SYNOPSIS

The project takes its offset in the fact that more than 40 percent of the world's population doesn't have access to basic sanitation. 1.6 million children die from diarrhoea every year. Inadequate sanitation along with unsafe water supplies is responsible for the majority of those deaths. Sanitaion is defined as personal hygiene and safe disposal of excreta. The offspring of the project is a toilet-plate to assist the rural people of Sub-Saharan Africa in safely disposing their excreta. Among other things the project focuses on making the toilet-plate more safe for children to use, while also implementing motivational factors beyond personal hygiene, such as utilising the urine as fertilizer for local crops.

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READER GUIDANCE

This project has been divided into two separate reports. The report you are holdin is the process report, which contains the initial research and problem mapping followed by the process of developing a product addressing the found problems. Parts of the investigation referred to during this report can be found in appendixes at the back. Source references are noted continuous throughout the report and listed as following: [Last Name, Year]. The second report is focused on describing the product-related outcome of the project and the scenarios concerning the implementation of the product.

PREFACE

This project was carried out on the 4th semester of the Industrial Design Masters Degree at Aalborg University's Institute 19 – Architecture & Design. It is a one-man project which has made the process a bit different, since the other nine semesters have been carried out in groups. The process is usually filled with discussions and brainstorming with the other group members. This time my discussions and reflections during the process have been managed through a daily report [appendix 1] on what I have been working on, what the next step is and if I have had any aha-experiences or reflections during the day. The work capacity of one person is of course also a factor in this project, which especially was perceptible during the final stages of the project concerning documentation and detailing. But despite these facts I hope you will enjoy reading through this project as much as I have enjoyed working on it.

TABLE OF CONTENT

INTRODUCTION

When the word design is mentioned, people often think of the stylish chair, the luxury car, the toothbrush or the power drill that possess the extra features that enable a larger price tag than the competitors. These are all products that only 10% or less of the world's population can afford.

But more and more designers are using their skills to assist the other 90% of the world's population who normally are not the target group for designers. Like bank robbers, rob banks - because that is where the money is – designers have designed for the wealthiest 10% of the world. But this tendency is changing as more and more designers try to develop affordable and socially responsible objects for the majority of the world that normally is not serviced by designers. Examples of this growing trend is; OLPC – One Laptop Per Child, Q-drum and the Pot-in-Pot Cooler. This growing branch of the design profession is what inspired the initiation of this project.

PROBLEM FRAMING

The definition of sanitation is taken from the agreement for the International Year of Sanitation 2008, which is described as following:

Sanitation:
Safe disposal of excreta and improved personal hygiene [Cumming, 2008].

The most important water-associated health problem is diarrhoea, accounting for 3 to 5 million deaths per year, especially among children under the age of five. Access to sanitary facilities and uncontaminated drinking water, improving the hygienic standards in the developing countries, could diminish death by diarrheal diseases [van der Hoeck, 2001]. The WHO/UNICEF Joint Monitoring Programme estimates that 2.5 billion people – approx. 40% of the world's population – lack access to sanitation.
The lack of proper sanitation does not only affect the people involved and their health but it also has an array of effects to the surrounding environment and society. Improving sanitation facilities will not only prevent disease and deaths but will also contribute to the industrial and financial development of countries when minimising the loss of working hours. As Maslow's hierarchy of needs states; the physiological needs must be fulfilled before an individual can contribute anything to society [Berg, 2008]. Below is illustrated some of the effects the lack of sanitation can result in.

Improvements to the sanitation facilities for those who have no form of hygienic sanitation have been placed into progressive steps by IRC-International Water and Sanitation Centre, named The Sanitation Ladder. The ladder consists of the following four steps:

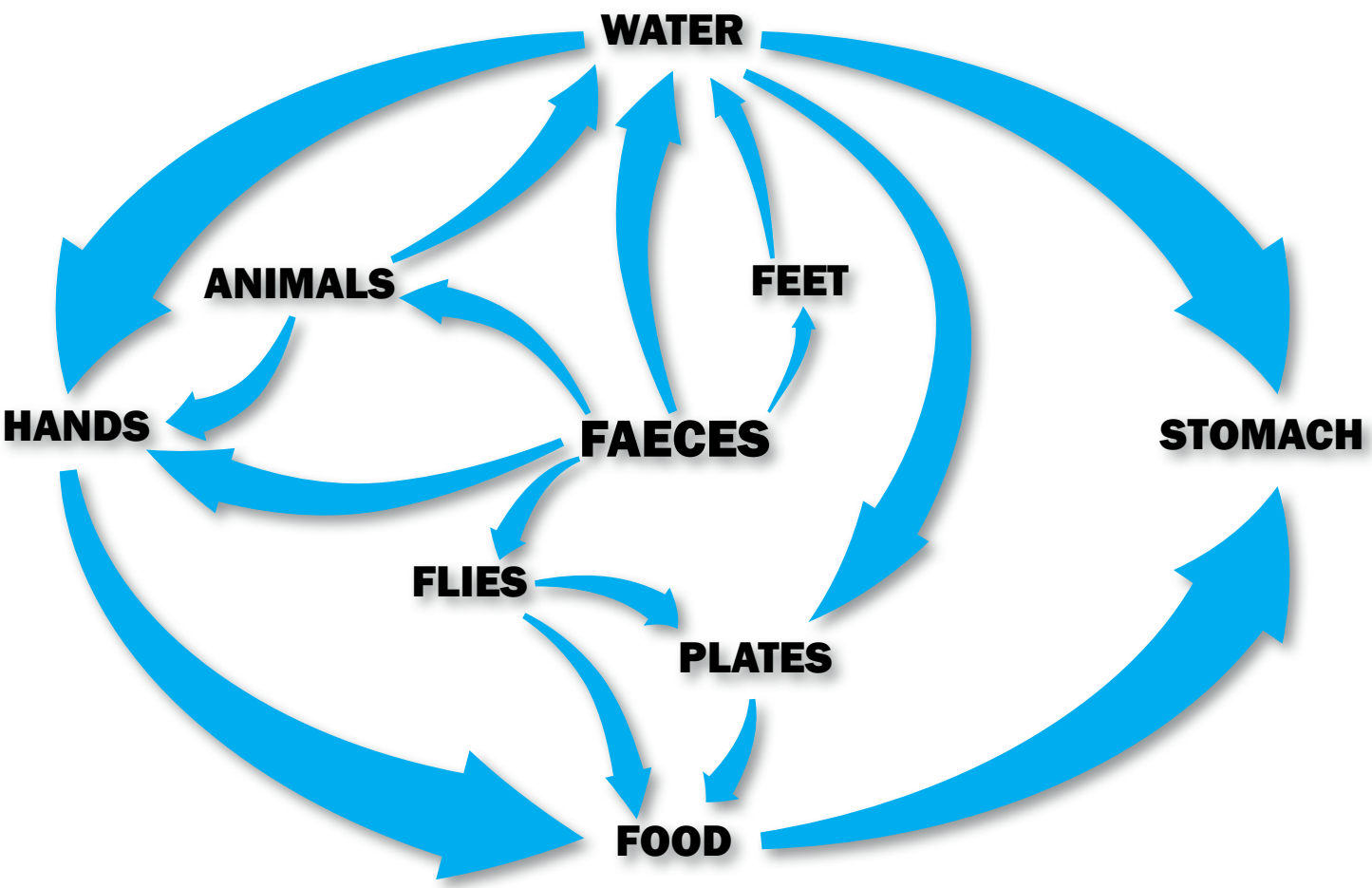
- No sanitation – the focus here is on improved hygiene behaviours, supported by education programmes and community-based cleanliness initiatives.
- Basic sanitation – generally low-cost technologies that protect health in the household environment by creating barriers between pathogens and humans and ensuring hygienic disposal of excreta and wastewater.
- Environmental sanitation – expanding the focus to include preventing pollution of water sources, effective use and reuse of water, protecting the health of the wider community, and improving the environment.
- Ecological sanitation – with the prime concern for reuse and recycling of nutrients to improve food production as well as protecting health and the environment [De Bruijne; Geurts; Appleton, 2007].

