Feeling home in a temporary environment

Creating a temporary living environment for students with shipping containers which gives a feeling of home

RESEARCH PAPER

Paul Robertson
4164253
Abstract.

The last couple of years it is very hard for students to find a proper and affordable home in Amsterdam. As a reaction to this matter, the government has built several student complexes which consist of transformed shipping containers. It is a very effective and quick solution in order to cope with the rising number of students who are in need of a home. But unfortunately there are also disadvantages about this way of offering students a home. Because the container is made of steel, it is hard to generate a good climate control. This has the consequence that in winter times it can be very cold as in the summer it can be very hot. Another disadvantage is that because the shipping containers are looking the same, you see that the container complexes have a very impersonal and unfriendly character. To tackle these problems this research paper tries to find a way in order to transform the shipping containers in such a way that a living environment is being created which gives the feeling of home. Before you are able to transform a shipping container you have to learn the basic knowledge about the container. Research about the construction, climate design, utilities, toxics and fire safety are needed. This research has shown that there are several ways to transform a shipping container. Most important is that you meet the building requirements. With this basic knowledge the next step can be taken which leads the research to examining what a feeling of home actually means. Literature research has shown that for a feeling of home, different terms are very important: personal, physical, social and identification. These terms also take place at two levels, namely the micro- and macro level. In this research paper, physical strategies, based on the knowledge of the container and the feeling of home, are being implemented in order to transform a shipping container into a home which gives a feeling of home.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BACKGROUND</td>
</tr>
<tr>
<td>2</td>
<td>METHOD</td>
</tr>
<tr>
<td>3</td>
<td>INTRODUCTION</td>
</tr>
<tr>
<td>4</td>
<td>CONSTRUCTION</td>
</tr>
<tr>
<td></td>
<td>4.1 Structure</td>
</tr>
<tr>
<td></td>
<td>4.2 Facade</td>
</tr>
<tr>
<td></td>
<td>4.3 Foundation &amp; Connections</td>
</tr>
<tr>
<td>5</td>
<td>CLIMATE DESIGN</td>
</tr>
<tr>
<td></td>
<td>5.1 Insulation</td>
</tr>
<tr>
<td></td>
<td>5.2 Ventilation</td>
</tr>
<tr>
<td></td>
<td>5.3 Heating</td>
</tr>
<tr>
<td></td>
<td>5.4 Cooling</td>
</tr>
<tr>
<td>6</td>
<td>UTILITIES</td>
</tr>
<tr>
<td></td>
<td>6.1 Watersupply</td>
</tr>
<tr>
<td></td>
<td>6.2 Electricity</td>
</tr>
<tr>
<td></td>
<td>6.3 Sewer system</td>
</tr>
<tr>
<td>7</td>
<td>TOXICS &amp; FIRE SAFETY</td>
</tr>
<tr>
<td>8</td>
<td>PHYSICAL STRATEGIES</td>
</tr>
<tr>
<td>9</td>
<td>CONCLUSION</td>
</tr>
<tr>
<td>10</td>
<td>REFERENCES</td>
</tr>
<tr>
<td></td>
<td>APPENDIX</td>
</tr>
</tbody>
</table>
1. Background

Problem statement
Since more and more students are living in containers they have also faced the disadvantages of living in them. The last couple of years’ student housing became a hot topic in the news in the Netherlands. Especially in Amsterdam, students are facing a lot of problems in finding a home. First of all, the prices for renting a room/house are very high and secondly there is a shortage of student housing in Amsterdam. To solve this problem, the government was looking for a solution to provide students for a temporary living. Containers seemed to be the perfect solution as they can be transported very easily, are very strong, are resistant against any weather conditions and can be stacked on top of each other very easily. One can say that this is a simple, cheap and therefore a legit way to solve this problem but in my opinion this is not the case. Because first, these containers are limited in offering the living quality the inhabitants need. Students are complaining about the noise pollution and isolation. For example, in the summer the containers can be very hot with minimum ventilation. Secondly, the containers are stacked on top of each other forming a big complex. Because all the containers look the same, a complex is created with a very dull and impersonal character. These issues are caused because the shipping containers aren’t used to their full potential in order to create a living environment which offers a high living quality.

