

and color, these are conceived as the last line of the facade. This ending of the building is highlighted by the facade pattern.



7.3 INTERIOR

CEREMONY SPACE

One of the most important interior spaces of the design is of course the ceremonial space. Everything is designed to highlight the sacred nature of the space, which is mostly created by the triangular openings in the trifold portals and the pattern of the back facade. The whole is accentuated by the shape of the space.

With regard to the materialization, it was decided to use closely related colors and textures to radiate rest and simplicity. Although the space has this sacred feeling, it emits no religion of any kind.

The big facade openings on the right side ensures that the right amount of daylight can enter the space. The facade openings on the left highlight the feeling of revelation towards the back facade by increasing the amount of light gradually.

This space will be used for events like weddings, commemorations, baptisms, etc. At the right side of the space there is a small room which can be used for more private and intimate sessions.

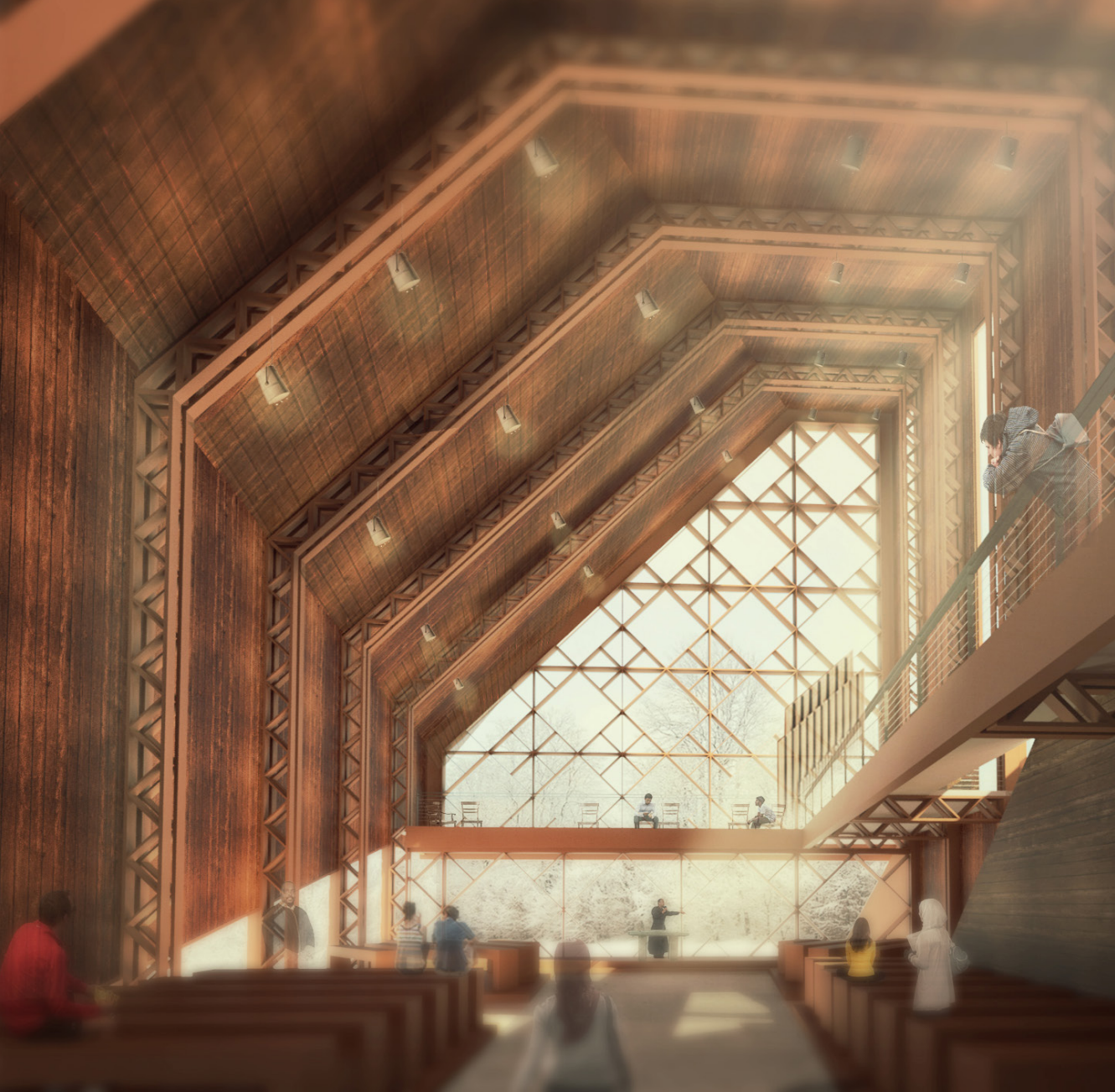


Fig 75. Ceremony space

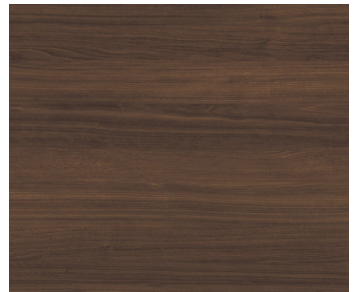
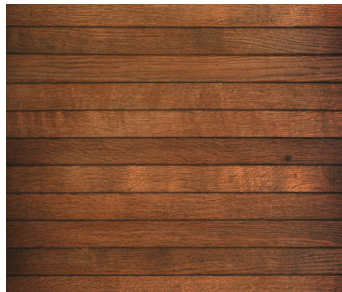


Fig 76. Main materials ceremony space

KNOWLEDGE CENTER

Another important interior space is the knowledge center. Here, the atmosphere must be way different from the aforementioned ceremony space. The materialization of the inside is brighter and has more contrast in it, what makes the space feel more friendly and neutral. This space contains multiple embankments of the ground level. These embankments divide the occupied areas, where people can sit and read, from the movement areas. The occupied areas can also be recognized from the bookshelves. These bookshelves are designed to be connected to the trifold portals. They offer enough space for books and the top side can be used as a seat to sit or lie on as shown in the image on the right.

The bottom image shows the entrance of the knowledge center at the eastside of the building. At this point, the public stair continuous inside as shown. The top layer is created for workplaces, the middle layer is a combination of reading areas with workplaces and the ground level contains rooms for lectures and reading sessions.

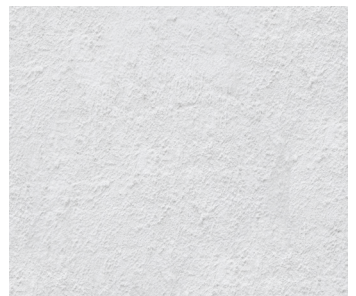
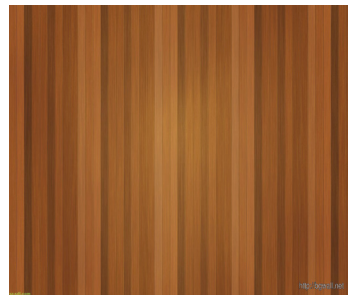


Fig 77. Used materials

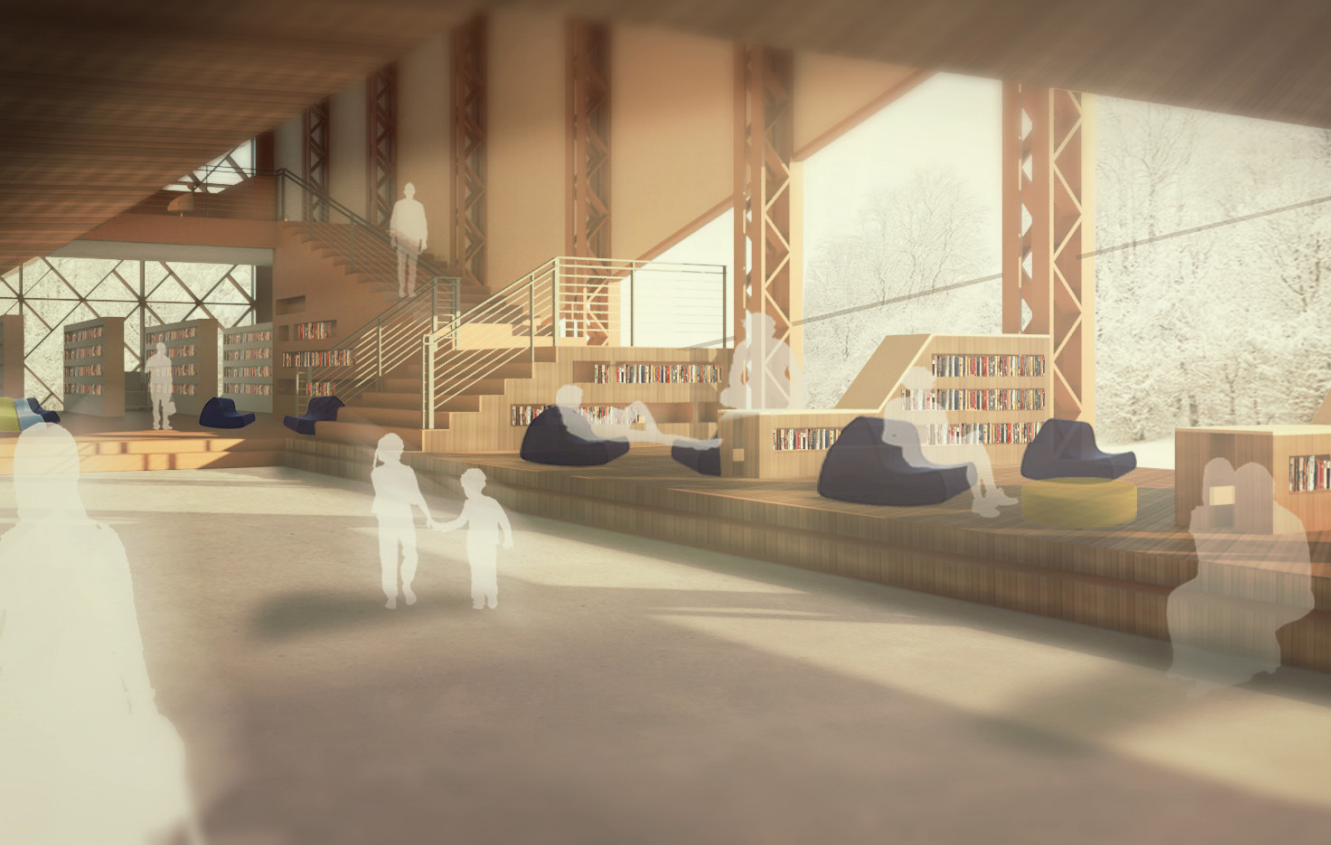


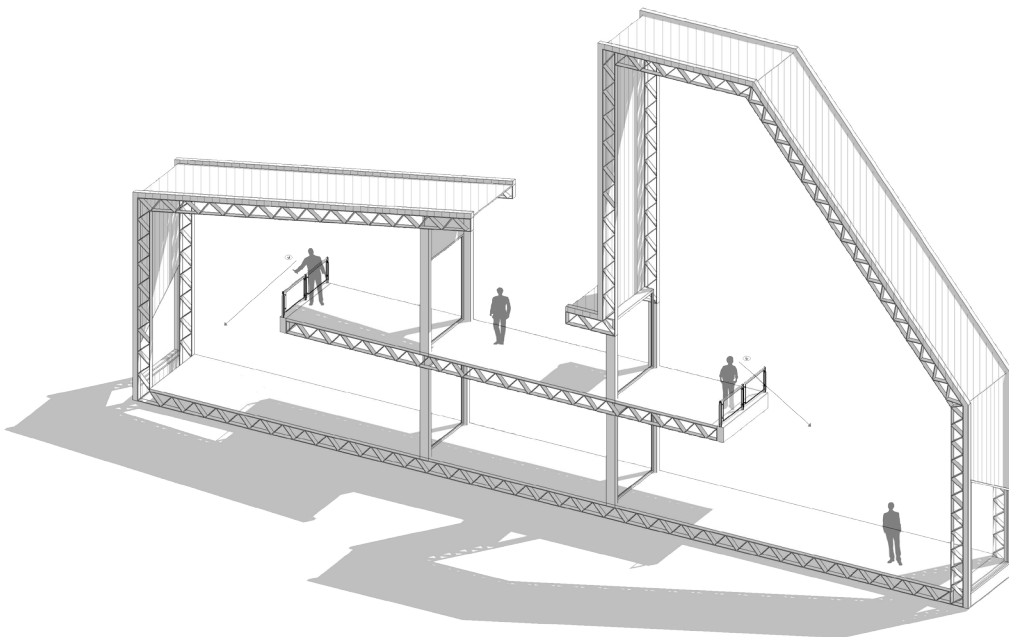
Fig 78. Ceremony space reading area



Fig 79. Ceremony space entrance at public stairs

SECTION A-A

Section A-A cuts through both the ceremony space and the knowledge center. Because of the plateau in the middle and the transparent facades at the inside of the volumes, the platforms (floor parts at the inside of the building volume at level 1) become part of the public street. From these platforms there is a direct relation with the underlying functions. These functions can be reached from this platforms by the stairs in the so called "stair zone" (Chapter 6.2).



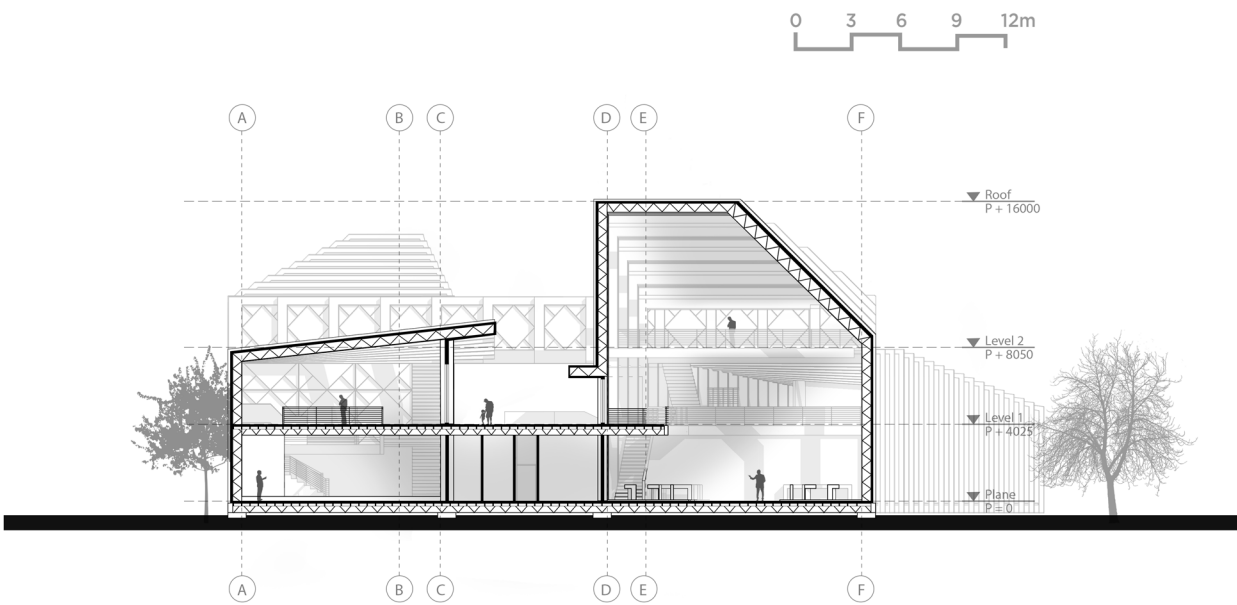


Fig 81. Section A-A, flat

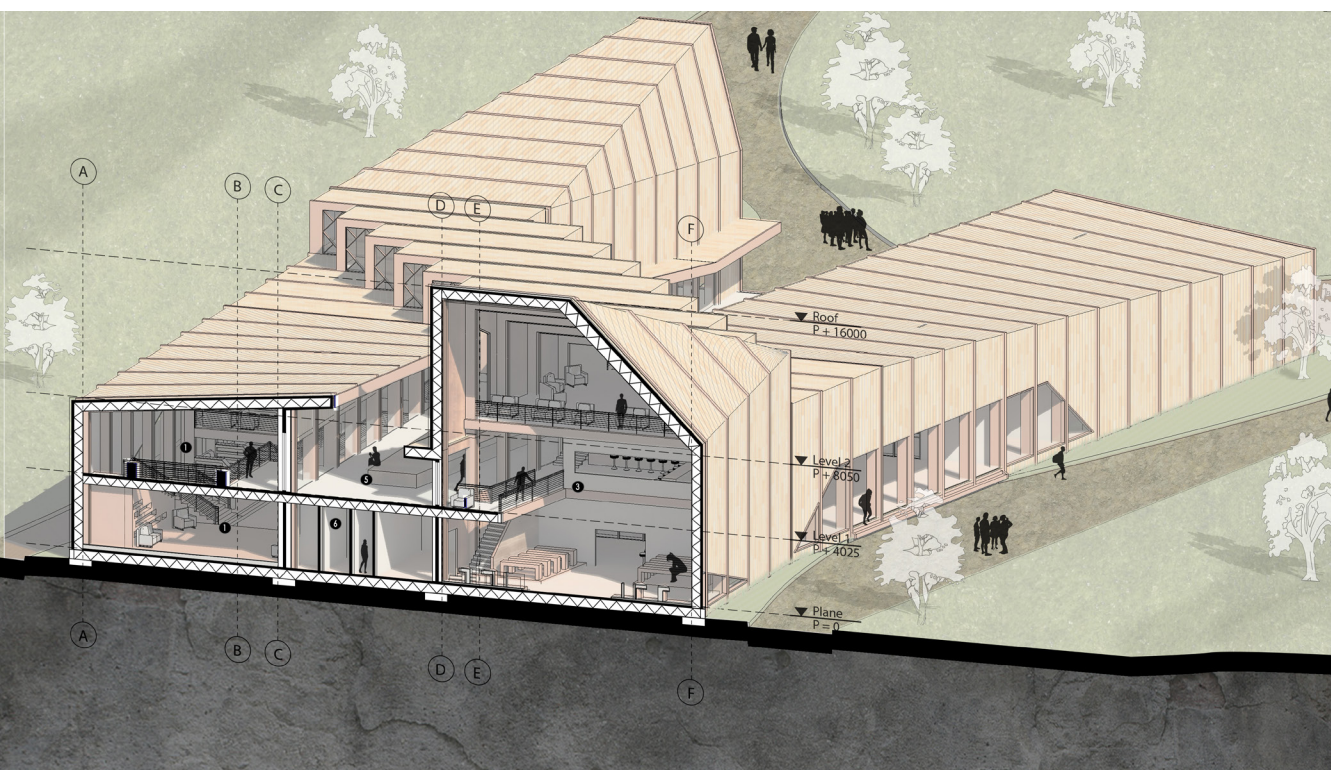


Fig 82. Section A-A, 3D

SECTION B-B

When the building is cut through its center, height differences in the platforms arise. These height differences have an important function.