HEALTH ISSUES	ENVIRONMENTAL EFFECTS	SOCIAL EFFECTS
Increase of cholera, worms, diarrhoea and pneumonia. Which can eventually can cause the death of people already suffering from weaken immune system or malnutrition.	**Contamination of ground water tables, lakes, streams and coastal zones - enabling continuation of human disease.**	**Lack of dignity.**
Parasites that origin from human faecal.	**Upsetting fragile aquatic ecosystems with nutrient overloading and eutrophication.**	**Crime - women looking for a secluded place often gets assaulted.**
Child death - currently one every 20th second.	**Loss of space for farming, play areas and other village expansions. Due to designated defecation spot.**	**Promotes poverty - loss of working hours.**
Psychological: menstrual management, sexual awareness, shyness.	**Food contamination.**	**Educational Loss of school days**
	Aesthetic: bad odours, increase of flies, and repugnant appearance.	**Prestige: loss of status and not being modern. This effect is larger if people are in contact with areas where toilets already are installed.**

INTRODUCTION

Where there are no latrines people resort to defecation in the open. This may be in indiscriminate or in special places for defecation generally accepted by the community, such as open defecation fields, rubbish and manure heaps, or under trees. Open defecation attracts flies, which spread faeces-related diseases. In moist ground the larvae of intestinal worms develop, and faeces and larvae may be carried by people and animals. Surface water run-off from places where people have defecated results in water pollution. In view of the health hazards created and the degradation of the environment, open defecation should not be tolerated in villages and other built-up areas. There are better options available that confine excrete in such a way that the cycle of re-infection from excrete-related diseases is broken[WHO,1992]. The following diagram illustrates the road of the pathogens from human faeces to people's stomachs, where open defecation is common.

Animals like stray dogs, chickens or birds are some of the elements in the transmission cycle which are more difficult to affect and change their behaviour towards faeces. Their transmission rate will on the other hand certainly decrease with the introduction of safe disposal of human excreta.



AID PROGRAMMES

The focus in this project will take it starting point on the second step of The Sanitation Ladder. On this step it is possible to focus on a simple product assisting the inhabitants in safe depositing of excreta and protecting drinking water from contamination. This choice has been made considering the project's time span and the fact that there is only one person working on the project. Initially the product is seen to be used as a temporary solution in the preparation of getting to the next step of the ladder.
To further narrow down within which frames the project should take place, existing frames from other relief projects have been investigated [appendix 2]. The frames assisted in mapping of all parties involved and their place in the programmes. To broaden the perspective of what frames a relief program can have, two widely different programmes in relation to problem and time span were investigated; rebuilding of a well and feeding a refugee camp.
After the initial research of facts and the frames of two different relief projects a set of frames for this project have been generated. The frame set is used to narrow down a set of preconditions for the creation of the product.

	PROJECT	ARGUMENTATION
WHERE	Sub-Sahara Africa.	Only 36% of Sub-Sahara Africa has access to sanitation.
WHO	Rural Village People.	Only 31% of rural inhabitants in developing countries have access to sanitation, as opposed to 73% of urban dwellers.
PROBLEM	No sanitation.	
ORGANISER	Relief organisation or World Toilet Organisation [WTO].	It's important to get an organiser which is aware of the problem at hand and that possesses the right enthusiasm to want to make the project work.
PRODUCT	Toilet	Provide safe disposal of human excreta.
PRODUCTION PROVIDER	Production should be placed within the developing country where the product will be distributed or in a nearby developing country.	The production is to be placed in the Africa to contribute to the economic development on the developing countries there, as well as the safe disposal of human excreta.
FINANCIAL PROVIDER	Donations through relief organisation such as WTO, Red Cross, UNICEF etc.	As other relief project rely on donations this project will.
TRANSPORTATION	Local freight companies.	Usage of local transportation companies will keep the money in the developing world and contribute to the society.
INSTALLATION PEOPLE AND TIME	Local crew, maybe with help consultants.	Save money for labour and create feeling of ownership to the project.
LIVE SPAN	5 - 10 years?	Until the next step on the ladder is reach.
MAINTENANCE	Everyday users or designated users.	With introducing the local users should be able to maintain the product. Though frequently supervision might be needed in the beginning to avoid stagnation.

CONTEXT

Ideally this project would have been conducted within reach of the users and started with observations and dialogues with the users about their understanding of their current situation and their knowledge about the disadvantages of open defecation. These actions should also map the motivating factors that would convince the users to start benefitting from safe disposal of their excreta but also figure out how to keep the project on its track concerning the cleaning, usage of urine and faeces and establishment of new toilets or replacement of additional toilets.
To establish an understanding of the potential end users of the product a series of personas is created as general representatives for the everyday situation concerning defecation. The personas are also going to function as facilitator for maintaining focus on solving the problems of the users and screening off ideas that might seem interesting but might feel redundant for the users. The personas are made up from literary investigations and through contacts with experiences from African toilet culture [Sørensen, 2008 & Kjær Jensen, 2008].

To further frame the perception of the everyday life of the users a fictive village has been created. The village is used to visualize the current context of the users and to map their behaviour in relation to relieving themselves. The village (see opposite page) is placed on a savannah in Sub-Saharan Africa with a population of approximately 200 inhabitants. The village has a small school that can manage the first six years of primary school for the local children. After six years the children have to walk to the larger village seven kilometres away. The main water source for the village is a small river four kilometres away. There are no toilets or other means to enclose their human faeces but they have selected a few areas on the outskirts of the village which the inhabitants should stay within when defecating. When the inhabitants are not near any of these areas they usually squat down beside the pathways, behind a tree or near the river bank.