Objective
The intention of my graduation project is to improve the living quality of the container homes by creating a feeling of home. In order to realize this, an improved way in the use of shipping containers has to be found. To improve the usage, one has to adjust the living environment more on the needs of the students in stead of transforming the containers with only the goal in mind to realize as much as container homes in a very short time. When one takes into account the needs of the students and translates this into a design, a living environment can be created with a higher level of comfort in comparison with the current container complexes. By creating this concept with a temporary building system such as shipping containers, a feeling of home is being created which enhances the quality of the living environment and at the same time can be disassembled very easily and used in other area’s of the city or anywhere else.

Overal design question
How can you create a temporary living environment for students on the Marine Area in Amsterdam with shipping containers which creates a feeling of home?

Research question
In order to answer the overal design question, more specific research has to be done. Therefore we look first at the scale of a shipping container itself and what the technical opportunities and solutions are:

What are the technical opportunities and solutions for the transformation of a shipping container into a home which creates a feeling of home?

Location
For this research the Marine Area in Amsterdam serves as the playground where this concept can be tested. As the local authority is very carefull about the Marine Area, they decided to slowly and gradually open up the whole area. Because a temporary building system such as the use of shipping containers offers flexibility, the concept of temporary studenthouses suits the vision for the Marine Area very well.
Subthemes

In order to answer the research question, research has to be done about several subthemes:

- Construction
- Climate design
- Utilities
- Toxics & fire safety
- Physical strategies

In the next section the working method is explained in detail and why the subthemes are important in order to answer the research question.

Relevance

The last couple of years Amsterdam is becoming a city with a rising density. This has caused that space for building new homes is very scarce. The government is forced to built more and more on the outside of Amsterdam and to find new innovative ways in order to cope with the increasing number of citizens. A living environment constructed out of a temporary building system can reduce the pressure on this matter as in the meantime new homes can be built elsewhere. Still these temporary student homes have to offer a high quality of living comfort. Finding a way in which a living environment for students can be created with a temporary building system which gives the feeling of home is important because this will not only enhance the quality of the living environment but will also have a positive effect on the location itself. By combining this with a temporary building system, it allows the design to be disassembled in a very quick and easy way and to be placed at another location in the city or anywhere else. Next to the fact that the quality of the living environment is being enhanced, you also are recycling the shipping containers. In this way you are giving the design a sustainable character which can have a positive impact on the awareness of the environment.
2. Method

As already described in the previous section, this research paper consists out of several subthemes. In order to answer the research question, one must examine these subthemes. Creating a temporary environment with shipping containers which gives a feeling of home, begins with the understanding of how you transform a shipping container into a home. Basic knowledge about construction, climate design, utilities, toxics and fire safety is therefore needed. To gain this knowledge literature is being examined about which steps you have to take for such a transformation. But also a lot of examples of existing container homes are being examined. As the use of container homes isn’t applied on a very big scale, a lot of DIYers (Do It Yourself) have transformed a shipping container by themselves and recorded and archived their process. Therefore, there exist a lot of different ways in transforming a shipping container. The literature research and the different examples of existing transformations are combined in order to set up a framework about the basic knowledge of a shipping container.

Next to the transformation of the shipping container, the feeling of home is an essential part. Therefore, research about the feeling of home is done and attached to this research paper in the appendix. This research is being done by examining literature. The output of this research is combined with the knowledge of the shipping container. By doing this, physical strategies are designed in order to be able to transform the containers in such a way that a feeling of home is being created. These strategies are forming the start for the design phase, where those strategies will be tested.
3. Introduction

A container is originally designed to be moved from one mode of transport to another without unloading and reloading. As it is a very effective way of transporting cargo, unfortunately nowadays there are a countless numbers of empty shipping containers which aren’t used anymore. The reason is that it is too expensive for a country to ship the empty and unused containers back to where they came from. Most of the time it is cheaper to buy new containers (Pagnotta, 2011). This has resulted in an extremely surplus of shipping containers. As the world is more and more in need of sustainable solutions, these shipping containers gained a lot of popularity.

History goes back to 8 August, 1989 as Phillip C. Clark received a U.S. patent describes as a ‘Method for converting one or more steel shipping containers into a habitable building at a building site and the product thereof’. (Pagnotta, 2011). The information and diagrams of this patent formed the basis for many current shipping container architectural ideas. As in 2006, Southern California architect Peter DeMaria designed the first two-story shipping container home in the U.S. as an approved structural system under the strict guidelines of the nationally recognized Uniform Building Code (BRON). Another impressive example is the Lot-tek’s Puma city, which was built with abundant material with a low price without substituting design quality.