In the left nave of the building, where the knowledge center is located, there is an abundance of light. By creating differences in height between the platforms and the central plateau, there is a gap which can be closed with glass. In this way the daylight can enter the space behind the wall further and deeper. So the public space underneath the street becomes lighter which makes it more pleasant and comfortable.

The height difference in the right nave has almost the same reason as the left one. Only instead of lowering the platform, it is heightened relative to the central plateau. This creates a light strip in the ceiling which lights the entrance area, which attracts people to walk into this space. This makes the transition from the bright outside to the darker inside less severe.

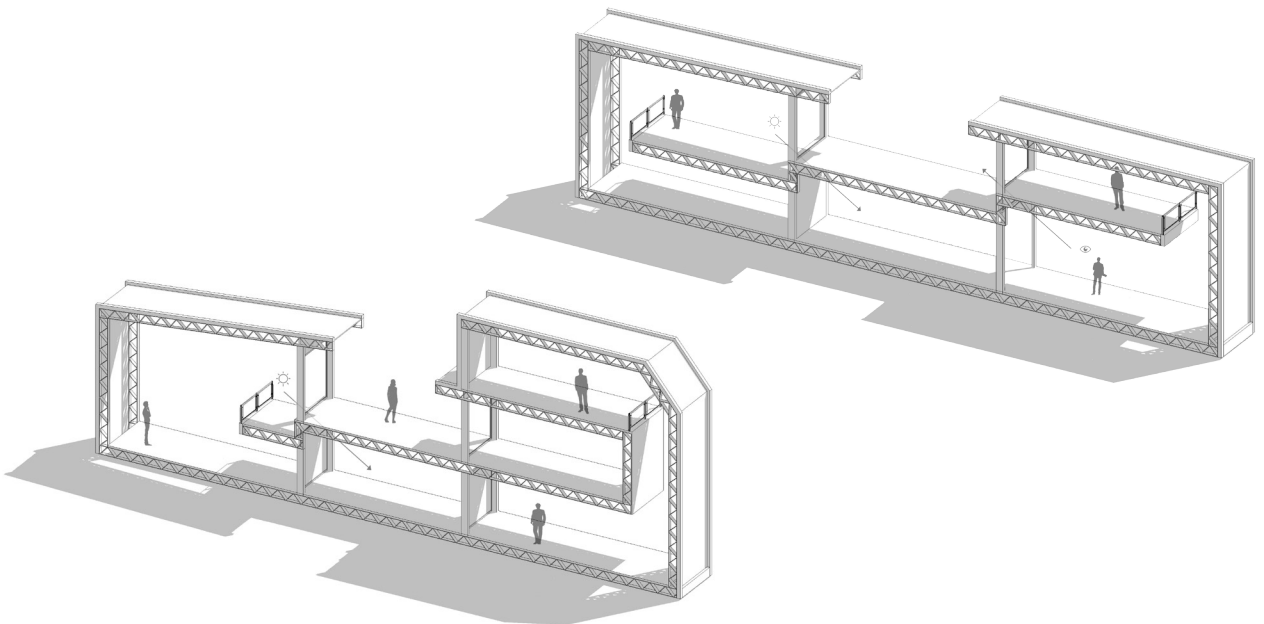


Fig 83. Trifold slice type 2 & 3

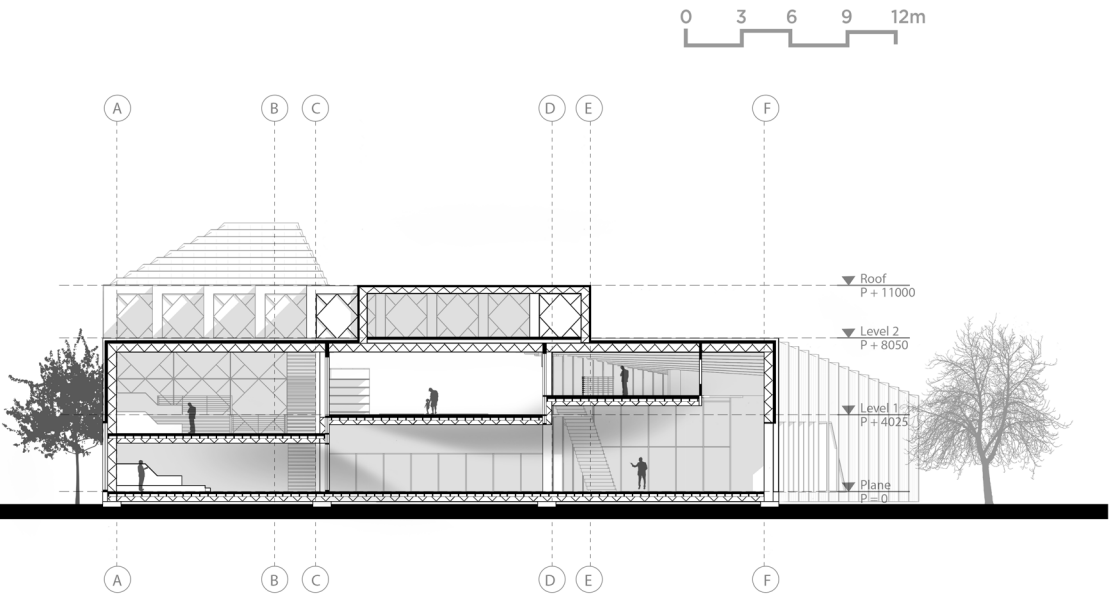


Fig 84. Section B-B, flat

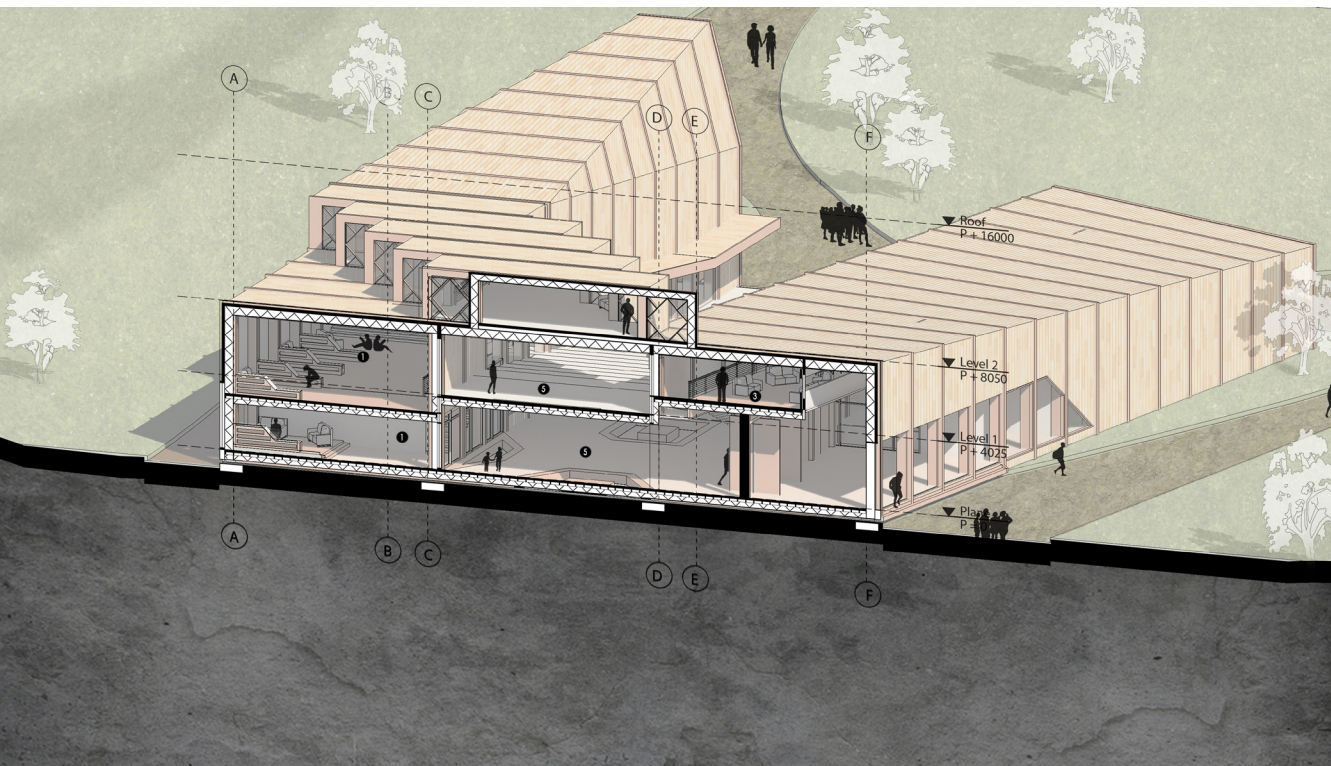
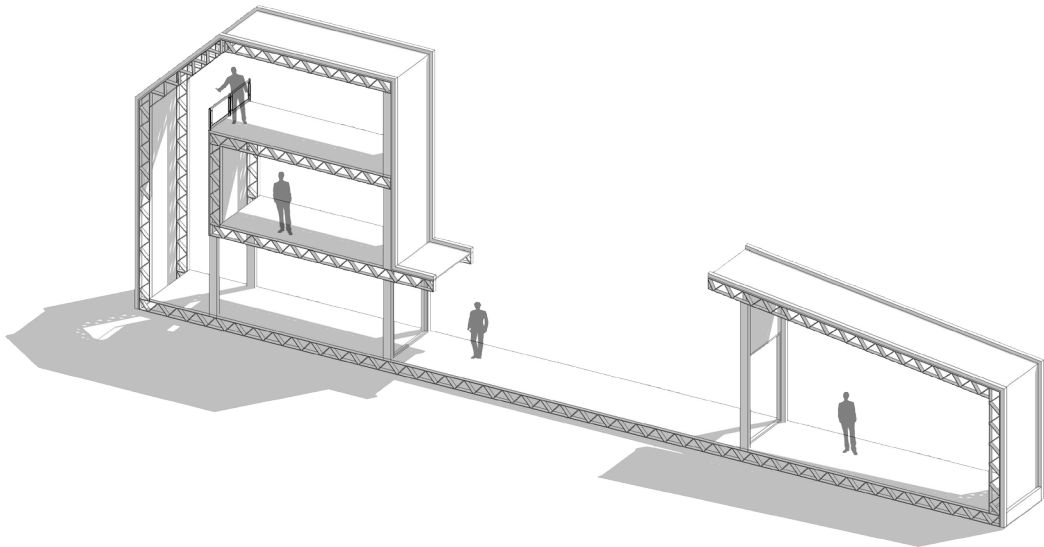


Fig 85. Section B-B, 3D

SECTION C-C

This section cuts through the knowledge center at the east side and the health center. Underneath the public space the technical space is located.



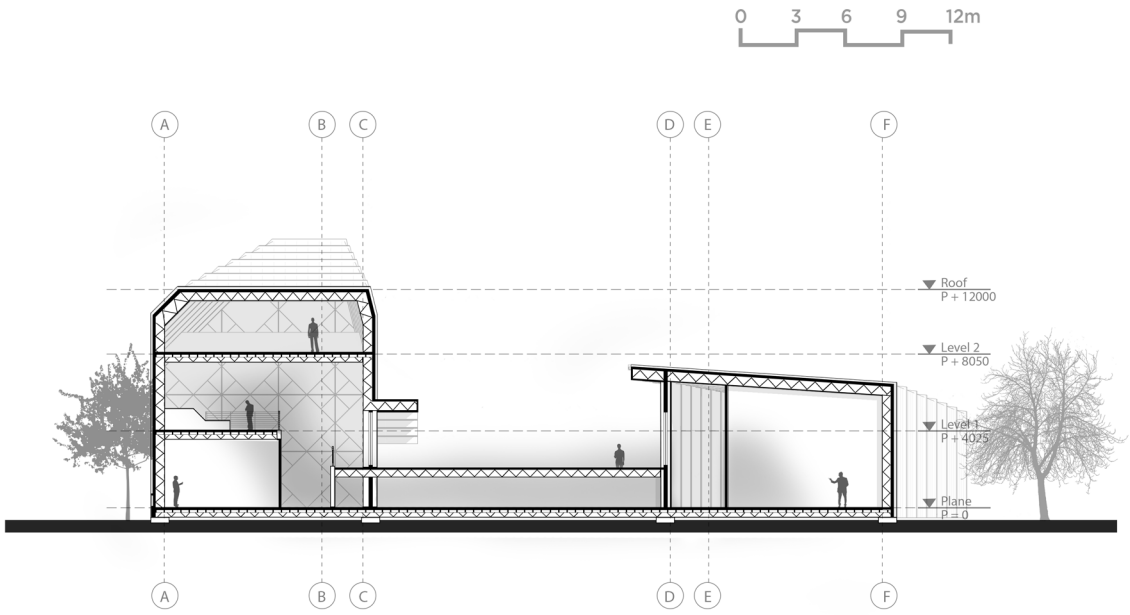


Fig 87. Section C-C, flat

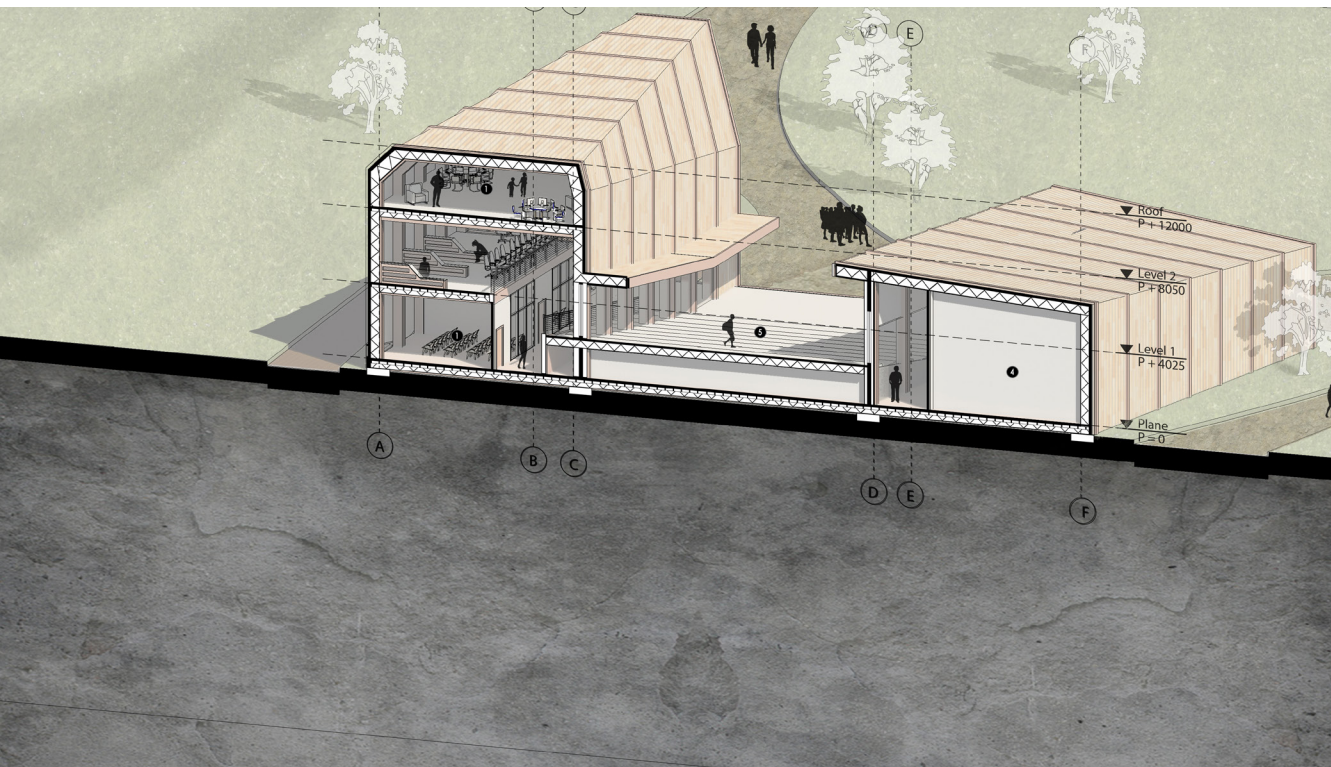


Fig 88. Section C-C, 3D

7.4 PUBLIC SPACE

Maybe just as important as the interior is the public space which the building creates in, on and around the building volume. The building contains three kinds of public space; covered public space, non-covered public space and heightened public space. The image underneath show this heightened public space consisting of multiple steps

and a flat area at the end. The public stairs also extends inwards in the knowledge center. At this public street, important public functions or sub functions are connected. For example, the entrance of the knowledge center and the community space. These are the most open and public functions in the building. The main space is thus the space between the two building volumes.