1 **At the defecation spot by his maize field.**

2 **At the defecation spot behind their house.**

3 **Along the road to the market in the larger village.**

1 **At the defecation spot behind their house. – waits until night fall.**

1 **Behind a bush or tree on the way down to the river for water.**

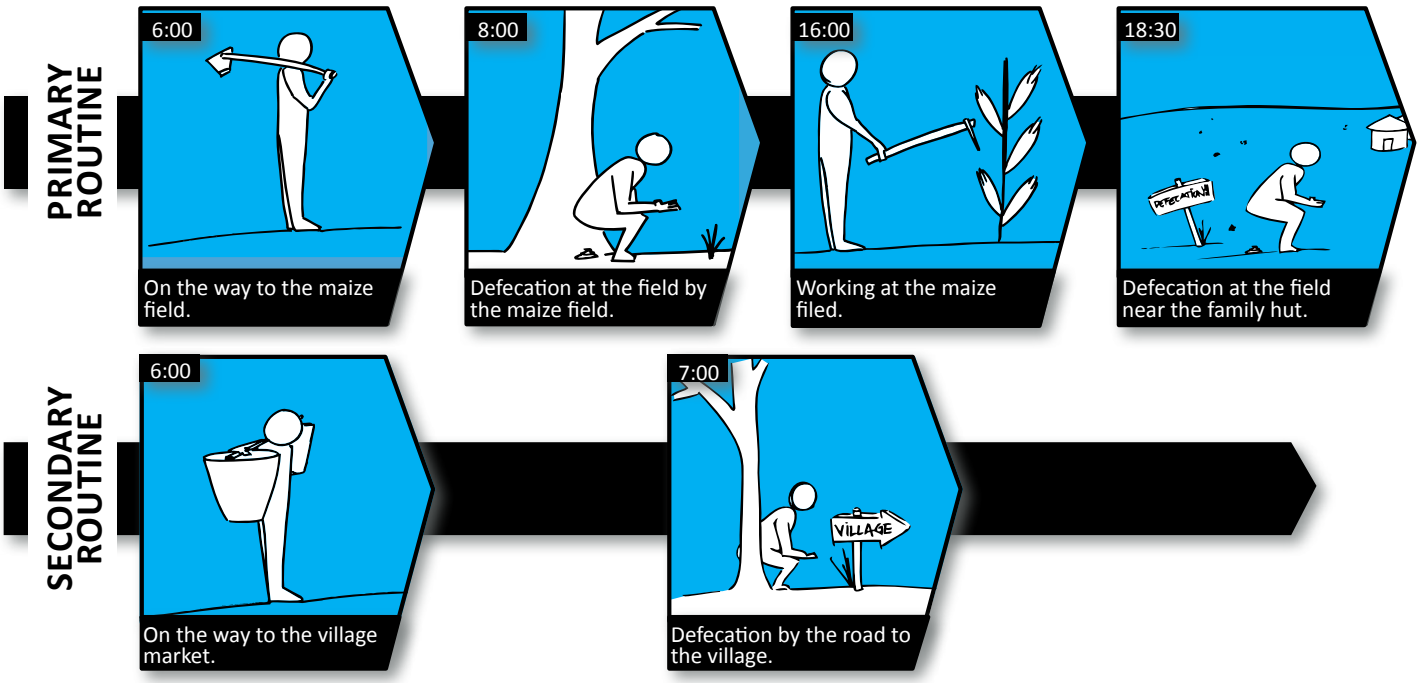
2 **At the defecation spot by her fathers maize field.**

3 **At the defecation spot behind their house.**

Designate defecation places, decided by the village community.


1
2
MAIZE FIELD
SCHOOL
ROAD TO RIVER BANK
1
4km to river
3
CATTLE
7km to large village
HOUSE OF THE MYAMBAS
BEAN FIELD
3
1
10m

Mekena Myamba is a 43 year-old farmer who has a maize field on the outskirts of the village where he spends most of the day. Some days he goes to the larger village 7 kilometers away to sell some of the flour he makes with help from his children and wife. He usually reliefs himself at the outer edge of the field when he is at work. Otherwise he uses the remote area at the outskirts of the village behind their house.



Primary Routine:
Mekena leaves the hut around six o'clock in the morning to go to work at his maize field. He usually uses the designated field nearby to defecate in the morning before he starts working at the maize field. He squats down near a tree on the field if there is not too much fresh faeces around there. Mekena has no problem keeping his balance while squatting since he has 43 years of experience in doing so. The tree is used as cover since he is not perfectly comfortable with the open defecation even though people do not seem to notice when he is relieving himself at the field. People keep to their own business when passing the fields and do not look at others defecating. For cleaning himself afterwards, Mekena uses nearby sticks or stones and sometimes he brings a leaf from one of his maize plants. Mekena only washes his hands if he has excess water with him to the field otherwise he might rub his hands in some dry dirt to get any excreta off. Beside this routine Mekena only uses his left hand for cleaning himself as well as holding his penis when urinating as it is custom for all the villagers and in most African cultures. After the morning defecation he continues his work in the maize field until dusk where he returns to the family hut on the other side of the village.
If he needs to relieve himself at home he uses the field behind their hut. The process is the same as the morning defecation, but if he is going to eat afterwards he cleans his hands with water, even though he as the custom is only eats with his right hand. But as most of the villages he consider the process of defecation very dirty and prefers to only do it the morning so he does not have to think about it for the rest of the day.

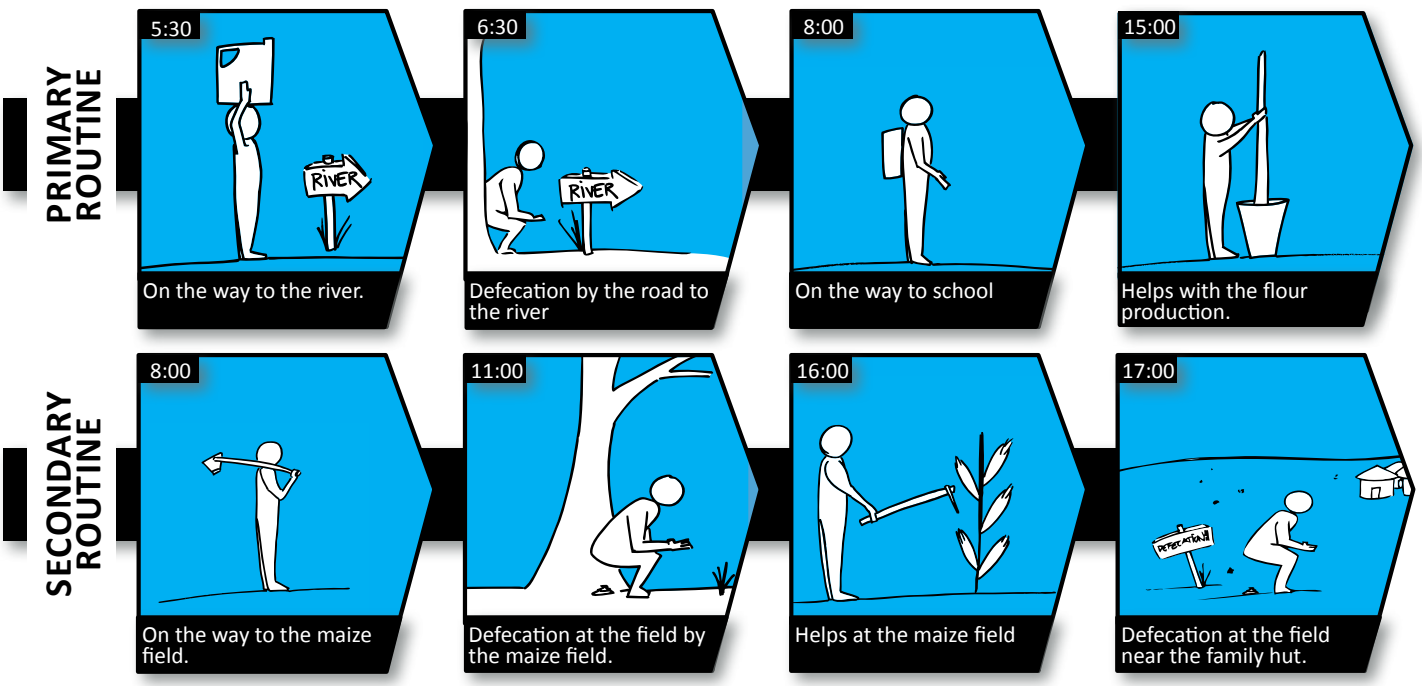
Secondary Routine:
On some days Mekena goes to the larger village seven kilometres away to sell his maize flour on the market. If he needs to relieve himself on his way to the village he squats down near the pathway and defecates. Mekena has enough to carry and has not brought excess water along to clean his hands and therefore does not. He does not use the latrines in the village if he needs relieving, because they are smelly, unsanitary and usually clogged, and therefore he waits until he is on his way back home.