Using shipping containers for architectural ideas has a lot of advantages:

- **Easy to use and construct**: Transforming shipping containers into a house is relatively easy. The framework is already there so actually the only thing you have to do is adding doors, windows and secondary walls.
- **Structural strength**: Because of its design and material, the shipping containers can bare high loads and can withstand any weather conditions.
- **Eco-friendly**: Re-using shipping containers lessens the impact of the use of other conventional materials but it also saves considerable energy which is otherwise used to melt down metal containers when scrapping (www.container-transportation.com, 2016).
- **Easy to transport**: Because of the dimensions, the shipping containers are easy to transport. As almost all of these shipping containers have the same dimension’s transportation can be done very effectively on sea but also by road.
- **Short building time**: You can build houses from modular units in a relatively short time, in comparison with construction of regular dwellings.

Of course there are also disadvantages when using shipping containers:

- **Climate design**: because the shipping containers are made out of metal, they conduct heat very well. In summer in can be very hot and in winter it can be very cold.
- **Structural weakness**: As the corners of container are very strong, the roof is very weak. Unconventional uses of containers must be considered wisely.
- **Toxics**: A concern about homes built from containers is the possibility of multiple toxic exposures from some modules (www.wiselygreen.com, 2016).
Before you are able to transform a shipping container into a home, knowledge about the construction is essential. Therefore, research must be done about the structure, the facade, the foundation and the connections. In the appendix, all specifications, such as dimensions and weight are examined. Also 3D drawings explain how the structure is being built up. With this basic knowledge, further design solutions can be made.

4.1 STRUCTURE

Shipping containers have monocoque bodies. The roof, sides, back, floor, frame etc. form an integrated structural skin (contraders.com, Unknown). The design and their strength makes them able to carry very high loads and makes it possible to stack them on top of each other (1). As they are made from steel, they are very strong and can handle a lot of force. But they have also some weak points. As the corners can handle a lot of force, the points in the middle are very weak (2). This is because there are no support columns in the length of each side of the container. If you are removing parts of the panelling along the length of the container the structural integrity is compromised (primerresidentialcontainershipping, 2016). Without reinforcements, the container will deform (3). In order to make adjustments to the structure of the container in order to stack containers with different dimensions, reinforcements have to be applied. This can be done by adding a steel framework, sometimes also column and roof support will be needed.

Containers are designed to make vertical contact with each other through the corner fittings. When they are stacked, all the vertical forces are being transferred through these fittings. The number of containers which can be stacked on each other are limited as it is determined by the strength of the corner posts. ISO standard 1496, a specification and testing manual for shipping containers, states that the corner posts should be tested to a load of 86,400 kg. This is the load applied to the posts of the bottom container in an 8-on-1 stack of 24,00 kg (bruto weight) containers. These tests are done for stacking on sea. The possibilities for stacking on land are different as research has shown that stacking on land, 10 containers are reasonable (Cooper, Kilmer, & Wands Fermi, 2003).

4.2 FACADE

Before you can make adjustments to the exterior and interior facade of the container in terms of windows, doors and interior, adjustments to the structure of corrugated walls of the container is needed.

EXTERIOR FACADE:

If you want add windows and doors first you cut out the desired shape. Then you put a wooden or steel frame in the hole. You can weld a steel frame to the corrugated wall but with a wooden frame you need a secondary L-beam in order to connect the frame to the outside wall. The gaps you can fill with silicon.
INTERIOR FACADE:

For adding insulation and to finish the interior facade, a secondary structure is needed. This can be constructed out of wood or steel. By doing this you actually are adding an extra inside layer. Within this frame, insulation can be placed or you can finish the inside by adding material on top of the frame. An issue is how you connect the frame to the corrugated wall as you don’t want to make holes in the wall. This can cause problems with the forming of condensation and moisture. A possibility is that you use the pressure of the container itself. You then actually pound the vertical wooden elements between the top and down side of the container. In this way the wood stays in place. After adding the vertical elements, you connect them with the horizontal wooden elements. Together they form a strong secondary structure on which you can finish the interior facade with for example plywood.
4.3 FOUNDATIONS AND CONNECTIONS

Before a shipping container can be placed on the site, a strong foundation is needed which can bear the weight. After the foundation is set, connections between the container and the foundation and in some cases between two or more containers, is needed. Different kinds of foundations and connections are possible, as it depends on the weight and the design of the container home.