Fig 89. Render of the public stairs

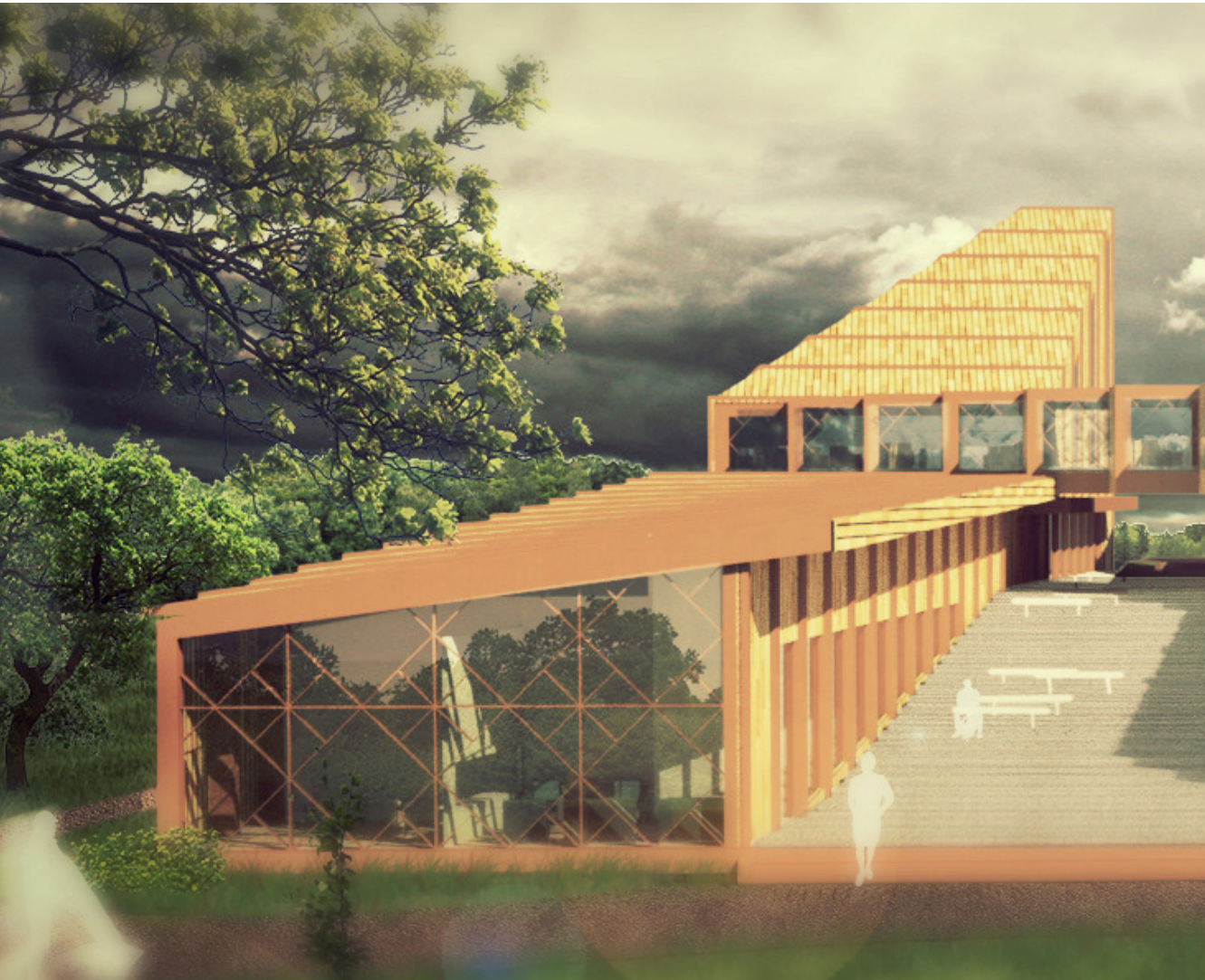
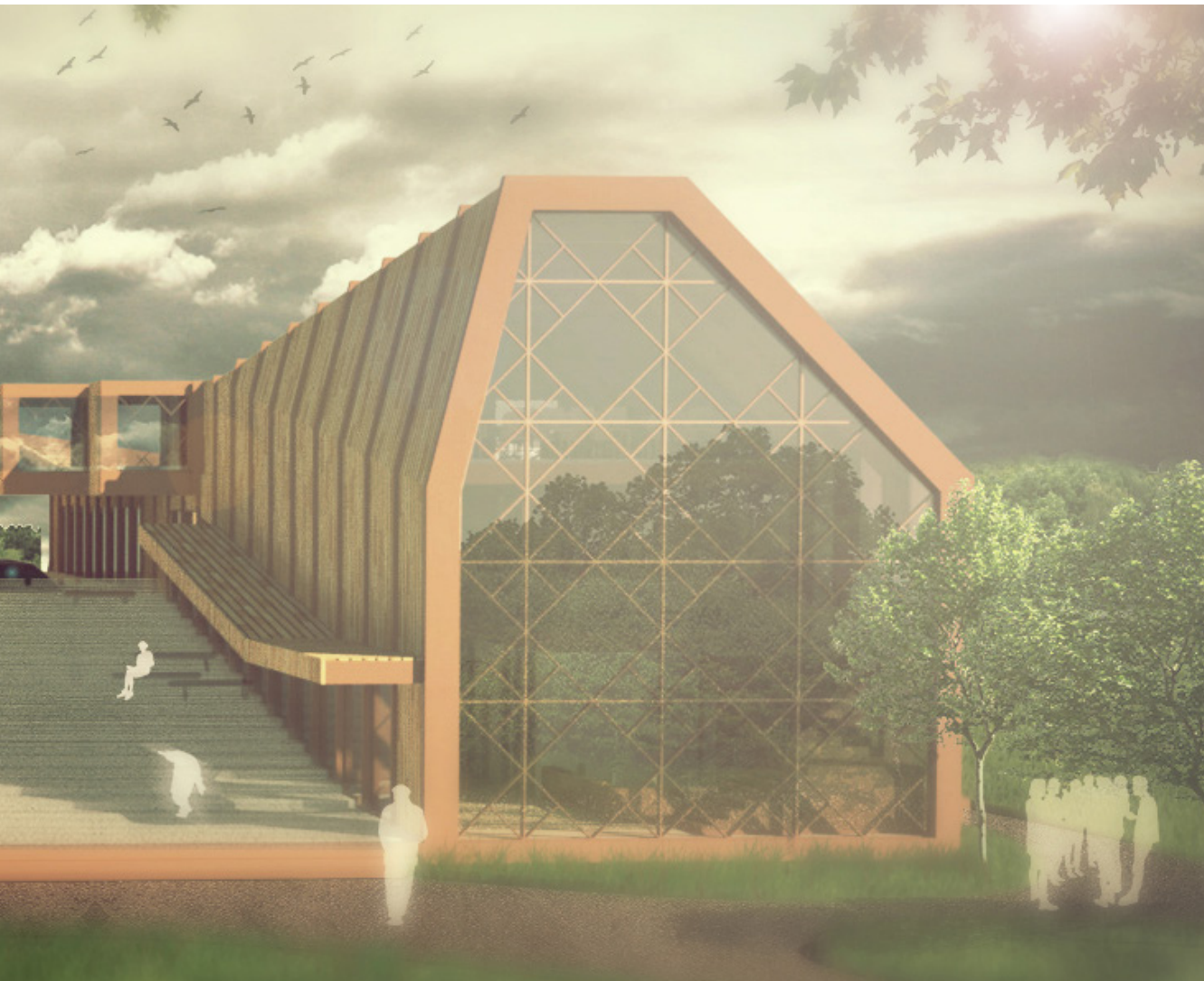




Fig 90. Render of the public street



The public space underneath this street has different qualities. All the intimate and more private functions are connected with this space. For example, the reading area of the knowledge center, food distribution, health care and ceremony space. In the space itself people have the opportunity to sit in one of the conversation pits. These pits are equipped with charging

point for mobile phone or tablets.

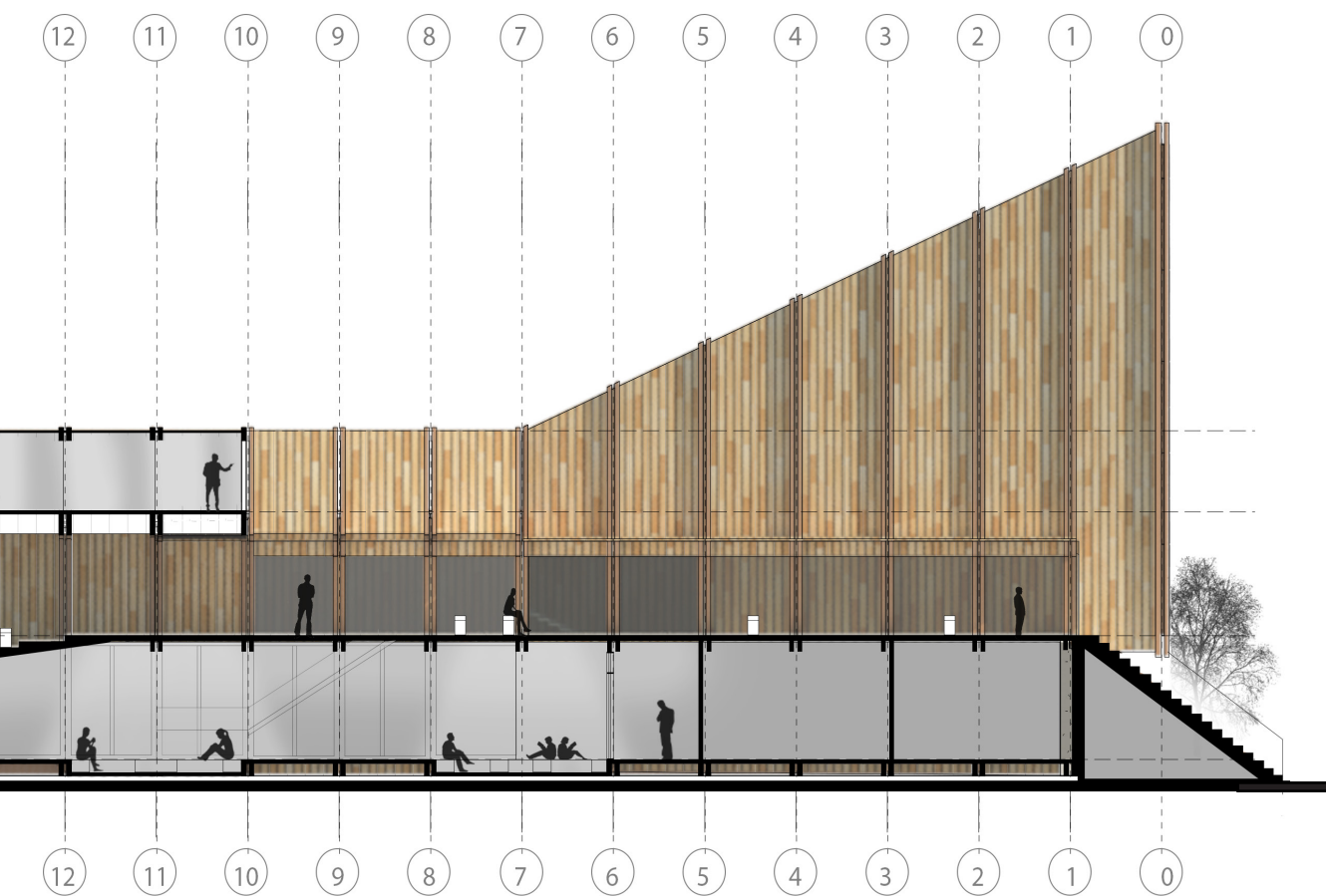
The whole space will lit by the light strips in the ceiling. From out this space people can reach the communal space on the first floor by using the stairs connected to this area. Because of the situated distribution point, the space also offers enough room for people to wait for their turn. Because of the mix of functions connected to this space, there will be stirring through out the whole day.

Fig 91. Section D-D





Fig 92. Render of the public space underneath the street



7.5 MODEL

Images 93 to 99 showsome pictures of the model. The model is made of MDF. The facades are cutted and engraved with a laser cutter. The glass surfaces are made of a semi-transparent plastic.