Olamide Myamba is the mother in the family. She takes care of the household and the little brother, Kato, who is only ten months old. Olamida does not feel comfortable using the defecation areas at broad daylight but waits until nightfall for. But when waiting for nightfall Olamide feels more exposed to assault and harassment which have occurred before in the village.

Olamide are taking care of the family's youngest, ten months-old Kato, and the production of maize flour from her husband's farm. Olamide, like the most of the women and adolescent girls in the village, does not feel comfortable with defecating on the designated fields at broad daylight. She therefore waits until dusk or nightfall to use the field nearest to her hut. Olamide was often absent from school when she had her menstrual periods as an adolescent girl. This was due to the fact that there were no private toilets where she could clean herself and change the cloth she uses as protections during her periods. Menstrual periods are a great taboo in the village and the women are often kept indoors during their periods [Bharadwaj & Patkar, 2004]. Olamide is preparing her daughter Eliza(11) for the menstrual management that she will experience within a couple of years.

At nightfall Mekena returns from the maize field and Olamide can leave Kato to him and go to the designated field behind their hut to defecate. Olamides practice is similar to Mekena's as she finds a secluded area and squats down. Her body has adapted to this daily routine along the years, but this is still a great physical as well as mental relief for her.

11 year-old Eliza Myamba is attending the small primary school in the village. She goes to school three days a week, when she is not too busy assisting her mother and father at the maize field or with the maize grinding at the hut. Her day starts with water fetching at the river bank 4 kilometres away. Eliza usually relief herself on the way to the river, or at the defecation area near the maize field. Eliza is getting more aware of her sexuality and public decency which affects her daily routine by postponing her defecation until the areas are less populated.



Primary routine:
Eliza usually defecates in the morning on her way down to the river for water. Sometimes she waits until she is at the river bank so she can clean herself with water after defecating. Normally she uses leaves or small branches she finds near the pathway to the river. It is also easier to find a place out of sight near the pathway compared to the open area near the river.
After returning with the water she continues to school. Since there are no toilets at the school she goes to one of the fields nearby designated for defecation. But normally she does not have to go during school hours. Eliza rarely washes her hands after defecation, but her parents tell her to do so before dinner. If she needs to go later she uses the field behind the hut like her mother and father. Eliza has been into the larger village with her father. She does not use the latrines there; not only because of the before mentioned repulsive condition of the latrines but also in fear of falling down the hole when squatting over it.

Secondary routine:
On other days Eliza has to assist her father in the maize field instead of attending school. On these occasions she usually does not have to go to the river for water and therefore she needs to finds a different place to defecate. She then follows her father's example and uses the area near the maize field and uses a maize leaf as toilet paper.

PROBLEMS MAPPED THROUGH THE PERSONAS

OPEN DEFECATION

The main problem within the village is the contamination of their surroundings and transmission of disease from their contact with human faeces.

PRIVACY

Like in most cultures around the world it is a private matter to defecate. People are usually not that shy when it comes to urinating with others, but defecation is a completely different matter.
Cleaning themselves afterwards:
The inhabitants in the village have problems finding stones, branches, leaves or other things to clean themselves with after defecating, along with the fact that these materials do not feel very nice against the skin.

HAND HYGIENE

Water is a scarce resource in most part of the Sub-Saharan Africa and people often have to travel long distances to gather enough water for their daily usage for cooking and drinking. This also limits the usage of water for washing hands after defecation to a minimum. Another factor is that the defecation is taking place in several designated places around the village which requires installation and maintenance of more than one washing stations, like the tippy tap initiated by Lifewater International. The tippy is made from an old canister that is punctured to provide a small water jet that conserves water while still being able to wash hands. This problem is more related to the part of the definition of sanitation which concerns personal hygiene and will not be addressed in this project.

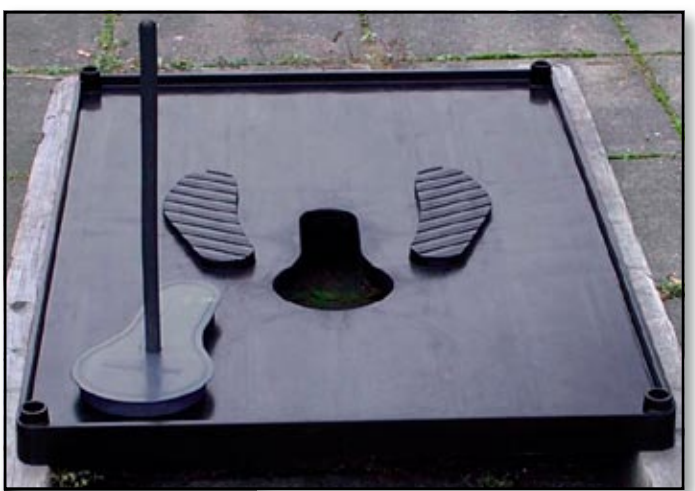
[tippy tap by Lifewater International]

ACCESSIBILITY

The villagers are often on the move; to the river, to their crop fields, herding their livestock or to other villages. The lack of public toilet around the village and along the pathways to the river and other villages promotes the open defecation. A number of public toilets around the village might be enough with the villagers' daily routine of defecating in the morning before starting the day's duties.

CHILD SAFETY

Children using some of the current version of squatting toilets are afraid of falling down the open pit. Even though the holes are not large enough for the children to fall completely down the pit, the children still prefer to use open defecation [Kjær Jensen, 2008].



[Monarflex]

PROBLEMS FROM NEWLY INTRODUCED TOILETS

When introducing toilets to people who are practicing open defecation there are often problems adapting to the more restricted use of a toilet. People bring along their old habits if they are not informed about the new way of defection and the routines that follow, such as using toilet paper and hand washing. The following problems are discovered in literature research and in conversation with Peter Kjær Mackie Jensen, who have experiences of introduction emergency latrines to African in refugee camps.

CLOGGING

The transition from open defecation to toilets can prove difficult if toilet paper or water for cleaning the buttocks is not provided. If not provided with new remedies the users will continue to use their current cleaning tools such as; sticks, stones or corncob. These remedies will eventually clog the toilets and reduce the decomposing process significantly [Nirola, 2008].

TOILET PAPER DISPOSAL

With the introduction of a confinement of human excreta one has to keep in mind the remedies mentioned above. Depending on which toilet technology is selected for the collection of the excreta a separate container for the cleaning remedies most be developed.

HANDLING OF EXCRETA

In most cultures throughout Africa the handling of human excreta and the usage of human excreta for farming food are generally not acceptable. Human waste is seen as waste products, unhealthy, unhygienic and harmful to humans. But it is not possible to generalise in this manner because every social group has a different relationship to excreting that also can vary with; age, sex, religion, class, locality, employment, or education. Another matter is the different relation towards urine compared to faeces. For example in the Kagera area in Tanzania, urine is given to anyone who has inhaled poison as an antidote [Duncker, Matsebe & Moilwa, 2007]. There are also examples around Africa where the usage of human excreta is slowly gaining ground when the users discover the beneficial impacts on crops treated with urine or compost [Morgan, 2007]. Here is shown an example of the usage of urine as fertilizer compare to only using water.