FOUNDATIONS
- **Slab foundation**: This type of foundation is usually used on softer soil types and when the ground requires an equal weight distribution. A benefit of a slab foundation is that it provides a solid base without hollow space in the foundation. At the same time this can also be a disadvantage because there is a lack of access to utility lines. If there are problems with the water pipes for example you have to cut out parts of the concrete slab to get access to the pipe (Tom, 2016).
- **Pier foundation**: Pier foundation is very popular because it is cheap and easy and quick to construct. These concrete piers have steel bars within them to give them extra strength. An advantage is that the container is up of the ground. This allows ventilation and prevents condensation forming underneath the container. Usually 6 piers are placed under one container. One pier for each corner and two piers are used in the centre to support the middle of the container otherwise the container will deform (Tom, 2016).
- **Strip foundation**: A strip foundation is more or less a combination of a slab and pier foundation. It is a simple strip of concrete which supports the container along the length of every side. It is ideal when the ground is damp and liable to lots of water. But also this kind of foundation has its weaknesses. Due to their shallow nature, they are only suited for small and medium sized builds (Tom, 2016).

CONNECTIONS
When you have placed the foundation, you have to set and secure the container to the foundation. Securing them to the foundation can be done by welding the corner blocks to steel plates which are imbedded in the concrete slab. When a design consists out of multiple units, you have to secure them to each other. Because the containers are so strong, they only have to be connected to each other at the corners. This can be done by welding all the corners to each other or using bolts and specialized clamps. Welding them together is mostly done when the idea is not to disassemble the containers from each other. When the idea is to disassemble them over a short period of time, bolts and clamps are most suitable. Next to the corner points the floors has also be connected to each other. The picture on the right show that this is done by welding a steel plate on top of both bottom side rails. This same method can also be applied for the roof (Homestead, 2014).
Another important aspect of the transformation of a shipping container is climate design. As a container isn’t designed to serve as a home, a lot of adjustments have to be made in order to create an indoor climate which meet the requirements. As the containers are made of steel, they conduct heat very well. Therefore, insulation is very important. This also means that heating and cooling systems or design solutions has to be made.

5.1 INSULATION

There are several different ways to insulate a shipping container:
- **Fiberglass Insulation:** For this option a secondary wooden frame is necessary. The sections of the insulation are cut and are fitted inside the wood framed interior. It is desirable to not make any penetrations to the exterior of the container when constructing the wooden frame. Holes in the exterior makes the container vulnerable for condensation and moisture. Important to take into account is the fact that the walls of a container are corrugated. When placing the fiberglass insulation, there may be gaps between the insulation and the outside corrugation. Depending on where the container is going to be placed, it is good to consider to put a moisture barrier between the container wall and the insulation.

- **Foam Panels:** A big advantage of foam panel is the interior space you can save because you don’t need to place a wooden frame at the interior of the container. When using these panels, they can be glued directly to the corrugated walls of the container or screwed into flat bar mounted to the container walls.

- **Closed Cell Spray Foam:** This option may be the most efficient insulation. It will offer a very high insulation value (R = 6 per inch) and the foam completely covers the surface of the corrugated shipping container walls. Because of this method there will be no gaps between the insulation and the wall of the container which means that there is much less risk of condensation or moisture developing. Also with this method, no secondary wooden frame is needed as the spray foam can be sprayed as thick as necessary (containertech, 2017).

The three given examples can also be applied for the roof. The floor at the other hand needs a different approach. As you don’t want to lose too much height within the container, a thick layer of insulation isn’t suitable. A possibility is to remove the existing floor and add insulation between the cross members. A big disadvantage is that you need a crane in order to access the bottom of the container. Another possibility is to use thin insulation panels which you can put over the existing floor of the container. One must think of Kingspan floorboard insulation. With a thermal conductivity of 0.18 W/m.k, it offers a high thermal performance. Other kinds of insulations are of course also possible but you have to take into account the thermal regulations (Bouwbesluit, 2012, Article 5.3):

- **Floor:** R - value of 3,5 m² K/W
- **Facade:** R - value of 4,5 m² K/W
- **Roof:** R - value of 6,0 m² K/W
5.2 VENTILATION

For ventilating a container home there are several options. Actually the same two options as with normal housing are possible, namely passive and mechanical ventilation. Originally shipping containers are equipped with small breather vents at the factory that allow a limited amount of airflow but those vents won’t be sufficient to meet the ventilation regulations, as per person a minimum of 25 m3/h of fresh air is advised (Bouwbesluit, 2012, Article 3.29). The minimum ventilation capacity for existing buildings are (Zondervan, 2014):
- User area: at least 0.7 dm3/s/m2 of floor area, with a minimum of 7 dm3
- User area with a cooker or an open combustion unit: 21 dm3/s
- Toilet: 7 dm3/s
- Bathroom: 14 dm3/s