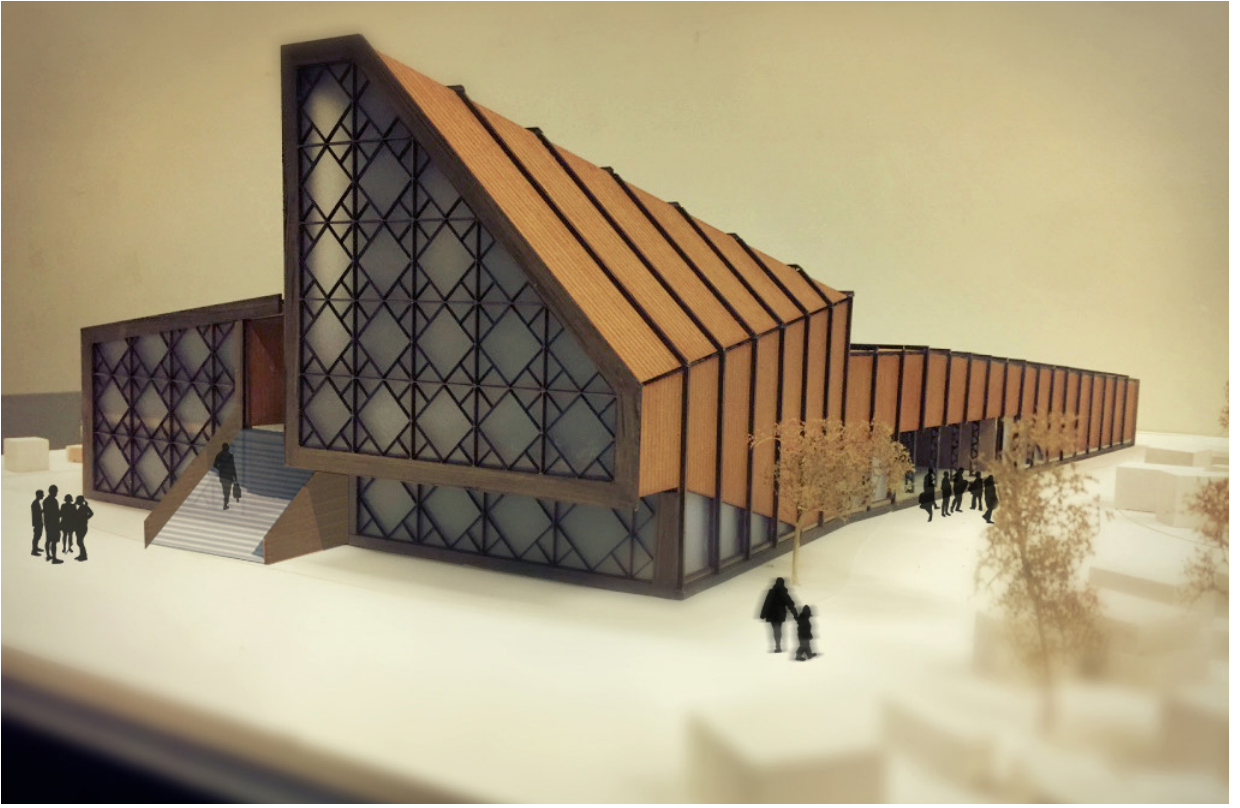


Fig 93, Southwest model impression



Fig 95, Southeast



Fig 96, Public street

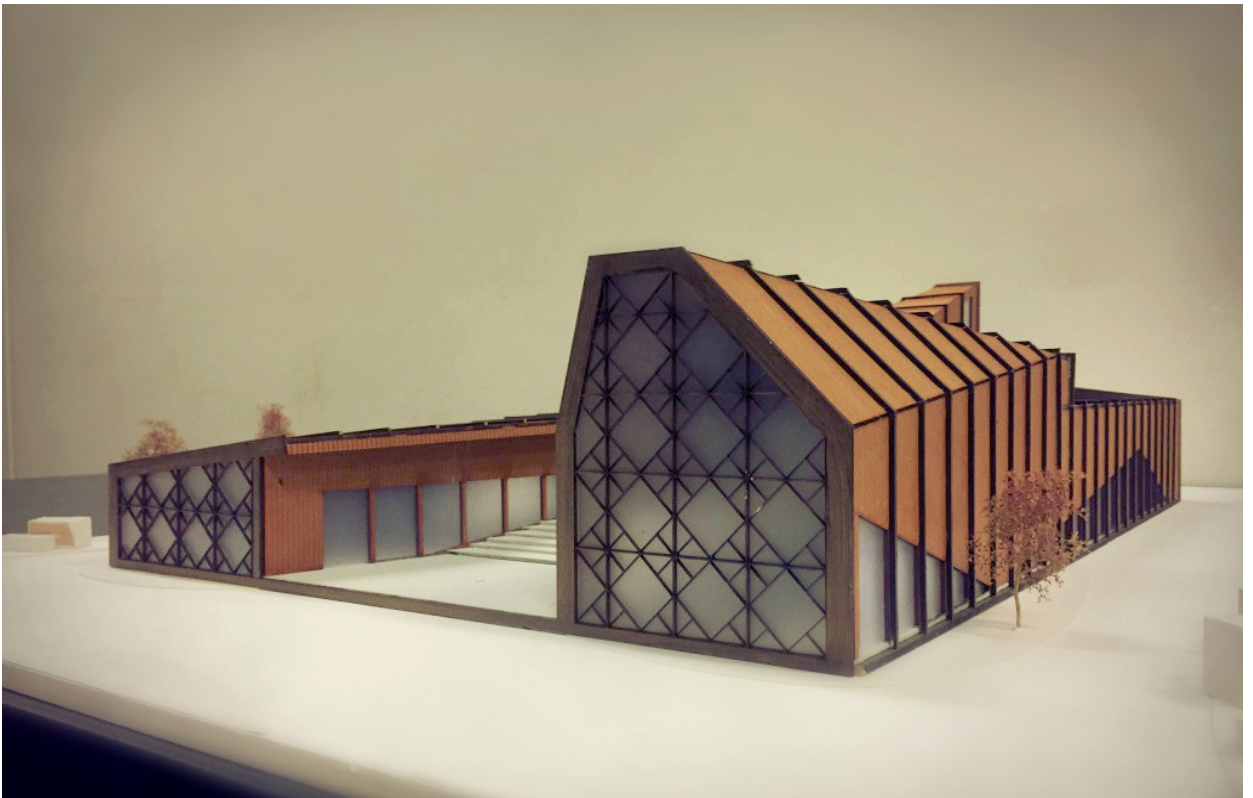


Fig 97, Knowledge center

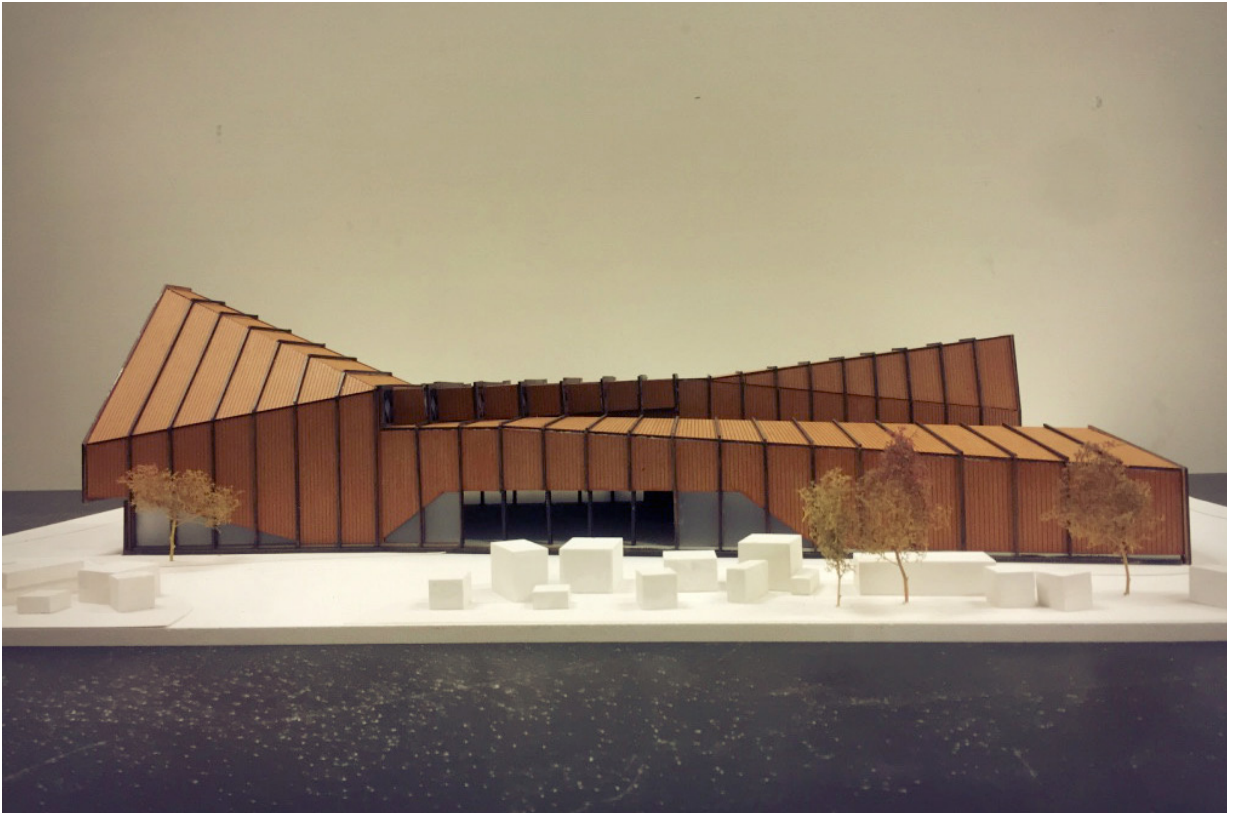


Fig 98, South facade



Fig 99, Public street top view

Chapter 8
Technique



8.1 SUSTAINABLE

An important part of technology is the way to deal with sustainability. Despite the fact that it does not appear to have the priority in the context of a refugee camp, it can play an important role in the feasibility. It would be ideal to create a building which is completely disconnected from the grid and its environment in terms of electricity and water. A building which can be assembled on site a functions right away, whether there is an gas, water light network in the area or not, it shouldn't matter. Especially in the context of informal settlements, where all kind of infrastructure can be missing in some situations, a self sufficient building would be perfect. However, making a low-tech building which can be self sufficient in every climate is a big ambition which is hard to achieve. With generating electricity, collecting and filtering water or processing waste such complex system are needed that the question arise whether these fits in the context of a refugee camp.

To discover the possibilities in terms of self sufficiency and see how they can be integrated in the building designed in this book, this chapter goes deeper in on the generation of electricity and collecting of water without the need to be connected to a grid.

Electricity

There are a lot of ways to generate electricity without using fossil fuels. The most used methods are; wind turbines, solar panels, hybrid hydrogen, water movement converter or using biofuels. Unfortunately, not all of these systems are as efficient as others. By far the most used technique is using solar energy by placing solar panels. The efficiency of solar panels on this scale is so much higher than the other mentioned techniques, that it would be naive to apply one of these other systems. For this reason only the use of solar panels is further elaborated.

Like we all know, solar panels are more efficient in areas where the sun shines a lot. However, this doesn't mean that they should not be used in regions with a cloudy climate. To see how much electricity can be generated by using solar panels, Calais is used as case study.

First the needed electricity is determined. The demand for electricity of a public building like designed in this booklet is about 50KWh/m²/year [14]. The total amount of sq. meters in this project is 3900, so this gives a total demand of 195.000 KWH each year or 16.250 each month.

When the maximum amount of roof area is used for placing solar panels, a surface of about

1500m² is available. With this surface and the known numbers, a general calculation can be executed to see how much electricity can be generated. This calculation can be seen in Fig 102. The result of this calculation shows that a total amount of 210.809 KWh/year can be generated. This is slightly more than the demand for electricity. But it is important to mention that for these results the whole roof has to be covered with solar panels, all with a yield of 15%. In practice this will result in massive steel structures on top of the roof. This is not only a huge investment, but will also completely destroy the architecture of the building. For this reason, it is better to use an external field nearby where the solar panels can be placed. This also raises the limit of surface which can be used.

Briefly, there can be concluded that it is possible to make the building energy neutral. However, this requires a huge amount of sq. meters of solar panels which are not only expensive to buy, but also in maintenance. The size of this investment and the complex design of the system which is needed to create an energy neutral public building make applying it very unlikely, especially in the context of an informal settlement or refugee camp. Therefore, it seems smarter in situations such as Calais, wherein there is a proper electricity grid available, to be connected to this network.

[14] *Commercial building benchmarks, 2016*

Table 1
Summary of the mains results about silicon PV.

Study	Panel type	PV system	Country	Modules efficiency	FU	Boundaries	Methodology	Mains results
[1]	Poly.	Roof-mounted	Spain		1 kW h	Production (BOS), installation and use	EPBT	EPBT 3.5–5 years
[10]	Poly. and amorphous	Roof-mounted	US	From 6.3 to 13%	1 kW h	Production (BOS) and use	EPBT CO ₂	EPBT: 3.15–7.4 year CO ₂ : 34.2–72.4 g/kW h
[11]	Poly.	Roof-mounted	Severals locations (EU, Austria, US)	16%	0.65 m ² panel	Production and use	EPBT CO ₂	EPBT 3.5–7 year CO ₂ : 50–800 g/kW h
[12]	Crystalline	Tracking system	South Europe and North Africa	12.4%	1 kWp	Production (BOS) and use	EPBT	EPBT < 5 year
[13]	Mono.	Facade-integrated	US		1 kW h	Production (BOS) and use	EPBT IPCC (GWP)	EPBT=3.8 year GWP=10.2 g/kWh
[14]	Poly. and mono.	Roof and façade	Switzerland	From 13.2 to 14.8%	3 kWp	Production (BOS) and use	Eco-Indicator 99 EPBT	EPBT=3–6 year GWP=136–100 g/kW h
[15]	Poly.	Ground-mounted	Italy	14.4%	1 kWp	Production (BOS) to EoL	Eco-Indicator 99	CO ₂ (with Eco-Indicator):8.74 g/kW h
[16]	Poly.	Tracking system	Spain	13.1%	1 kW h	Production (BOS) to EoL	IPCC 2007 (GWP) EPBT Eco-Indicator 99	EPBT = 1.45–1.5 years
[17]	Mono.	Building Integrated Concentrated	Spain			Production	Eco-Indicator 99 (Norm) EPS 2000 (Norm)	
[18]	Poly.	Roof-mounted	Netherlands		1 kW h	Production (BOS) to EoL	Eco-Indicator 99 (Norm)	
[19]	Poly.	Ground-mounted	Germany	12.5%	1 kW h	Production (BOS) and use	Eco-Indicator 99	GWP=0.063 kg/kW h
[20]	Mono.	Tracking system	Italy	13.8%	1 MW h	Production and use	Eco-Indicator 99	EPBT= 5.5 years GWP=44.7 g/kW h.
[23]	Poly. and mono.	Roof-mounted	South-European locations	From 11.5 to 14%	1 kWp	Production and use	CML 2000	EPBT: 1.7–2.7 year CO ₂ : 30–45 g/kW h
[24]	Crystalline			15%	1 kW h	Production	EPBT CO ₂ CML 2000 (Norm)	Direct CO2 emissions < < indirect
[25]	Amorphous/nanocrystalline	Roof-integrated	Netherlands	10%	1 kW h	Production (BOS) and use	ReGiPe EPBT	EPBT=2.3 year

FU= Functional Unit. Boundaries: (BOS): the BOS components are included in the LCA – EoL: End of Life. Methodology: (Norm): the results are only expressed after normalization – CO₂=CO₂ emissions calculation.

Fig 101. Efficiency of different kind of solar panels - Gerbinet et al., 2014

Calculation of the solar PV energy output of a photovoltaic system

	Yellow cell = enter your own data
	Green cell = result (do not change the value)
	White cell = calculated value (do not change the value)

Global formula : $E = A * r * H * PR$

E = Energy (kWh)	210809	kWh/an
A = Total solar panel Area (m ²)	1500	m ²
r = solar panel yield (%)	15%	
H = Annual average irradiation on tilted panels (shadings not included)*	1250	kWh/m ² .an
PR = Performance ratio, coefficient for losses (range between 0.9 and 0.5, default value = 0.75)	0,75	

Total power of the system 225,0 kWp

Losses details (depend of site, technology, and sizing of the system)

- Inverter losses (6% to 15%)	8%
- Température losses (5% to 15%)	8%
- DC cables losses (1 to 3%)	2%
- AC cables losses (1 to 3%)	2%
- Shadings 0% to 40% (depends of site)	3%
- Losses weak irradiation 3% yo 7%	3%
- Losses due to dust, snow... (2%)	2%
- Other Losses	0%

Fig 102. Calculation of estimated electricity generation - photovoltaic-software, 2017

Water

Making a building self-sufficient in terms of water can be very hard. In general there are two measures that have to be taken; reduce the water usage and collect water from an alternative source. However, both the reducing and the collection of water needs a second pipe system to be mounted in the building. A so-called gray water system.

Adding a grey water system into an public building like this is a drastic intervention which requires a large investment. A question that comes to mind instantly, of course is: are the costs of the construction and maintenance of a grey water system worth the investment? To investigate this, first the amount of water that can be collected have to be determined. For this, we need to look at rainwater harvesting.

The definition of rainwater harvesting according to Myers: the practice of collecting water from an area treated to increase runoff from rainfall or snowmelt [15]. Rainwater harvesting is an old method that today is being used in many arid countries to compose the water shortages.

Rainwater harvesting is a technique whereby water that falls on roofs, ground surfaces and roads is being stored and used in daily life. One of the biggest benefits of this method is that the collection and storage of water can be arranged with relatively simple

techniques when the system design is well thought out and smart located. A rainwater harvesting system is based on three basic components: a collecting surface, a conveyance system and a cistern or storage [16]

The water that is being collected is pure rainwater. In some countries in the world this rainwater is so clean it can be drunk without any risk. However, in Calais, drinking rainwater is not recommended and unsafe. This is because the water is often contaminated by activities in industrial environments. Yet this does not mean that the water is useless. This rain water can be regarded as the above mentioned grey water, so fur flushing toilets.

To be able to calculate how much water can be gained in the studied situation, use is made of the following formula:

$$VR = (R \times A \times C/1000)$$

VR: Amount of collected rainwater

R: Average rainfall in mm/y

A: Total collection area

C: Runoff coefficient (std. 0,8) compensate loss

In Calais, there is an average rainfall of 45-50 mm each month. Converted to a year this is 540 mm rain. The estimated collecting surface of the building is about $70 \times 35 = 2450$ m². This therefore means:

$$VR = (540 \times 2450 \times 0.8/1000) = 1058 \text{ (m}^3\text{/y)}$$

So in one year there is a total amount of 1058 cubic meters of water collected. This is the equivalent to 1058000 Liters grey water. The demand for water in the public building like this is about:

$3900 \text{ (total m}^2\text{)} \times 0.203 \text{ KL/m}^2 \text{ (standard for libraries [17])} = 791.7 \text{ KL or } 791700 \text{ Liters of water.}$
In theory, there is sufficient water can be collected to compose the use. It is important that there is sufficient storage since the rainfall in Calais from month to month may fluctuate a lot.