[Water versus urine]

PROBLEM DEFINITION

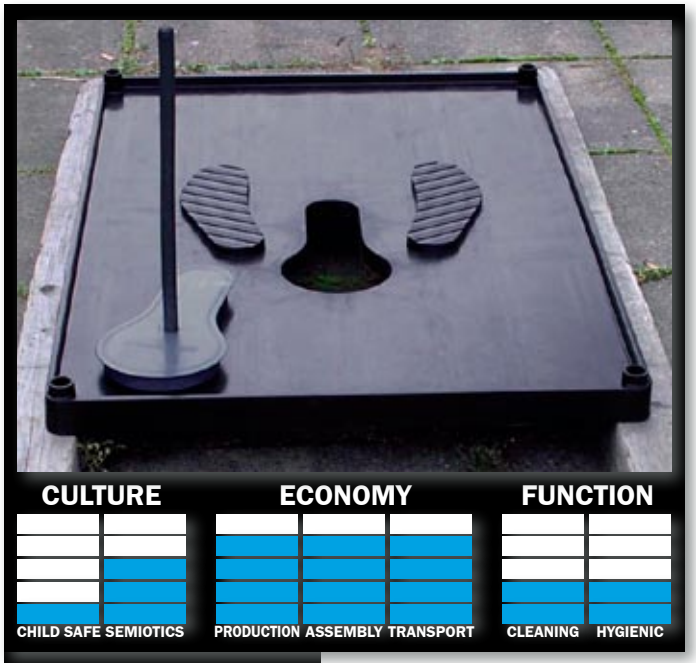
The main problems targeted in this project are going to be the open defecation, child safety and the reuse of human excreta. These problems are focused on the development of the squatting plate and less on the enclosure, hygienic education and disposal of toilet paper. This led to the problem definition;

How can a squatting plate be developed that assists Sub-Saharan rural people in safe disposal of human excreta?

-With focus on cleanliness, child-safety and motivating usage

DESCRIPTION OF CURRENT VERSION

To find out what was on the market that solved a similar problem, I looked at squatting plates for fast instalment during emergencies like natural disasters, refugee camps and other temporary situations. Even though this solution is targeting emergency toilets and this project is focusing on a more permanent solution, it can still be used as a "state of the art" product, since the outcome of this project could, if need be, be used in an emergency situation as well. The squatting plate is very simple, with one hole for both urine and faeces and two shoe-sole-shaped footrests. Additionally a lid can be added to limit the smell from the pit latrine, which is usually the technology, applied in such emergencies. This is properly why consideration to the re-use of the urine and faces is not taken. The simplicity of the squatting plate lowers the cost and makes transportation and cleaning easy. But in concern to cleaning the non-skid surface of the footrests would be difficult to remove any spillage faeces. There are a few drawbacks to the simplicity of the squatting plate. Some smaller children are afraid of using the squatting plate due to the fairly large open hole [Kjær Jensen, 2008]. The children therefore tend to practice open defecation since they are not so concerned about being seen while defecating. The footrest limits the flexibility when placing oneself over the hole before squatting and does not consider people's different levels of flexibility in their legs.



[Score sheet for monarflex]

CHILD SAFETY:
Size of hole, height of foot rests, position of foot rests, balance support.

SEMIOTICS:
Indications on how to be positioned over the hole, shape of foot rests, shape of hole.

PRODUCTION:
Complexity of shape (less complex equals higher score), material selection.

ASSEMBLY:
Skills and tools needed for assembly, level of introduction/size of manual.

TRANSPORTATION:
Size during transportation, durability.

CLEANING:
Fillets and acute angles, liquid directional.

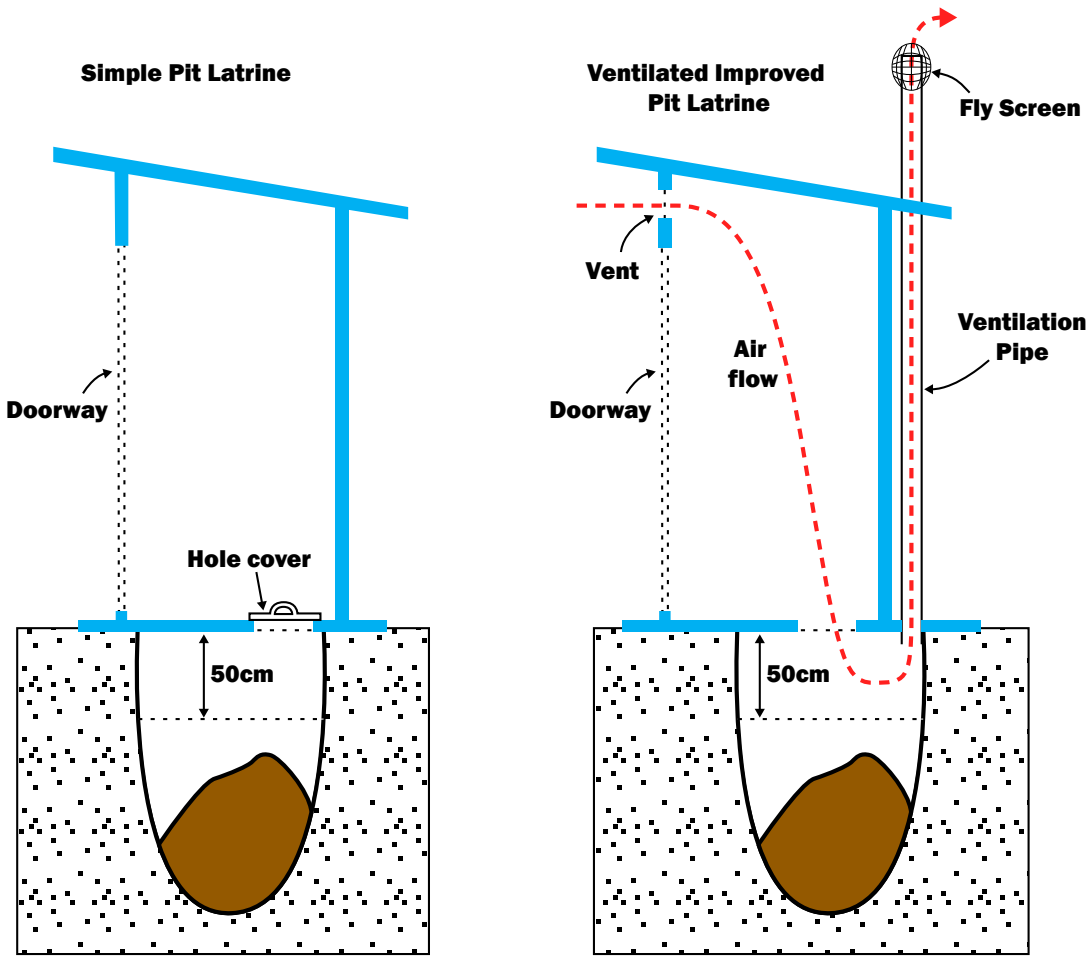
HYGIENIC:
Distance to floor, material, colour, fillets and acute angles.

TOILET TECHNOLOGY

There are different toilet technologies that the squatting plate can be placed on top of. I have looked at waterless systems due to the scarcity of water in the context but also due to the fact that most of these systems are more eco-friendly than the known sewages systems used in the western world.