PASSIVE VENTILATION

For passive ventilation you can place vents in the container. Placing them allows air to blow both in and out of the container. It is also referred to as cross ventilation. You place vents on the side of your container in which the wind blows and then place vents on the opposite sides of your container. This allows air to flow in through vents on one side of your container and out of the vents on the other side (Tom, 2015) Another option is a turbine vent which you place on the roof. For this system you need a balanced system. When there is enough wind, and you have plenty of intake to feed the system, the top part will spin and it will create an air flow which sucks up the air from the inside.

MECHANICAL VENTILATION

For mechanical ventilation you can use a supply only ventilation. With this kind of ventilation, the fan sucks fresh air into the room. Supply only ventilation is very useful when your home has passive ventilation systems in place and you just need to increase this passive ventilation on hot days.

Another but expensive option is to use a balanced ventilation system. This involves having fans to both push stale air out and suck fresh air in. The air can then be sent throughout your container using ducts (Tom, 2015). This means in moisture prone areas such as bathrooms and kitchens air can be extracted, and fresh air can be blown into other areas of your home such as the lounge and bedrooms. Using a balanced ventilation system, you can very easily manage the moisture and humidity levels in your home.

5.3 HEATING

As already mentioned, shipping containers conduct heat very well. Next the the insulation, a proper heating system is required in order to keep the container home warm enough in winter times. One must take into account the needed Watts per m3 per room:
- Living room: 75 watts per m3
- Sleeping room: 60-70 watts per m3
- Kitchen: 60 watts per m3
- Bathroom: 75-80 watts per m3
- Toilet: 70 watts per m3
FLOOR & RADIATOR HEATING

When you want to place floor heating, you must take into account that the floor of a shipping container is minimal. It only consists out of steel cross bars and a thin wooden floor. Therefore, you have to put a isolation layer first, before you are placing the floor heating. Otherwise all the heat will disappear through the floor. What you also can do is to put an aluminium foil between the insulation and the floor heating, causing the heat to reflected back to the inside. Another option is a normal radiator which you can place in every room. With this option you have to be aware that you have to know where all the gaps in the inside walls are placed.

5.4 COOLING

Cooling can be done by air conditioning or by operable windows. The need of cooling depends also of course on the climate in which the container home is being placed. Another solution is to place and orientate the container home in such a way that it heats up and cools down when needed.
6. Utilities

Because a container home is a separate unit which is not connected to the water supply and electricity system, you have to begin from scratch in terms of water supply, electricity cables and the sewer system. As there are a lot of examples in which people show how they installed all their utilities, there isn’t a specific way to do it as everyone does it in a different way. It also depends on the climate in which the container home is being placed. What you must do is to take into account the regulations about the water supply, electricity and the sewer system.

6.1 WATER SUPPLY

It is important to have a water lay-out. This is all the incoming and outgoing water into the shipping container home. This will include the bathroom, toilet, shower, sink and the kitchen sink. The way in which the water system is constructed also depends on the foundation. When you have a slab foundation, the water pipes will have to constructed in the slab foundation. Therefore, it is very important to already know where the pipes and cables will enter the container from underneath. A pier foundation makes it much easier to be able to reach the cables and pipes.

Warm can be locally heated by natural gas, electricity or other sources as solar power, a heat pump or district heating (Zondervan, 2014). Temperature of the water depends on the type a capacity of the machine, the volume flow and the temperature of the cold water. This all depends on the specific location of the container home. If there is no possibility to connect the container home to the water company, an external water buffer is needed. The size depends of course on how much people are going to life in the container home.

6.2 ELECTRICITY

Also an electricity lay-out is needed. This is the flowchart of all incoming electricity, the location of the outlets, switches and the fuse box. If the possibility is there, you can connect your container house to the existing electricity system. When there is no existing electricity supply near, you have to supply the container home with an own electrical system. This can be done by solar panels or batteries which you can install in the container itself. Also here you have to take into account that the electrical network has to meet the requirements which are described in v1041 (Bouwbesluit 2012, article 6.8)

6.3 SEWER SYSTEM

An important regulation for the sewer system is that the collector pipe (which is the horizontal connection between the appliance and the standpipe), always have to be sloped, 5 to 20 mm/m (1:200 tot 1:50) and is required to prevent congestion. Besides this there are many regulations in detail about the how to connect and make curves in piping (Zondervan, 2014). With the slope in mind, special solutions have to be taken when you are designing. This can for example have an effect on the foundation.
Before you are going to transform a shipping container, you must be aware of the fact that wooden floors used in the majority of shipping containers are treated with hazardous chemicals such as pesticides. Some other shipping containers are coated in paint which contains harmful chemicals such as phosphorous and chromate (Tom, 2015).