[15] Ben-Asher, 1982

[16] Al-Shareef, 2009

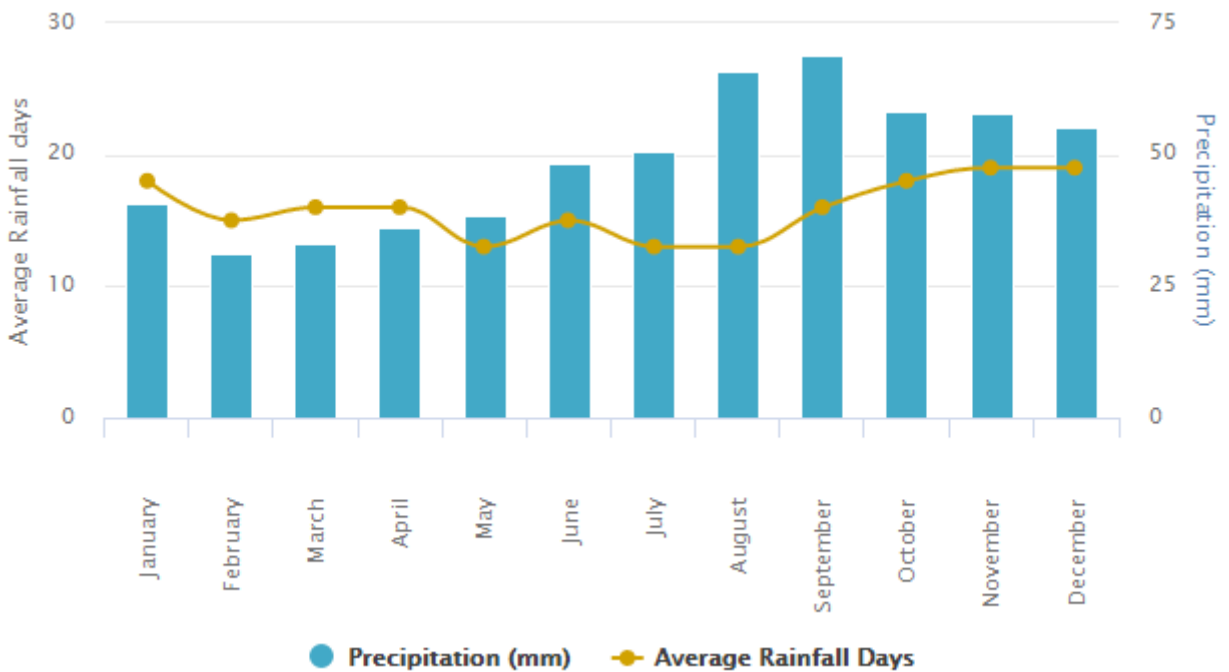


Fig 103. Rainfall in Calais - WWO, 2017

However, the calculations on the opposite page are indicative only. The figures used are not precise enough and too many factors are disregarded.

Besides this, this only includes grey water. So to obtain potable water a high-tech filtering system is needed, which in its turn uses a lot of electricity.

Also, the wastage of water during transport is not taken into account. The transport of this water through this grey water system also requires an extra water pump which also uses a lot of electricity.

And then there is also the last issue. Obtaining of water is in fact not all. The water used must also be processed. The wastewater from toilets cannot simply be dumped to the street but has to be discharged in to septic tanks. After this, it must be filtered in detail in order to be able to be incorporated into the soil or pumped back into the gray water system.

All in all, it is obvious that there are so many interventions needed with sometimes complex techniques that the question arises how well such a system on this scale actually fits in a refugee camp. Therefore, it seems smarter in situations such as Calais, wherein there is a water network available, to be connected to this network.

To give an indication on how such a system will look like in this building, there is an overview diagram on the next page containing the piping and the necessary devices.

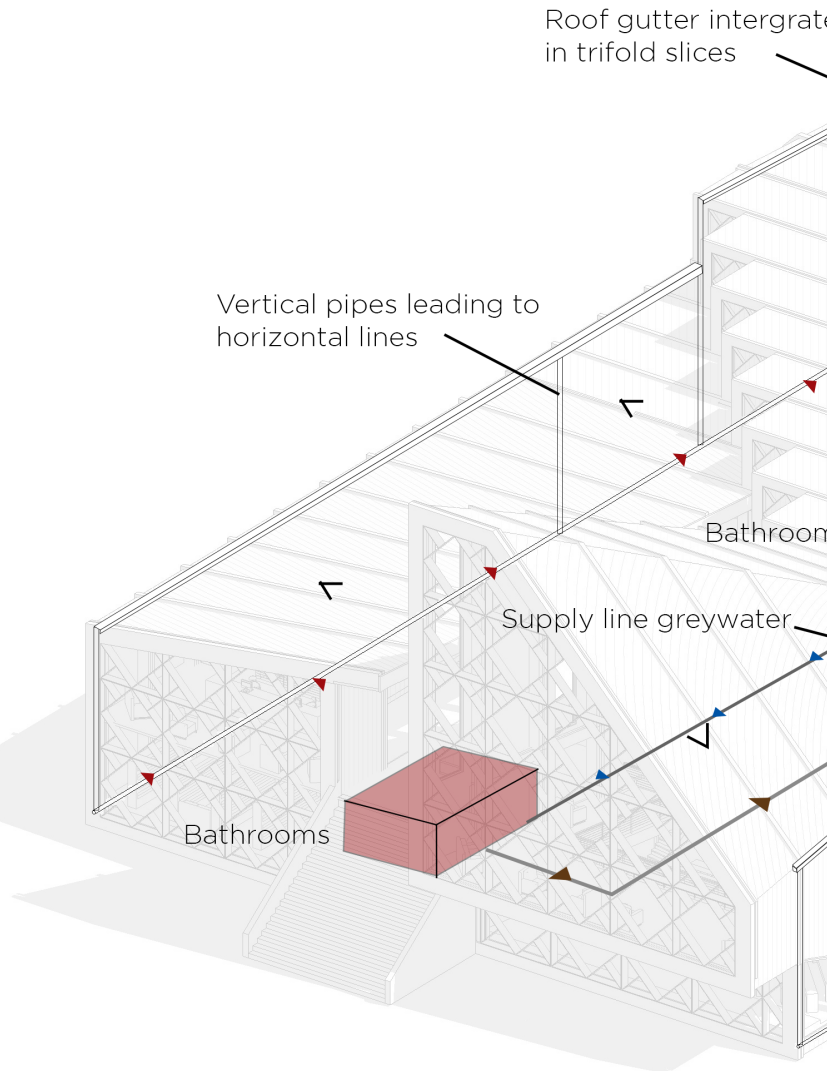
[17] Bio intelligence service, 2016

Recap

So is it in the end possible to create a complete self-sufficient building? Probably, yes. Judging from the checks which have been carried out in the field of electricity and water. So in situations whereby no electricity or water grid is available, as sometimes occurs at the location of an informal settlements, this could be the solution. However, the research done in this book in terms of self-sufficiency is too superficial and inaccurate. In order to be sure of the possibility further research is needed.

But as mentioned before, it is not recommended to create a self-sufficient building. The necessary technologies are too complex and in situations with so much tension and uncertainties, these applications do not fit.

The aim of the project was to create a low-tech, relatively easy to build public facility which can be executed without needing a lot of prior knowledge. Using a system like this is thus in conflict with the concept of the project.



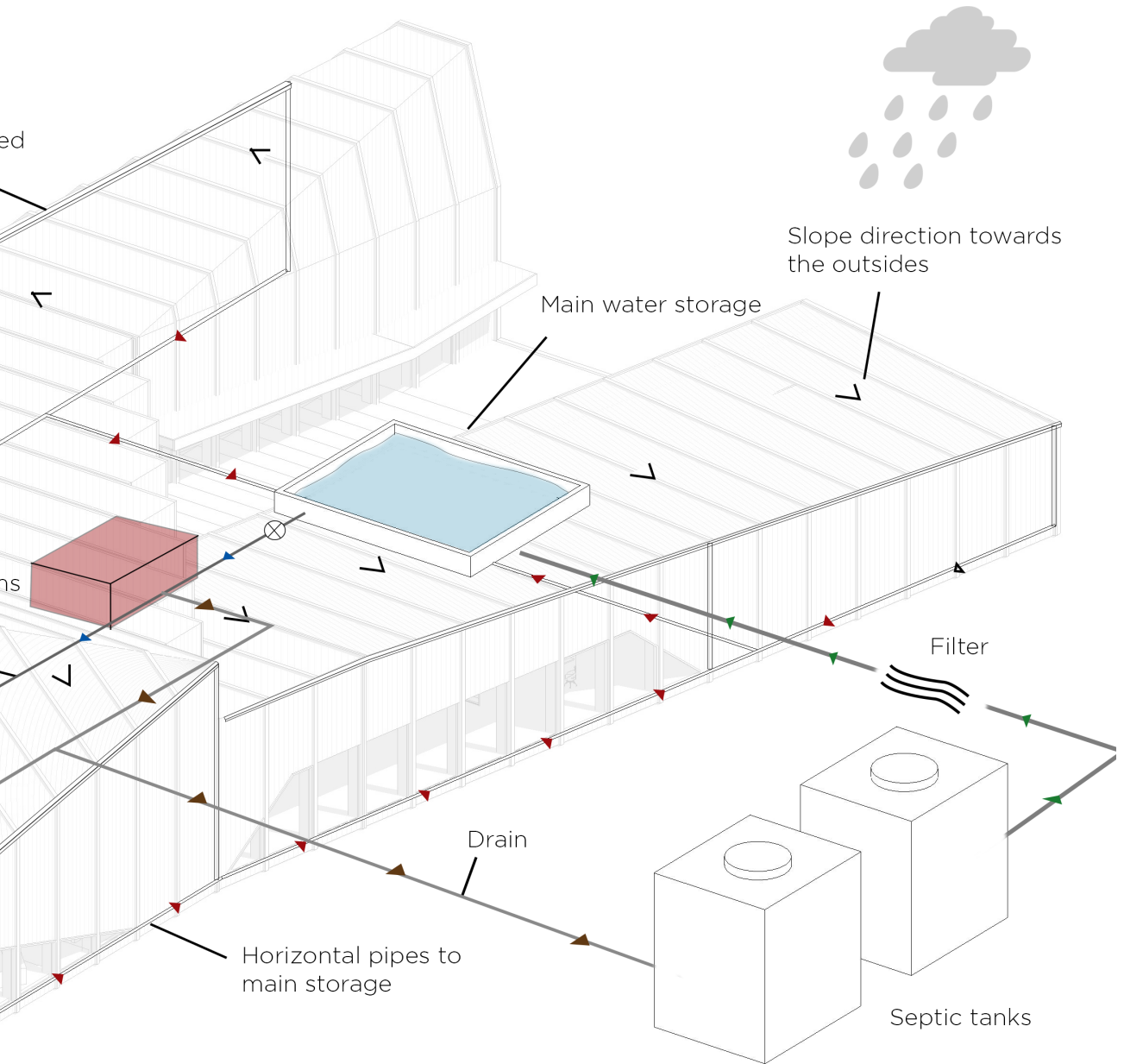


Fig 104. Grey water system with rain water harvesting

8.2 DETAILING

Eye for detailing is very important, even in situations where on the first sight it doesn't seem to really matters like in refugee camps. But there are some fundamental problems which have to be solved to create a well functioning building. For example, the connection of the building with the ground level is very important, but also the way rainwater is handled and the building is insulated. In this chapter, some critical points are further elaborated, starting with the facade.

The trifold building system is used as the structure of the building. Against these structural portals, prefabricated facade panels will be mounted. These panels are basically a wooden sandwich panel with facade finishing included. The composition of these panels is shown in figure 105.

The facade panels are not only mounted to the trifold structure, but are also interconnected with each other. At the location of these connections, there is a detail which is reflected in the facade resulting in the aforementioned dominant

lines. This detail is further elaborated at page 142. But first, a summary by means of a fragment. In this fragment all details are indicated.