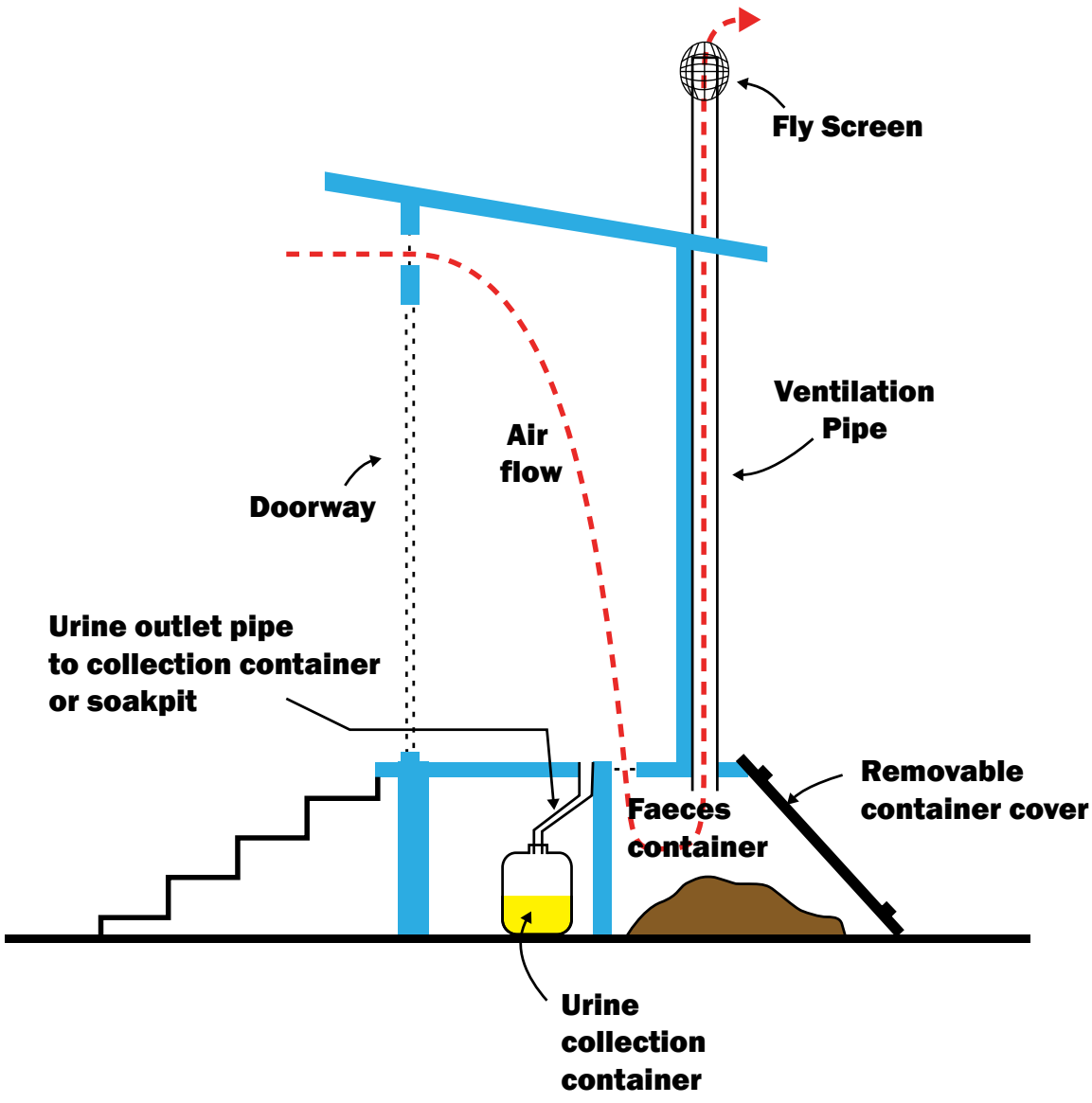
PIT LATRINE

The simplest system is the drop-and-store system of a pit latrine. The excreta is not treated but just hiding under ground. The system is still better than open defecation since it helps break down the transmission cycle of pathogens. But the pit latrines are prone to periodic flooding, causing them to spill their content and contaminate the immediate context. The pathogens can also contaminate the ground water if the hole is dug to deep or near a water source. They are difficult to install on rocky or loose grounds, generally smelly, often infested with flies, and in most parts of the world badly maintained and therefore not assisting in improving the sanitation. The flies and the smell can be limited with the implementation of a vent in the structure [ill ?]. The pit latrine solution should only be used in emergencies, temporarily or if other systems are not possible to implement.