What you can do to protect yourself from the toxics is to use a non-breathable flooring underlayment. This underlayment was laid straight over the original wooden flooring. If you don’t want to take any risk on this matter you can of course remove the original wooden flooring and replace it with a new wooden floor. After you have done this, you may still have to problem with the harmful paint coating. This paint coating is used to protect the container from salt water whilst they are being transported across the sea. If the container is indeed coated with harmful chemicals then you need to use spray insulation (Tom, 2015). This you will need to spray on the internal walls of your container. This will create a complete vapour barrier.

Because containers are used to transport all different kinds of materials, strong fire safety regulations have been set up to let the transportation go as safe as possible. Regulations on what can be shipped in intermodal shipping containers will vary from city to city and state to state, but some regulations across North America include things like “Shipping containers used to store flammable or hazardous materials must be properly ventilated and placarded to identify the materials within,” and “Fire extinguishers must be installed in accordance with city code.” (Rediehs, 2009)

You can assume that if you want to transform a shipping container into a home, that you don’t have to worry about the fire safety.
8. Physical Strategies

Now the basic knowledge about transforming a shipping container into a home is being examined, the next step is to transform them in such a way that a feeling of home is being created. The ultimate goal of this graduation project is to create a temporary living environment with shipping containers which creates a feeling of home. In the appendix a literature study about the feeling of home is included. Based on the findings of this research, a couple of requirements and strategies on both micro and macro scale are being examined in the following tables. These strategies are divided into hard and soft. With soft strategies you must think of strategies concerning the more objective requirements. The soft strategies will address more the subjective requirements.

### PHYSICAL STRATEGIES - HARD

<table>
<thead>
<tr>
<th>Micro</th>
<th>Macro</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daylight</strong></td>
<td></td>
</tr>
<tr>
<td>0.5 m² daylight is required</td>
<td>By using bigger windows and also using the roof as a window, more daylight can enter the house.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ventilation</strong></td>
<td></td>
</tr>
<tr>
<td>User area: 0.7 dm³ / s / m² Cooking: 21 dm³ / s / m² Toilet: 7.0 dm³ / s / m²</td>
<td>By using more sides of the shipping container, more ventilation can be reached.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heating</strong></td>
<td></td>
</tr>
<tr>
<td>Energy consumption 2 - house hold: 3400 Kwh</td>
<td>Making zones in the house itself, heating can be done more effectively.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Watersupply</strong></td>
<td></td>
</tr>
<tr>
<td>Water usage per day per person: 120 liters</td>
<td>As the design concerns a temporary housing, the house needs to have a own water supply unit which can be removed and refilled.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Electricity</strong></td>
<td></td>
</tr>
<tr>
<td>Energy consumption 2 - house hold: 3400 Kwh</td>
<td>As the design concerns a temporary housing, the house needs to have a own electricity supply unit which can be removed and recharged.</td>
</tr>
</tbody>
</table>
**PHYSICAL STRATEGIES - SOFT**

<table>
<thead>
<tr>
<th>Lay-out</th>
<th>Micro</th>
<th>Macro</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Making zones you allow people to do different activities in the house in stead of that every activity is being done in one room.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>By shifting the shipping containers, this principle can be applied for every house. In this way, every home gets enough daylight.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Architectural style</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Letting every house have a different style/dimension, density or lay-out gives the house a own identity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This principle can be applied on a bigger scale by giving each complex another style, dimension etc.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Privacy</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Making zones, you allow people to have privacy whenever they want it.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>By placing the shipping containers less directly on top or next to each other, more privacy is created.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shared space / social interaction</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To enhance the social interaction, shared spaces have to be applied between the houses. In this way the social interaction is stimulated.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applying this on a scale of a complex, shared space between the complexes have to be created. One must think of a supermark, studycentre or cafe.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To create container homes with different kinds of materials can enhance the feeling of identification.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applying this on a scale of a complex, an own identity of a complex can be created. This brings diversity to the whole campus.</td>
<td></td>
</tr>
</tbody>
</table>
9. Conclusion

What are the technical opportunities and solutions for the transformation of a shipping container into a home which creates a feeling of home?