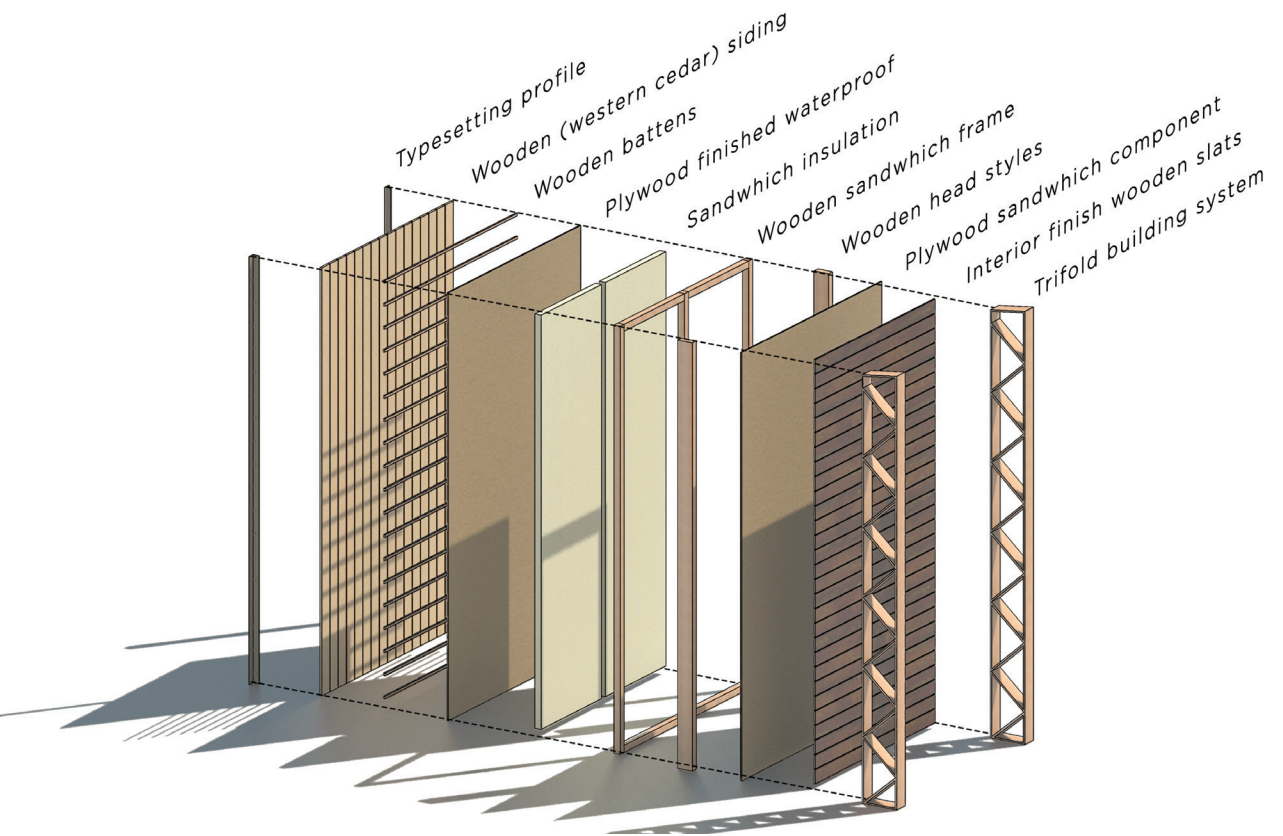


Fig 105. Exploded facade

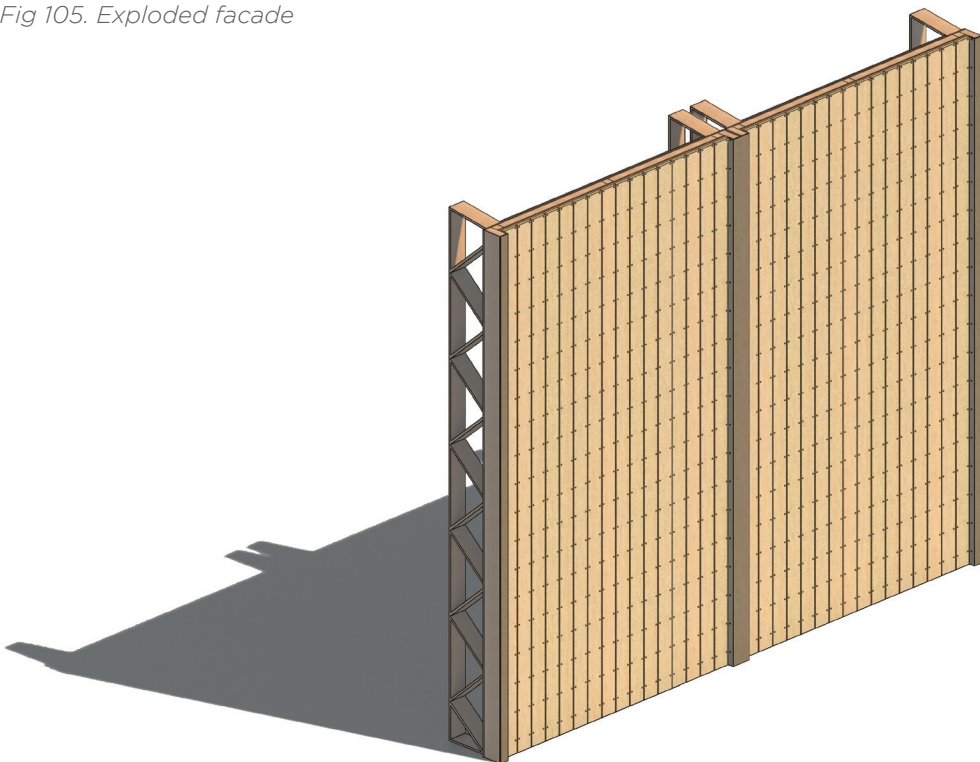
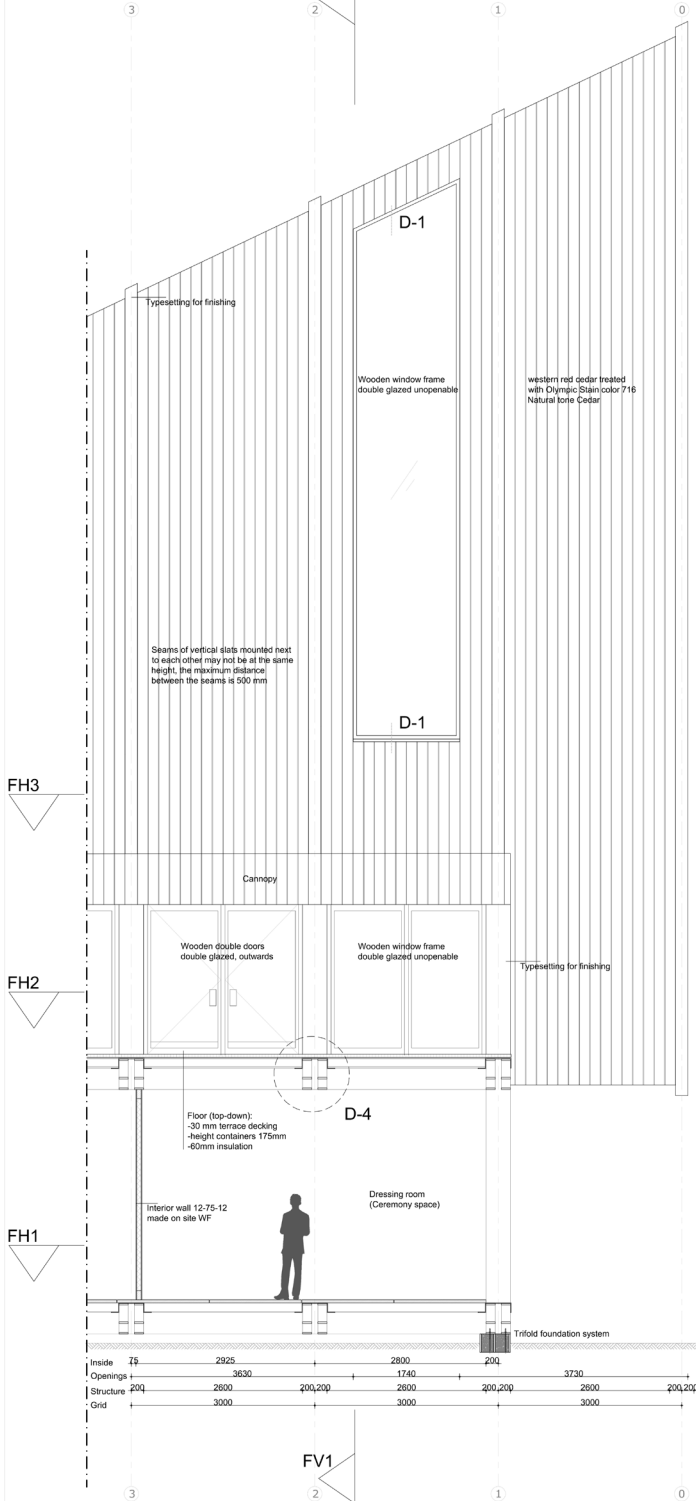


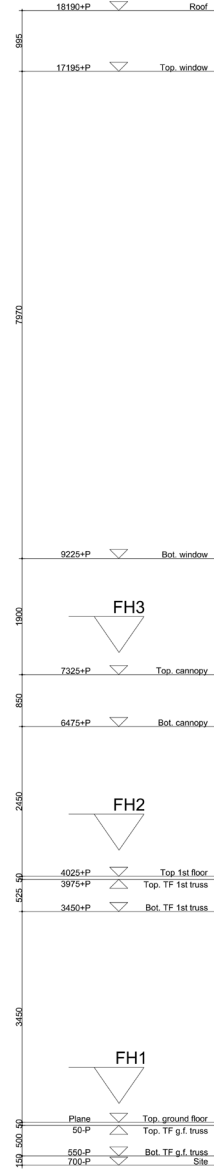
Fig 106. Interconnection of facade panels

FAÇADE

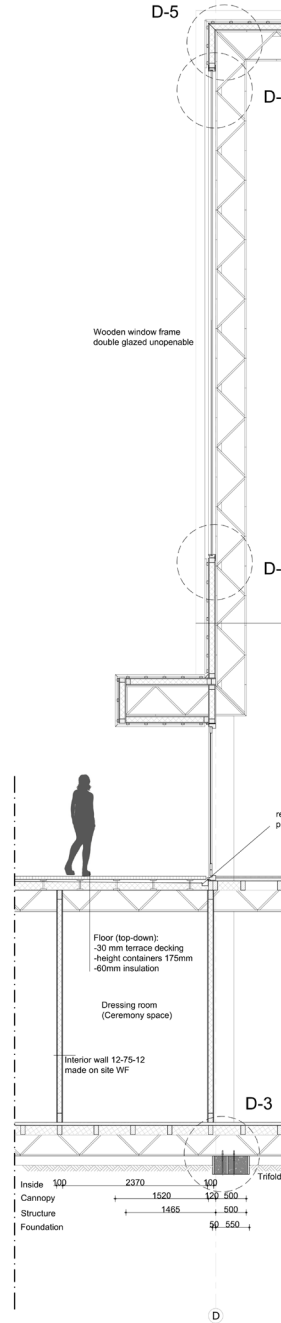
FV1



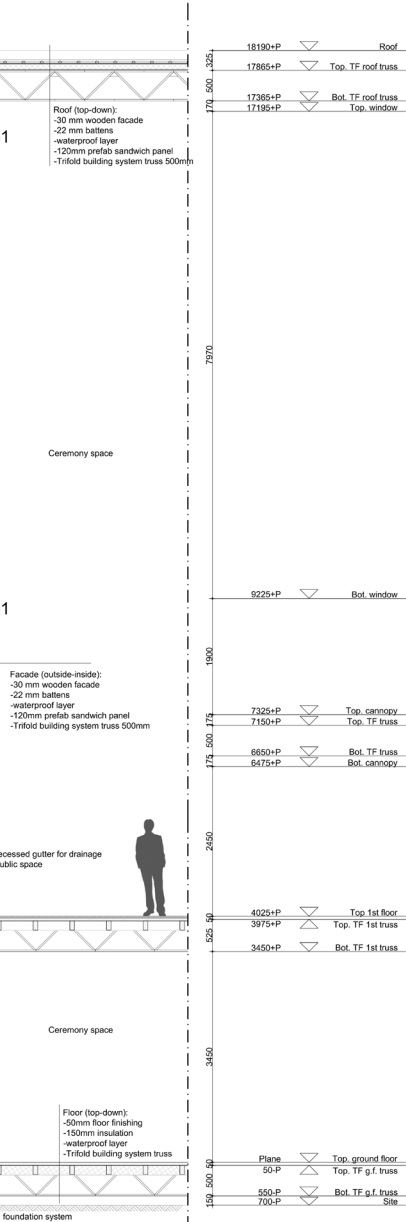
FRAGMENT V



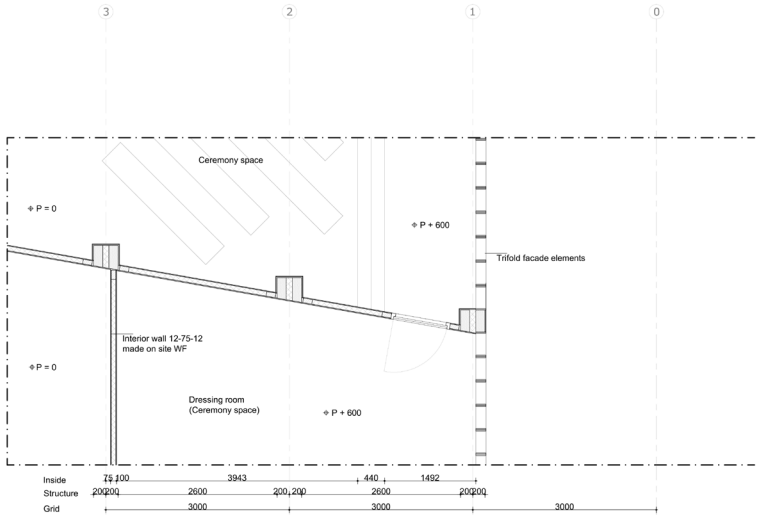
D-5



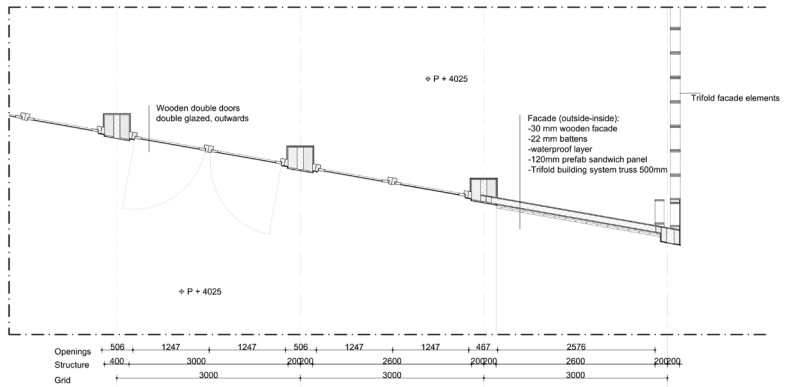
VERTICAL 1



FRAGMENT HORIZONTAL 1



FRAGMENT HORIZONTAL 2



FRAGMENT HORIZONTAL 3

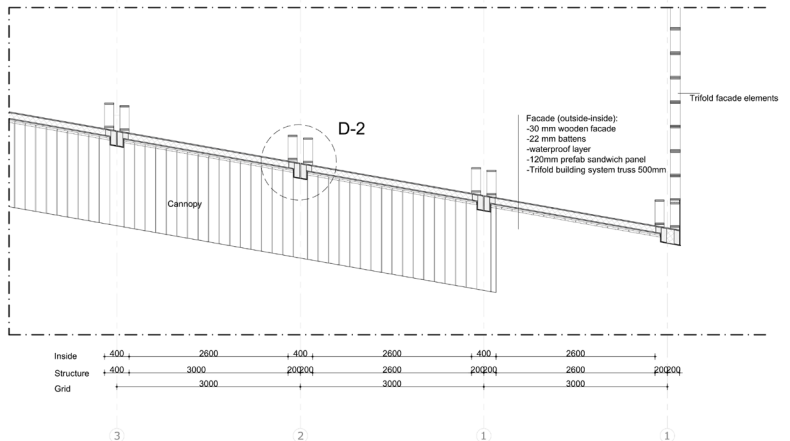


Fig 107. Facade fragment

In figure 108 to 112 the most essential details are presented. To see where these details are situated in the building, the preceding page can be used.

The first detail, figure 108, shows the way the window frames are mounted in the facade. Because the facade elements are completely prefabricated, installing the frame can be done in a proper and secure manner. The second detail shows the horizontal connection between two panels. The sandwich panels have been carried out with large styles at both ends, on which a cap is seated which must guarantee the watertightness of the whole. The panels themselves are mounted to the trifold structure and are screwed into a wooden block at the inside of the structural portal.

The next detail is the foundation detail. The foundation is made of trifold elements filled with concrete. In order to avoid sinking, these foundations are laid on Stelcon plates. To make sure the forces are transferred properly, there is an adapter piece formed in the trifold system that can be mounted on the pins in the foundation.

Figure 111 shows a detail of the flooring system. To reduce the height of the floors, a steel profile is used to be placed around the trifold trusses. On this profile wooden beams are placed. On top of this comes the subfloor and floor boarding. The last detail, figure 112, shows the eaves of the building. Here also an adapter piece is used to connect two separate portal elements with each other at the correct angle.