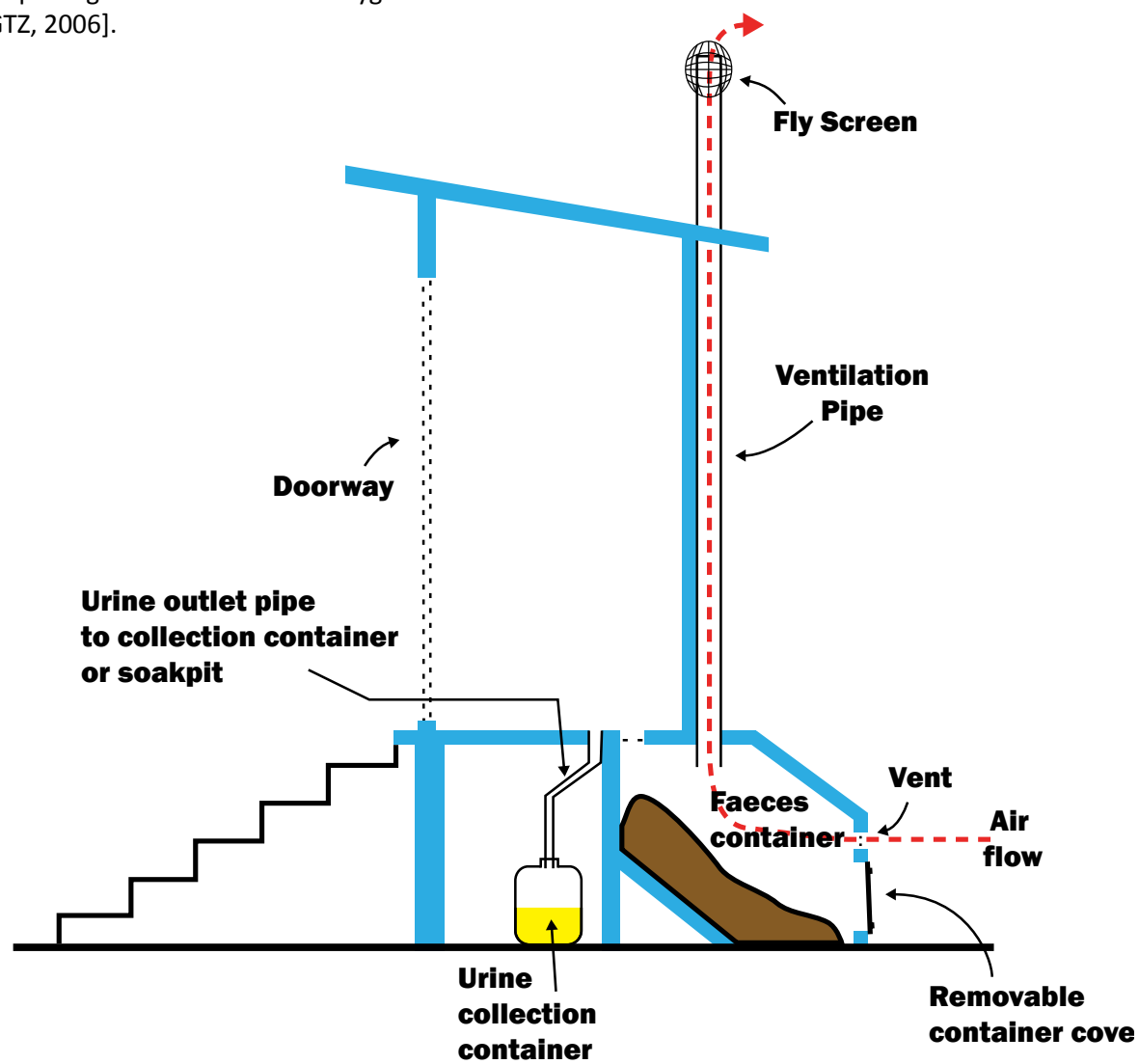
DEHYDRATION TOILET URINE DIVERSION

In a dehydration toilet the excreta is collected in a chamber below the toilet pan where it is dried. Ventilation and high temperature in the chamber are the most important mechanisms during the drying process. Urine diversion is recommended to allow sufficient drying of the faeces. This also allows the usage of the highly nutrient and sterile urine as fertiliser. Absorbents such as; dry earth, ash or lime, should be added after each defecation to accelerate the dehydration of the excreta. These additives also reduce bad odours and flies, plus make it less unsightly for the next user. When the chamber is almost full, it needs to be emptied. The content can be further stored and used as soil conditioner, buried or composted. The dehydration toilet could be expanded with a second vault, so the processing of the excreta can happen on site [GTZ, 2006].



COMPOSTING TOILET

The basic principle of a composting toilet system is the biological degradation of excreta and toilet paper in a specially designed container. Urine is usually collected separately, or in some types of composting toilets collected and treated together with faeces. If the urine is collected separately it can be used immediately. Organic food waste can be added too. Additives are needed to start the degradation process given the fact that human excreta and food waste does not possess the right carbon to nitrogen ratio (C/N ratio). So bulking agents such as; wood or bark chips, saw dust, paper etc. are used to raise the carbon level. Besides the right C/N ratio, the composting process relies on good aeration and the optimal moisture content. The end product of a composting toilet is an odourless stabilized material, which is very valuable as soil conditioner. It can be used for nonfood plants or for agriculture. But further storage and heating might be needed to secure sufficient destruction of pathogens and increase the hygienic conditions [GTZ, 2006].



[Toilet technologies attributes. Derived from appendix 3.]

The most important difference between composting toilets and dehydration is the moisture content of faeces within the vault (around 50% comparing to 25% in dehydration toilet). Composting toilets need organic bulking materials to increase carbon content whereas dehydration toilet can use also other dry absorbents such as ash or dry soil to lower the moisture content. The nutrients in products from composting toilet are on the other hand more readily available to plants than those from dehydration toilet. The selection of which technology to use in this project has been decided with consideration to the level of maintenance, complexity of the process and climate related cons. In all of these criteria the dehydration toilet is the preferred solution. It is not as complex as the composting process and does not need as much looking after to keep the process running. The climate of Sub-Saharan Africa also promotes the dehydration process.

The selection of the dehydration toilet with urine diversion prompts the product to be able to facilitate urine diversion. Even though this is implemented in the product it can still be used for pit latrines or composting toilets depending on the situation in the different contexts within which it is going to be installed. The squatting plate could initially be installed over a pit if the users are not ready for the handling and re-usage of their excreta and later installed on the dehydration technology to benefit the rural people in supplying their crops with fertiliser. In terms of the taboos of handling human excreta the dehydration toilet have another advance with the conversion of the moist and smelly sludge into a dry soil-like substance, which is far from the state of the human excreta from open defecation.

[Outcome from a dehydration toilet where dry soil have been added after each defecation]

SQUAT COMPARED TO SITTING

In the following the choice of squatting compared to sitting is argued. The primary factor is the transition from open defecation to usage of a toilet. Users squat while defecating in the open and the selection of the same method meets the users on their level and eases the change in their toilet behaviours.
When squatting the user is not in contact with the toilet with their private parts which increases the hygienic feel during usage. On the other hand sitting on a toilet might help people dispose of their excreta without missing the toilet.

Another factor that speaks for choosing the squatting position instead of sitting is the physiological benefits of squatting compared to sitting while defecating [see more in appendix 4]

USER MOTIVATION

To introduce the users to toilets the initiatives should not be focused on the health benefits from safe disposal of their excreta but on more apparent benefits such as:

- **Growth of crops** - urine as fertiliser.
- **Expansion of crop fields** - the fields used for open defecation can be utilised for crops or livestock.
- **Convenience** - save the time used for finding a proper place for defecation.
- **Privacy** – an enclosure
- **Cleaner surroundings**.

These benefits are more comprehensible to the rural people than the less apparent connection between diseases and the contaminations from open defecation. It is important not to thrust anything upon those who time after time are expected to want assistance from NGO's on a mission. In most cases the users have enough to do with fetching water and working to survive and do not have the energy or time to participate in education programmes [Sørensen, 2008]. Several examples show that projects decay after some time with misuse and lack of maintenance or no usage at all. There are no clear-cut reasons for these failures but there are some factors constraining stakeholders in participating in the programmes. The constrains mentioned in the follow is mainly from projects concerning improved sanitation:

- **Culture, taboos, habits**
- **Hygiene concerns.**
- **Unfamiliarity.**
- **Fear of loss of comfort.**
- **Unavailability of structural elements.**
- **Economic factors.**

These factors are very different from case to case and very difficult to predict. But with patience, thorough knowledge about culture and customs and involvement of the users in the project, giving them a sense of co-ownership, the projects have greater chance of success. Motivation of the users is the main factor for implementing the urine diversion and child safety into the squatting plate.

Some places around the world where open defecation is common in urban areas, and therefore a greater health risk than in rural area, ecological sanitation has been introduced when the motivating factor of payment for using the toilet. This was also to create awareness of the value of excreta; urine and faeces are so rich in nutrients for farming that they are worth buying [Saniblog, 2008].

[Ecological sanitation toilet in Musiri, India]