From the research it can be concluded that there are several technical opportunities and solutions for transforming a shipping container into a home. Not all the possibilities are examined as there will be plenty more ways to do it. As transforming shipping containers into homes isn’t applied yet on a bigger scale, not much specific rules and official buildings are created. The existing container home stock consists more of smaller projects which are done by DIY’ers which have documented their process. This means that there a lot of different ways in which a container can be transformed. Of course you have to meet the requirements such as ‘Het Bouwbesluit’ but in general you have a lot of freedom in transforming a container.
8. References

LITERATURE:


WEBSITES:


**OTHER IMPORTANT SOURCES:**

http://www.containerhome.info/

www.youtube.com - Bush Block Homestead

www.youtube.com - Paul Chambers

www.youtube.com - Von Thompson Tinker
Specifications

As there are a lot of different shipping containers, there are a couple of standard dimensions (K-trainer, 2017). With the overall design question in mind, the following diagram shows which are the most common ones and are most suitable for a design:

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Bulk</th>
<th>High Cube</th>
<th>Open Top</th>
<th>Mini container 6ft</th>
<th>Mini container 8ft</th>
<th>Mini container 10ft</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal dimensions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>2348 mm</td>
<td>2348 mm</td>
<td>2348 mm</td>
<td>2345 mm</td>
<td>2350 mm</td>
<td>1860 mm</td>
<td>2106 mm</td>
</tr>
<tr>
<td>Length</td>
<td>5900 mm</td>
<td>12025 mm</td>
<td>5900 mm</td>
<td>5910 mm</td>
<td>12032 mm</td>
<td>11550 mm</td>
<td>1800 mm</td>
</tr>
<tr>
<td>Height</td>
<td>2392 mm</td>
<td>2392 mm</td>
<td>2503 mm</td>
<td>2690 mm</td>
<td>2699 mm</td>
<td>2377 mm</td>
<td>1730 mm</td>
</tr>
<tr>
<td><strong>External dimensions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>2438 mm</td>
<td>2438 mm</td>
<td>2438 mm</td>
<td>2438 mm</td>
<td>2438 mm</td>
<td>2438 mm</td>
<td>1950 mm</td>
</tr>
<tr>
<td>Length</td>
<td>6058 mm</td>
<td>12192 mm</td>
<td>6058 mm</td>
<td>6058 mm</td>
<td>12192 mm</td>
<td>12192 mm</td>
<td>1980 mm</td>
</tr>
<tr>
<td>Height</td>
<td>2591 mm</td>
<td>2591 mm</td>
<td>2711 mm</td>
<td>2891 mm</td>
<td>2896 mm</td>
<td>2591 mm</td>
<td>1910 mm</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terra</td>
<td>2250 kg</td>
<td>3900 kg</td>
<td>2275 kg</td>
<td>2420 kg</td>
<td>2350 kg</td>
<td>750 kg</td>
<td>950 kg</td>
</tr>
<tr>
<td>Volume</td>
<td>33 m3</td>
<td>67 m3</td>
<td>35 m3</td>
<td>37 m3</td>
<td>33 m3</td>
<td>65 m3</td>
<td>10 m3</td>
</tr>
</tbody>
</table>

Appendix
Construction drawings (containerhome, 2017)

Figure 1: Primary structural components for a 20ft High Cube container

Figure 2: Exploded isometric view of a 20ft High Cube container
Figure 3: Side Wall

Figure 4: Roof

Figure 5: Underfloor
Appendix

Figure 6: Door End & End Wall

Figure 7: Wall Section
A LITERATURE RESEARCH: A MEANING OF HOME

A lot of research has been done about what the meaning of home means and how this is experienced in an environmental way. For a lot of people home defines our identity and provides security for us and we find relaxation when we set foot in it as for others it means a place where they interact with other people and where new interactions and relationships begin. It is important to be aware of the fact that feeling home takes place at different kinds of scales considering the living environment (Shidfar, 2013). This feeling takes place in your own house but it also has an important role in your neighbourhood, community, the city and also in the country in which you live in. As there is a lot of research been done about feeling home, there are a lot of different definitions and interpretations about this matter. Despite of all the research, the meaning of home is still a complex subject (Sixsmith J., 1986). As the feeling of home appeals to different scales, this research paper examines two scales: micro, which concerns on the scale of the house and macro, which concerns the scale of the neighbourhood / community. For the design it is therefore important to take into account these different scales in order to enhance the quality of the living environment.