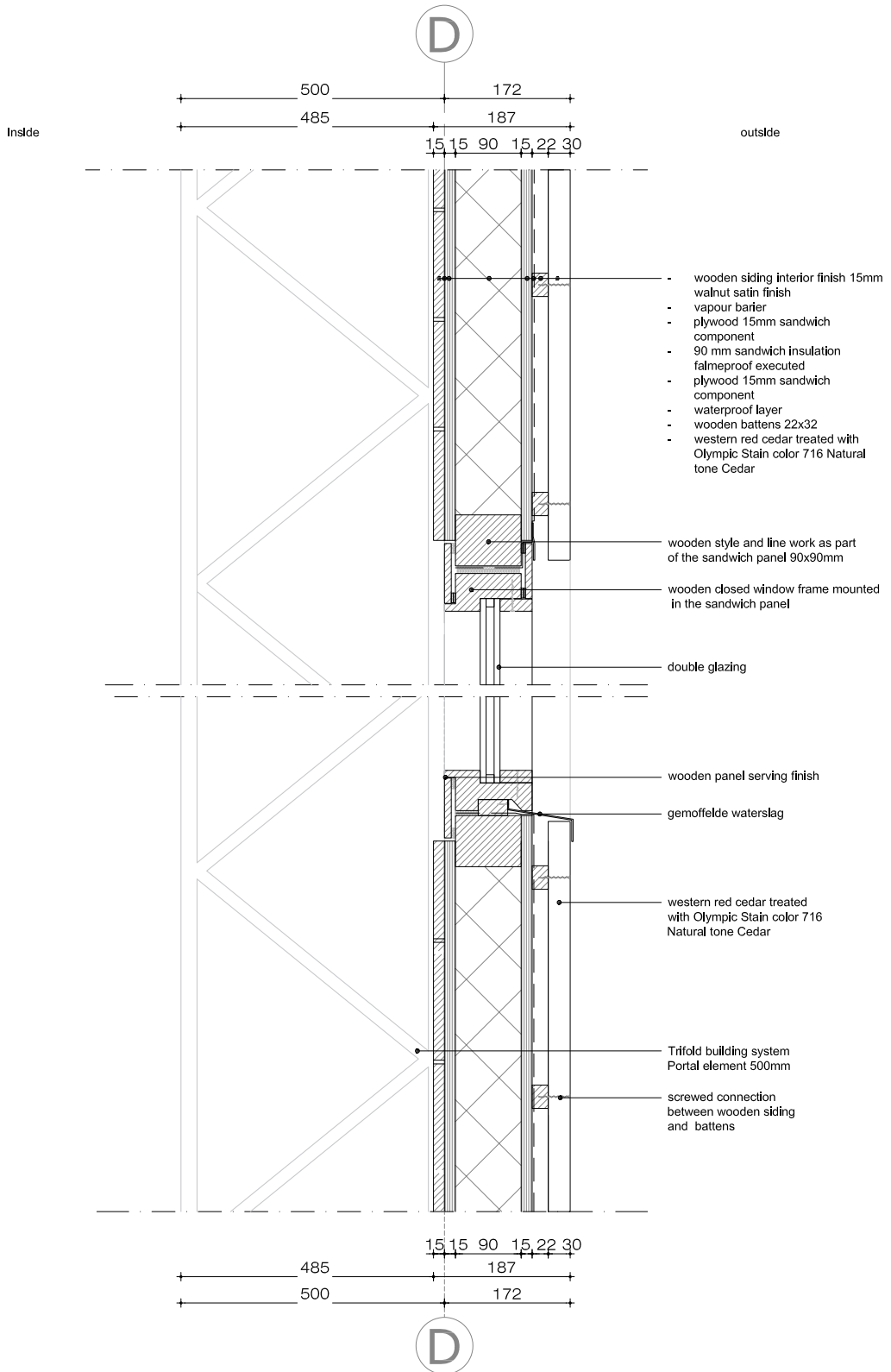


Fig 108. Detail

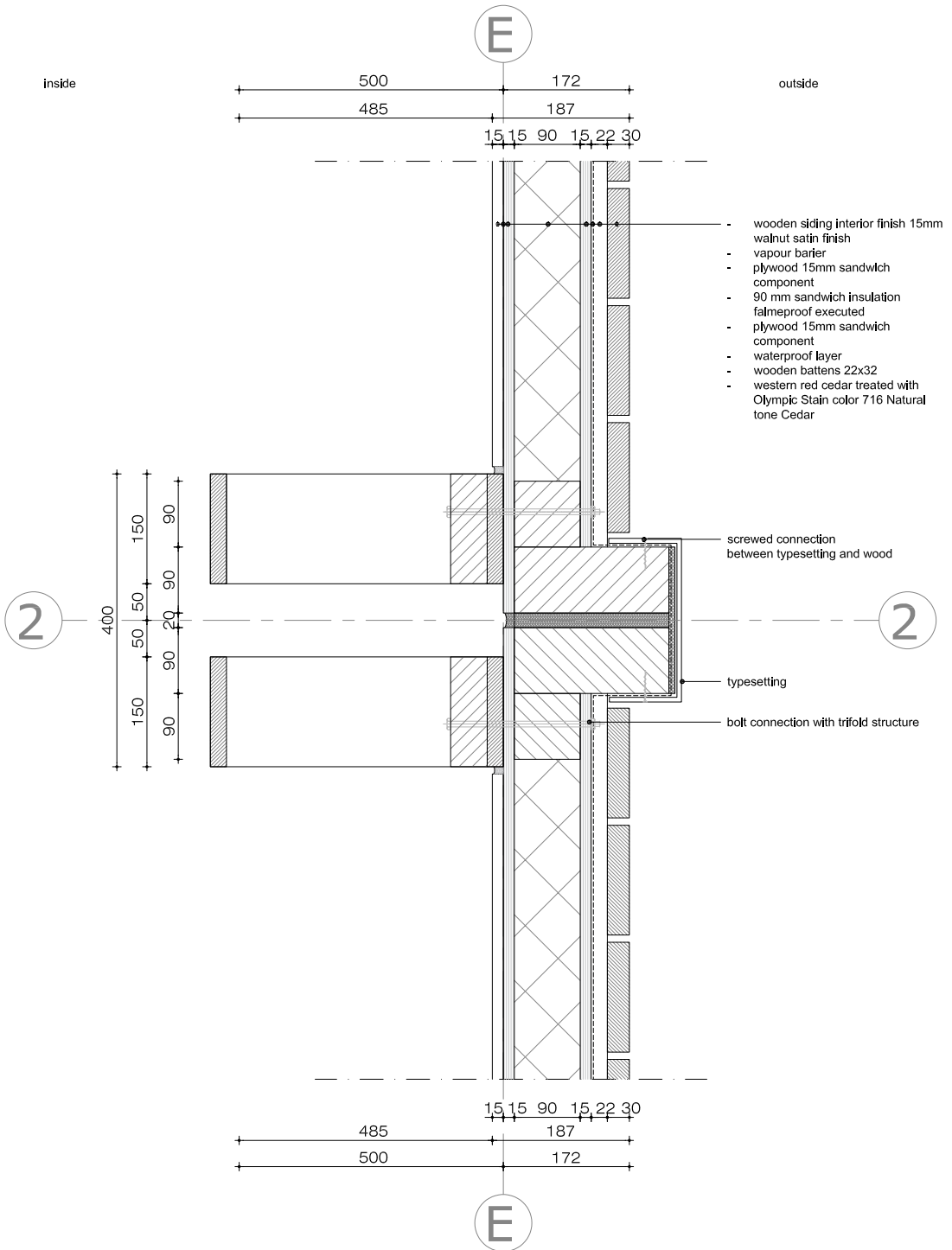


Fig 109. Detail

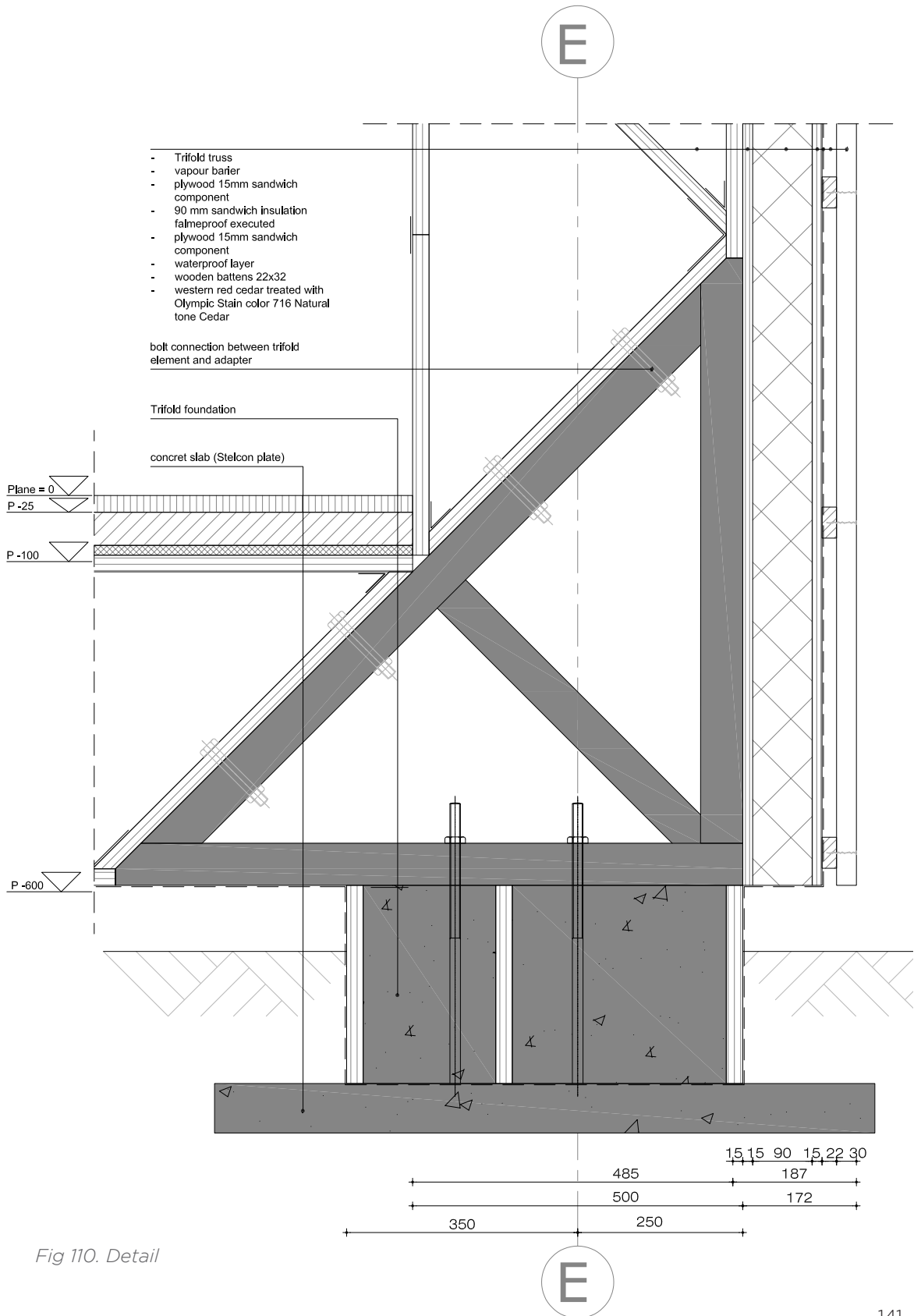


Fig 110. Detail

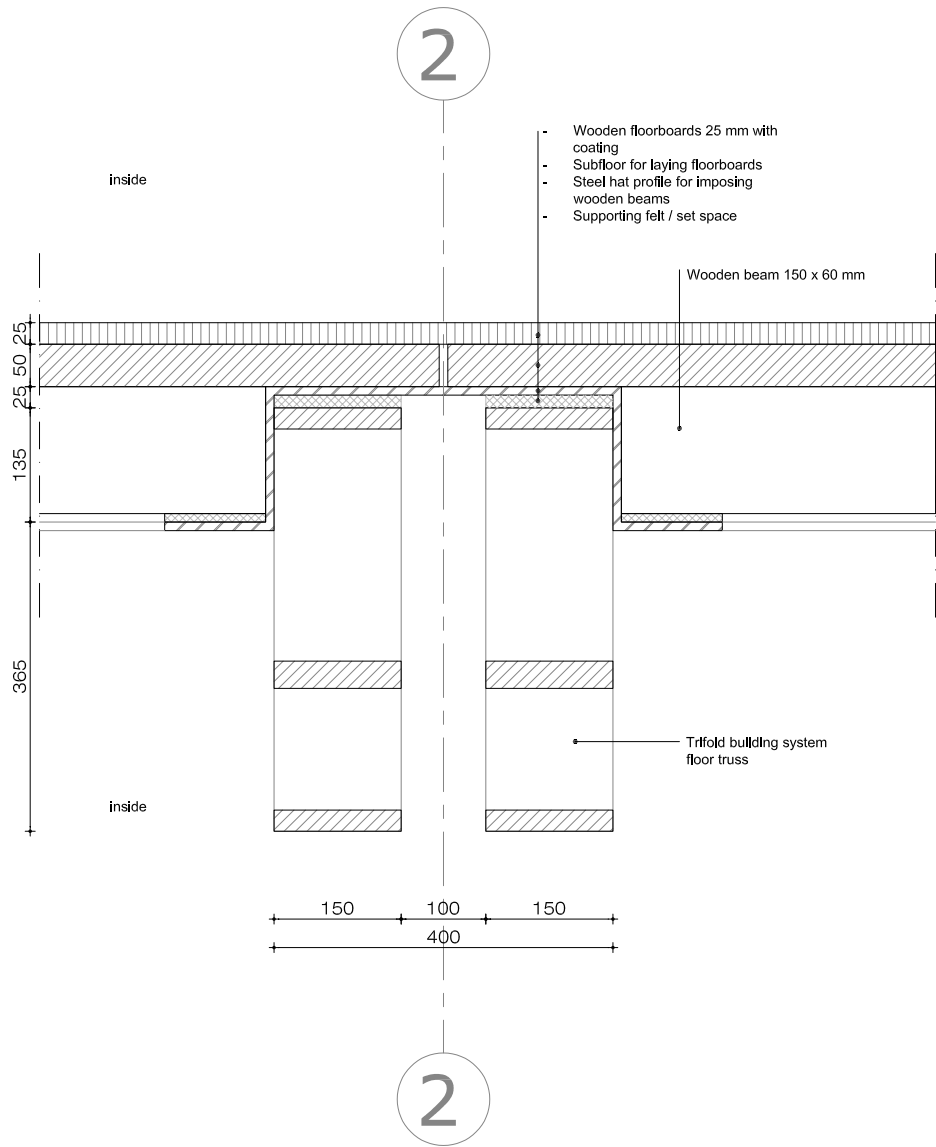


Fig 111 Detail

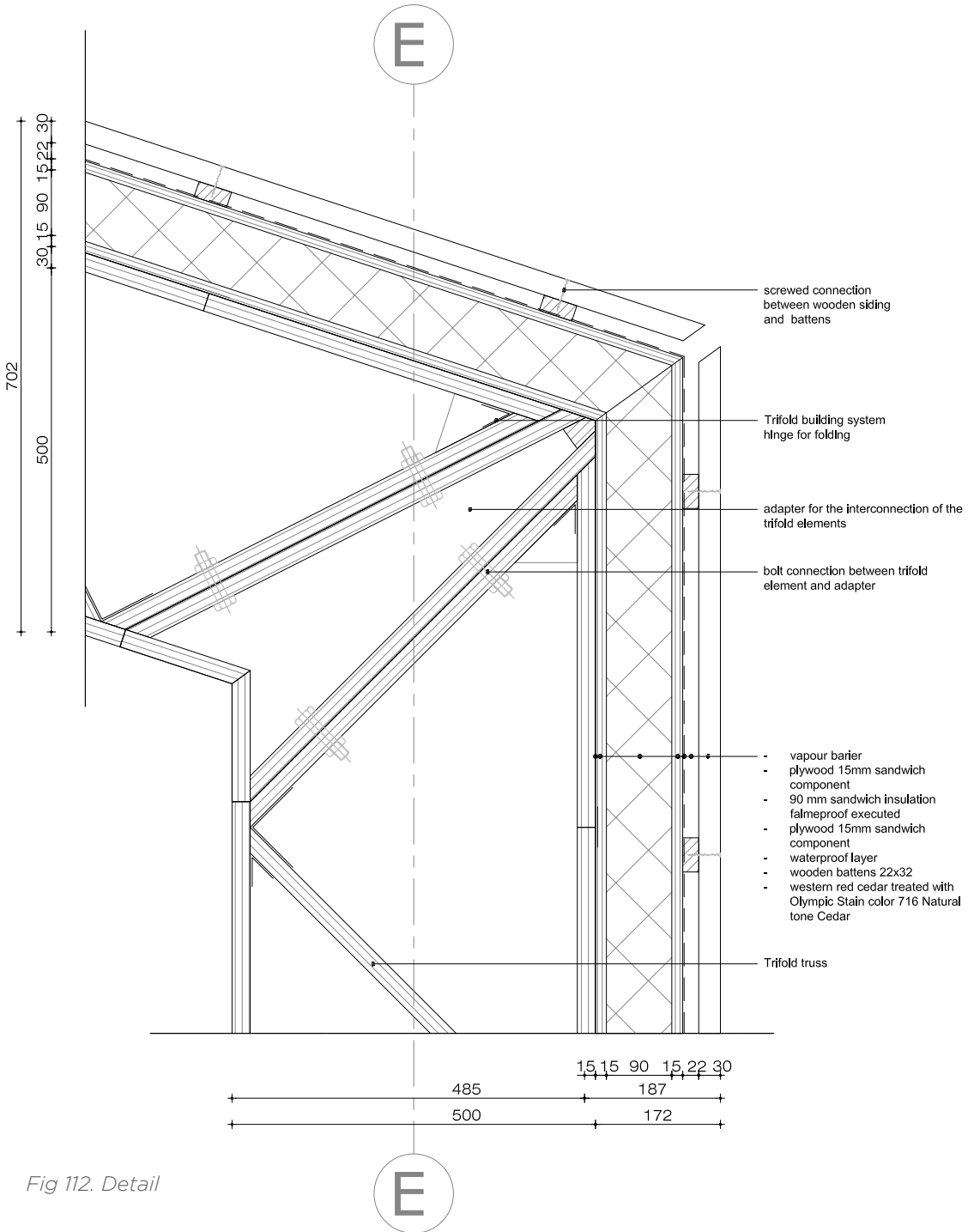
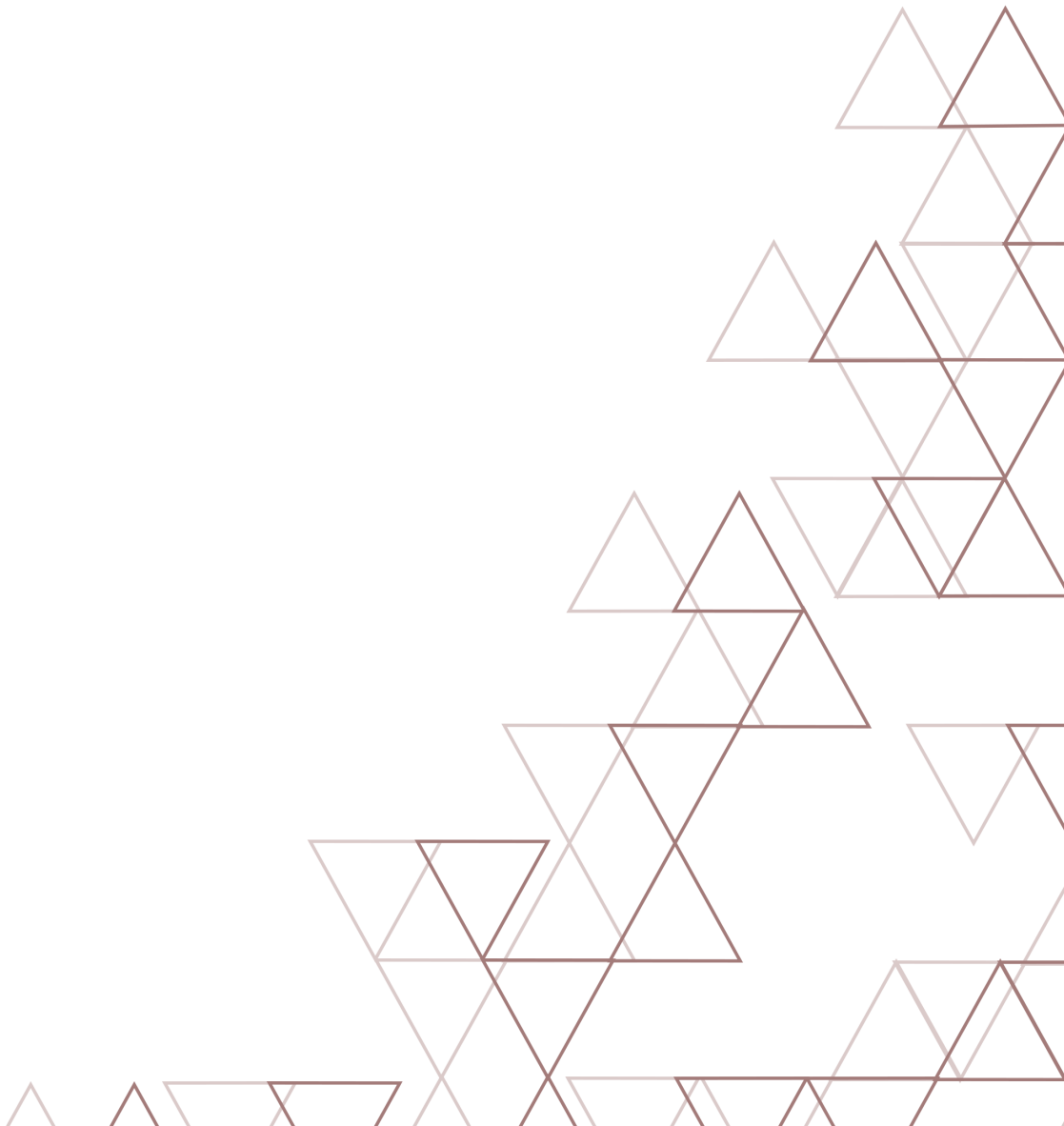


Fig 112. Detail

Chapter 9

General usability



9.1 GENERIC

It would be ideal the design a building which can function everywhere at the world without having to change something. Although it is not impossible to create such a building, this will probably be at the expense of the functionality of it. A building with thick walls to insulate against the cold in Africa? Sandstorm protection in France? Emergency overflows in the Kalahari? Sun protection in Norway? Examples of inconveniences that comes with a complete generic design. For this reason it would be better to strive for a good general basis, on which small changes or additions can be made to make it specific for a location and its climate.