MICRO:

For every person, home is a place which features a unique and dynamic combination of personal, social and physical properties and meanings (Sixsmith J., 1986). This definition reveals that the feeling of home takes place at different kind of levels. When we look at the level of home, Sixsmith explains that there are three modes in which the meaning of home can be explained:

- **The personal home:** In this mode, the relationship between places and the attributes and processes of the self are important. The home appears as a profound centre of meaning and a central emotional and physical reference point in a person’s life which is encapsulated in feeling of security, happiness and belonging. At the other hand you must also think about what makes your home your home? The structure, lay-out, style, decoration etc. makes it a place above any other. In this way you also feel home because these things form the reflection of those valued aspects of self-identity.

- **The physical home:** The physical part of home not only means the structure and style of architecture but also the human space available. This means that facilities and services have a share in creating a place of being home. Warmth, ventilation, everyday modern conveniences are important. Next to that home can be more than just a living place. It can also serve multiple activities such as working. Spatiality plays a important role in structuring what people do.

- **The social home:** Next to the importance of a personal and physical home, literature has shown the importance of the social function of a home. In this aspect the presence and the relationships with other people contribute towards the place of being home. But it is also a place allowing entertainment and enjoyment of other people’s company.
As already mentioned, the social aspect plays a significant role in the feeling of home. When one is placing this in a broader context, place identity becomes very important which can be defined as an interpretation of self that uses environmental meaning to symbolize or situate identity (Cuba & Hummon, 1993). Places influence the process of identification directly as physical, social and cultural environments (Cuba & Hummon, 1993). To clarify this, Cross (2001) describes different kinds of community attachment. One of them is cohesive rootedness. People which experience a cohesive rootedness have a strong sense of attachment, identification, and involvement in one community. This rootedness begins with a social mediation of place. Local social involvements prove to be the most consistent and significant sources of sentimental ties to local places (Cuba & Hummon, 1993). Therefore, it is important to extend the feeling home to a broader scale and create a place or community which allows social interaction, participation and relationships.

Next to the social aspect, a more physical one plays an important role in creating a feeling of home, namely identification. Places which differ in their boundedness, distinctiveness, scale and proportion enhance the identification (Steele, 1981). This is supported by the fact that standardization of built form weakens the personal identification with the locale (Buttimer, 1980).

Diagram shows all the constituents of each of the modes. As you see a lot more terms can be added to the feeling of home. As some terms are hard to capture within an architectural design, this research tries to focus more on the ones which can be formed by physical strategies.

As these modes are more concentrated on the scale of the home itself, the feeling of home also appeals to a larger scale. One must think of a neighbourhood or community.

MACRO

As already mentioned, the social aspect plays an important role in the feeling of home. When one is placing this in a broader context, place identity becomes very important which can be defined as an interpretation of self that uses environmental meaning to symbolize or situate identity (Cuba & Hummon, 1993). Places influence the process of identification directly as physical, social and cultural environments (Cuba & Hummon, 1993). To clarify this, Cross (2001) describes different kinds of community attachment. One of them is cohesive rootedness. People which experience a cohesive rootedness have a strong sense of attachment, identification, and involvement in one community. This rootedness begins with a social mediation of place. Local social involvements prove to be the most consistent and significant sources of sentimental ties to local places (Cuba & Hummon, 1993). Therefore, it is important to extend the feeling home to a broader scale and create a place or community which allows social interaction, participation and relationships.

Next to the social aspect, a more physical one plays an important role in creating a feeling of home, namely identification. Places which differ in their boundedness, distinctiveness, scale and proportion enhance the identification (Steele, 1981). This is supported by the fact that standardization of built form weakens the personal identification with the locale (Buttimer, 1980).

CONCLUSION

By this research you can conclude that the feeling of home takes place at two different levels: the micro- and the macro-level. In the micro-level, personal, physical and social home plays a major important role. Every person is forming own home to his own needs on the basis those three principles. In the personal home, a person is trying to make a house his own home which reflects the self. In the physical home, the services and the facilities contribute to a persons feeling of home. At last, in the social home, relations and social interaction within a home are valuable.

At the macro level, identification and social interactions and relationships plays an important role. Identification means that it is important for a person to feel boundedness distinctiveness as also the proportions and scale.
Appendix

Inspiration

12 Container House by Adam Kalkin

Proposal Ganti & Associates

XS House / UNI

Ccasa Hostel by TAK architects