The page on the right show examples of the building in different locations around the world.

The building, elaboration and detailing presented in this booklet are specifically designed for Calais. To discover which changes should be made in a complete opposite climate, the building will be projected in Za'atari.



Fig 111. Building in Calais

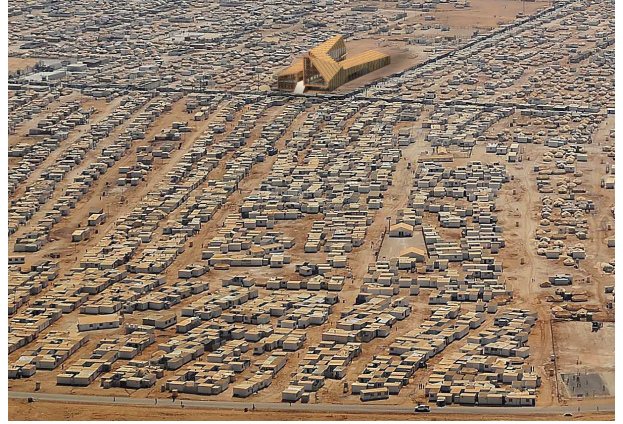


Fig 112. Building in Za'atari



Fig 113. Building in Dadaab



Fig 114. Building in Sudan



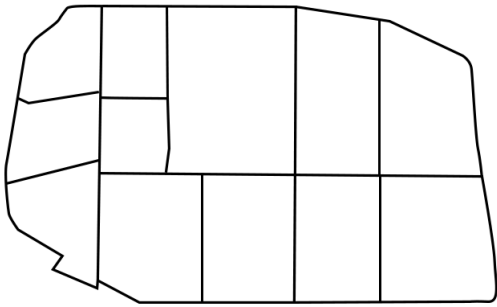
Fig 115. Building in Jaman



Fig 116. Building in Lebanon

9.2 CONTEXT

Za'atari is build in phases, and the image on the right page shows these different phases. The building should be the connector between a new phase and the main infrastructure of the camp. The function of the building will be more or less the same as in Calais. It should help to stimulate development in this new area of Za'atari. It will be the public center of this building phase. People living in this phase will come here to get food, medical care, to read books, attend ceremonies or just to hang out in the covered public space, which protect the people from the burning sun. When the area is developed and land filled with houses or shelters, a new phase will be build Za'atari. This new phase will in its turn also start with the placement of this public building. And so this cycle repeats itself again and again and. The image on the right shows how the building could have helped to guide development trough the phases.



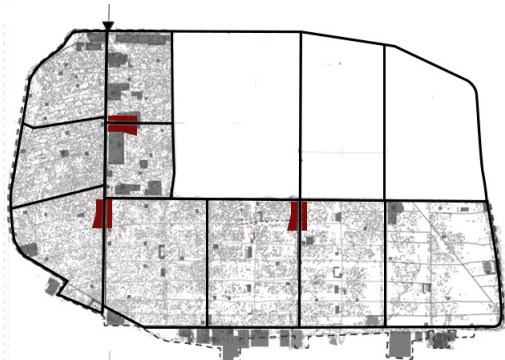
1. Empty plain



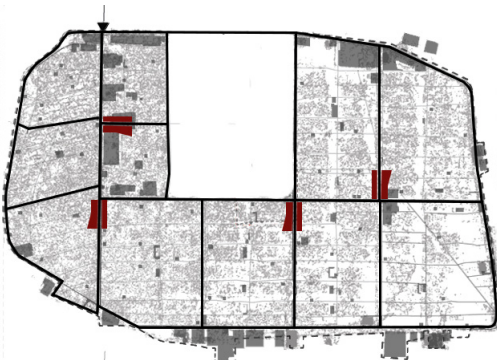
2. Emergence of Za'atari



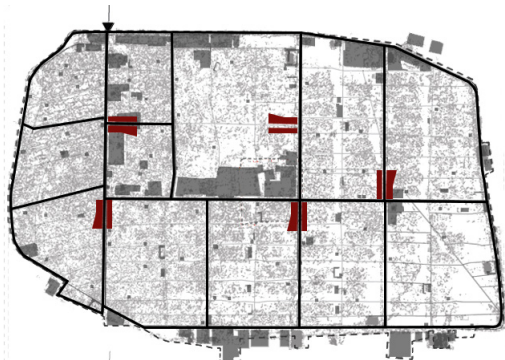
3. Second phase



4. Third phase



5. Fourth phase



6. Final situation

Fig 117. Scenario of Za'atari development

9.3 DESIGN

Living in extreme conditions like this requires adaptability. Providing protection from the sun is one of the most important aspects of designing in these climates. Where the sun in Calais can be a pleasant factor, it is avoided as much as possible in Za'atari.

Public space thus needs to have different qualities. They should be cool, pleasant places where people can stay around protected from the elements. In the design, there were two main public spaces; a covered public space and a public street. This covered public space already protects the users from the sun, but the public street as presented in the design does not provide this protection. The biggest part is uncovered and there are parts which stand in the sun throughout the whole day.

So here the first design adjustment has to be made. The canopies of the volumes must be extended to create more shade on the public street.

Also the amount of sunlight which enters the building has to be decreased. The large facade openings provide a lot of daylight, but can also cause heating when the sun shines. A simple but effective solution is

to create awnings to ensure that the direct sunlight remains outside.

However, the earlier design shown also contains elements which are also well functioning in the conditions in Za'atari, such as, for example, the previously mentioned public space underneath the street. But the introvert concept of building also fits effortlessly into the Arabic culture, where nearly all building designed towards the inside.

The design itself thus doesn't need to be changed a lot to be implemented in Za'atari. Most changes concern the technique of the building. The way it handles the extreme temperatures and sandy environment are the most important aspects.

The big differences in temperature between day and night is an important climate factor in determining the facade composition. In these circumstances, the aim is to create an internal temperature as stable as possible. The extent to which the interior temperature is stable depends to a large extent on the thickness of the facade. In comparison to the earlier detailing shown in chapter 8, the facade panels thus have to be much thicker.

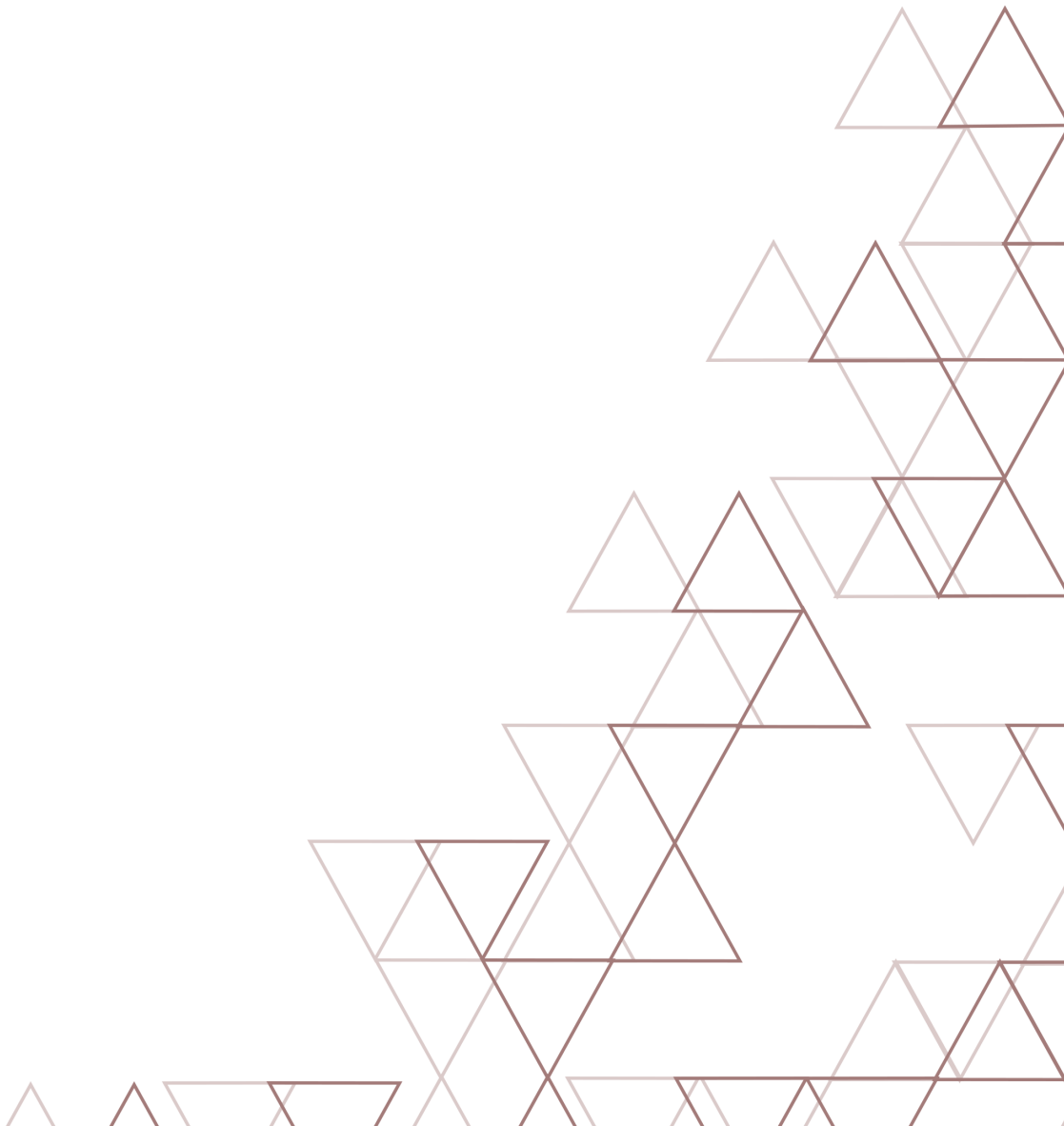
The heat also affects facade material. Untreated wood is not resistant to high temperatures. It starts to bend and to crack. For this reason, the facade has to be finished with a heat resistant coating.

Another feature of building in the desert is of course the sand. The disadvantage of sand is that it is so light, so that it can be moved by the wind. For this reason, the connection between the building and the ground level is of great importance. Because of the fact that the building is lifted from this ground level by the foundation elements, the sand can be blown underneath the building. This ensures that no sand accumulations occur against the facade and that less sand can reach the floor of the building.



Fig 118. Building in the context of Za'atari

Chapter 10
Conclusion



10 CONCLUSION

The end result of the project is largely determined by two important elements; the developed building system and the needs of refugees in the context of informal settlements.

The building system is of course a very important part of the graduation. With the design made for the DDW it is proved that the system can create impressive spaces in a relatively simple manner. In this design there was sought for a balance between simplicity and architecture.

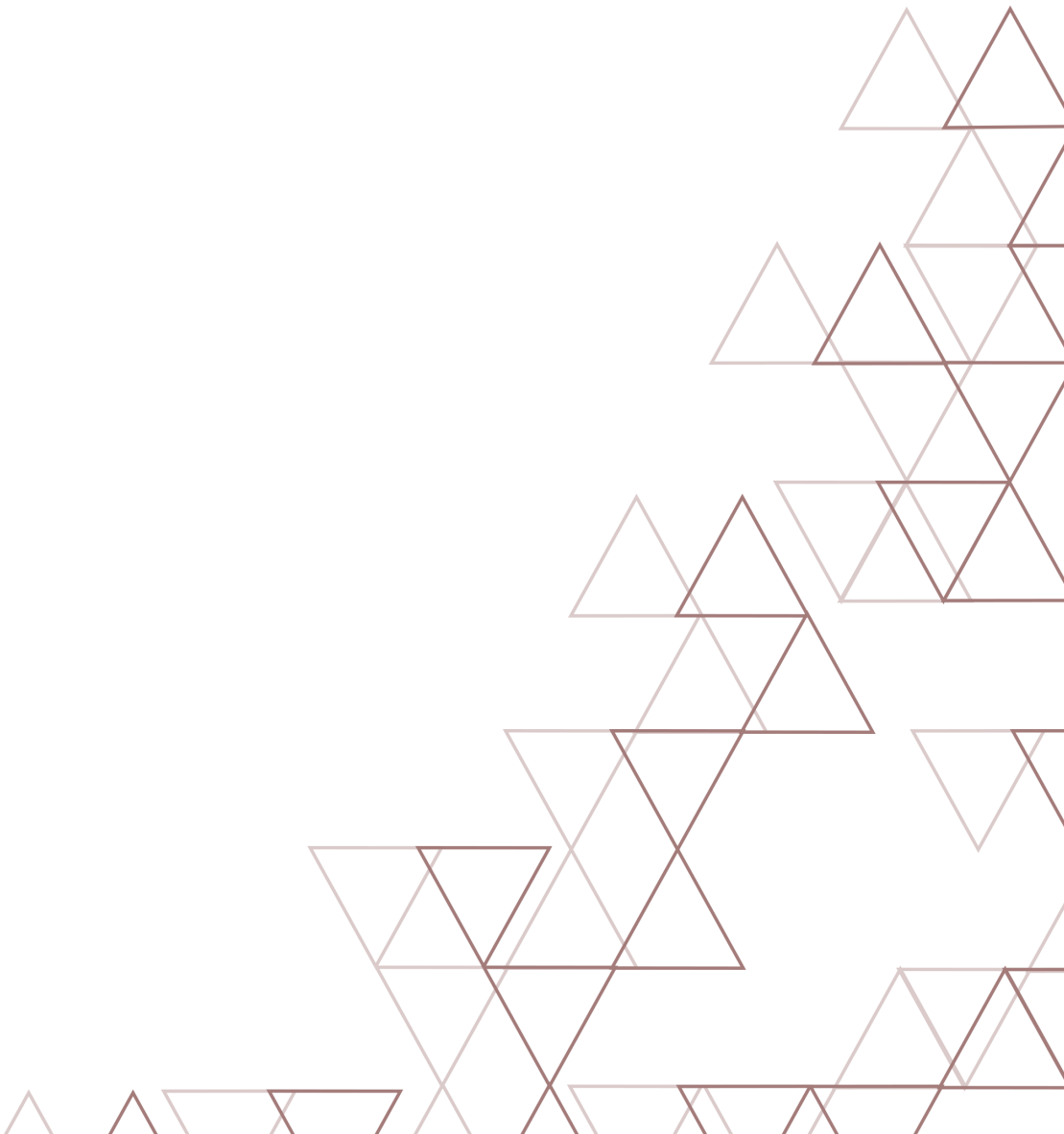
In the main design, however, there is chosen to loosen up from the building system a bit more. Despite that a system like this offers many opportunities, it also brings restrictions with it. Because the design of the DDW already proved that it is possible to create a building perfectly in line with the system, the emphasis is now more on the architectural language and the needs of the refugees.

In stead of starting the design from the building system, the building system is now later implemented in a design. The difference between these approaches is clearly visible when the design of the DDW is compared with the final design.

Looking back on the main and subquestions of this project, it can be concluded that every question is answered. However, the ambition to create a building which is able to operate everywhere in the world seems to much asked. The needs and demands in different informal settlements in different climates vary so much, that a generic design can almost be excluded. It is better to strive for a generic basis in the form of a structure and shapelanguage, which can be made specific for a location by making small additions or changes to this basis.

Nevertheless a solution is provided for all the other questions. A buildig system is created with takes the criterea valid in a refugee camp in to account, a transforming program is developed which responds to the needs in the camps and a design is made which can function as a camp icon a can evolve into a new public center of the refugee settlement.

Chapter 11
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FIGURES

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