AID PRODUCTS

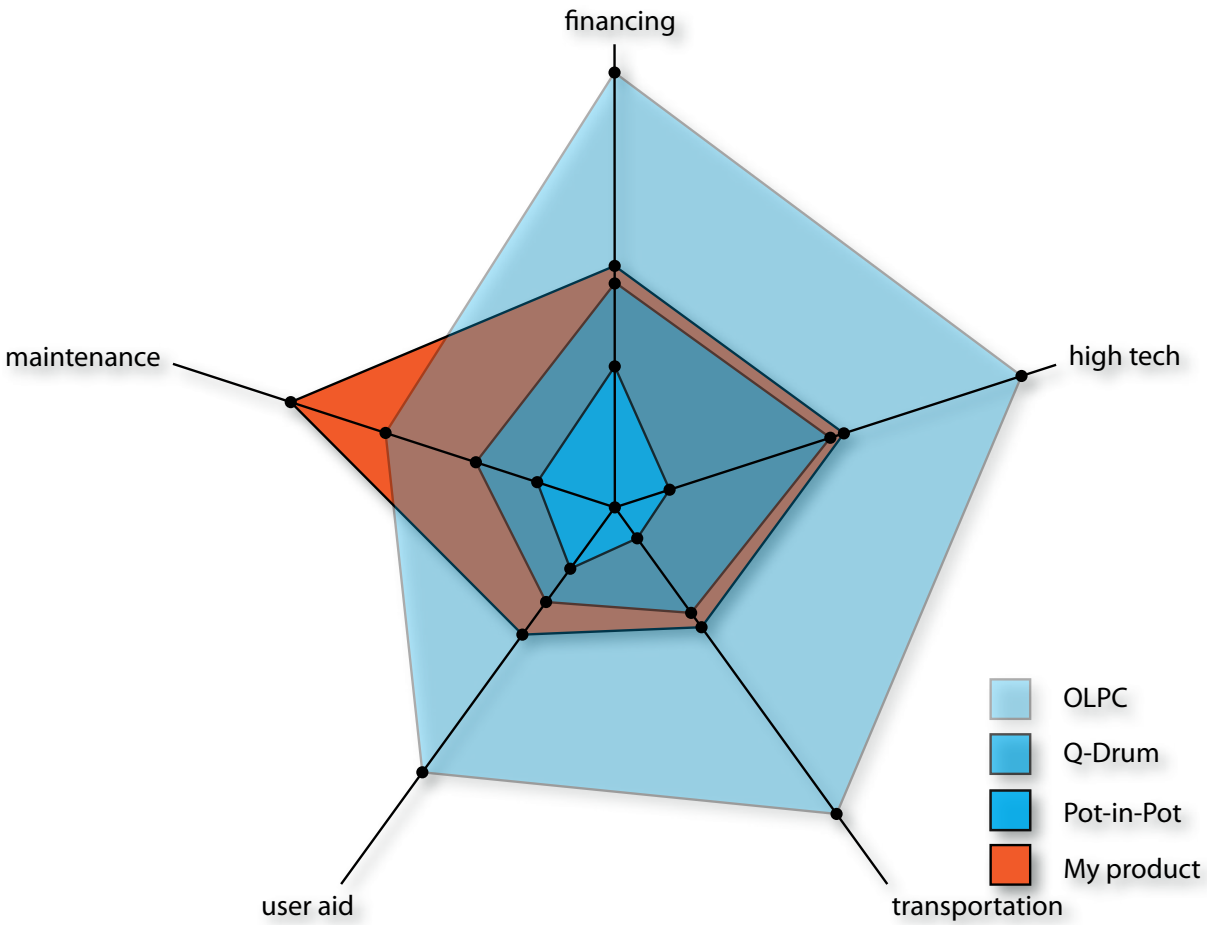
To increase the perception of the products complexity and its level of assistance to its recipients a comparison of three aid products was conducted [appendix 5]. The products represented different segments of the large spectrum of aid products in production today; from the high-tech One Laptop Per Child (OLPC) through the water carrier Q-drum to the make-it-yourself Pot-in-pot cooler.

[One Laptop Per Child]

[Pot-in-Pot Cooler]

[Q-drum]

The complexity of the three products has been assembled in a spider diagram. They are compared in five categories; how much financing that is needed for the product to be (financing), how much technology is embedded in the product (high tech), how far from the end-user the product is produced (transportation), how much introduction is needed for the users to start using the product (user aid), and finally the level of maintenance to keep the product “running”. The goal for my product is added to the diagram to illustrate the forecast for the complexity.

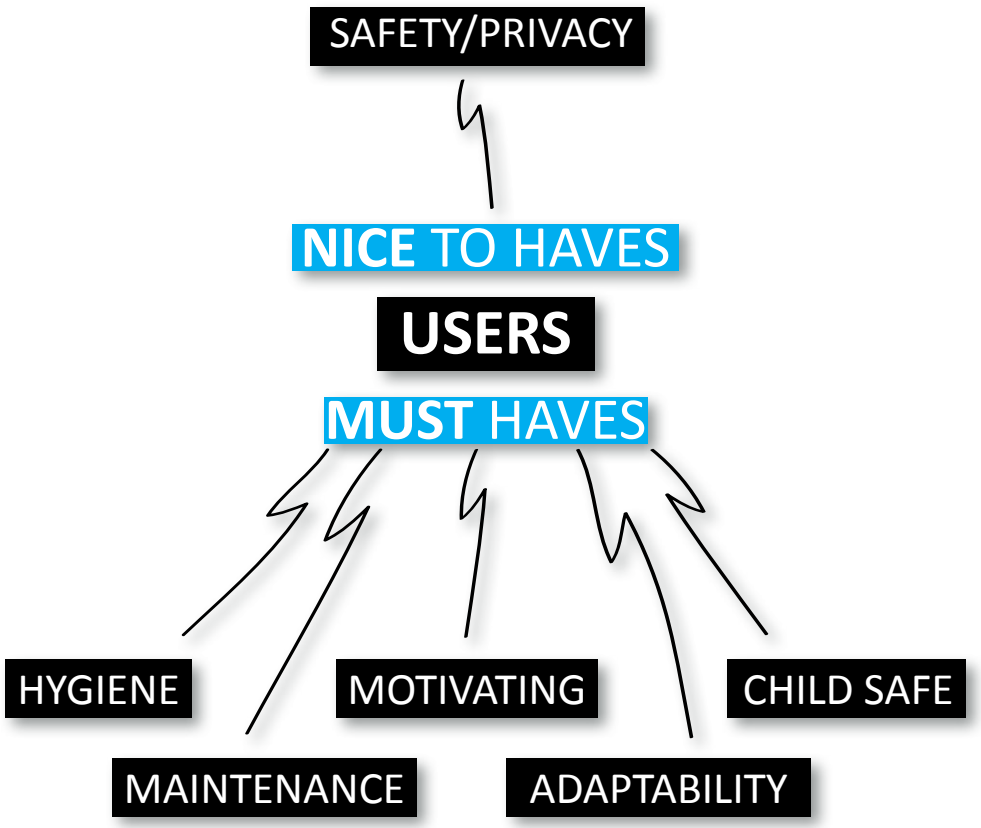


My product is in many ways similar to the Q-drum. The Q-drum does not eliminate the main problem, namely the lack of wells and the access to safe water sources; it on the other hand assists the users in limiting the strain of fetching water several kilometres away from home. In the same way my product is going to give the users a tool to start safe disposal of their excreta, but it does not help them with the other part of improving sanitation; personal hygiene. The OLPC is manufactured in Taiwan and shipped all around the world to developing countries, opposite the Pot-in-pot cooler which is made by local potters or the end-users. The product in this project is going to follow the example of the Q-drum, where production is in the developing country.

The Pot-in-pot cooler is user driven and based on helping the users help themselves where the OLPC is all dependent on contribution from the outside. The Q-drum can be bought for a small amount or donated by the NGOs and need none to very little introduction. My product will need some introduction to users with no toilet experience. The initial introduction of the squatting plate will be financed by NGOs whereas additional plates of replacements should be available at local distributors in villages in connection to the main road. The maintenance of my product is going to be a bit more in comparison to the other products, being an essential part of the everyday usage of the product to clean it after defecating.

DESIGN SPECIFICATION

Through the problem research a list of things that the squatting plate should facilitate were assembled. The product should assist both the end-users and the NGOs implementing the product. The following are the intentions of what the product should do for these stakeholders:



HYGIENE
The squatting plate should assist the users in a hygienic defecation by limiting the chances for misuse and spillage.

MAINTENANCE
Cleaning of the squatting plate should be limited and easy to secure continuous usage of the toilet.

CHILD SAFE
Children should feel more secure and stabile using the new squatting plate compared to the current version.

MOTIVATING
The product should assist the users in safe diversion and reuse of urine to motivate them in the change from open defecation to toilets.

ADAPTABILITY
The product should meet the users on their level to secure an easy transition from open defecation to start using toilets.

SAFETY/PRIVACY
The enclosure should provide the users with privacy and safety.

ECONOMICS

The price of the product should be as affordable as possible without opposing the users' needs. Lower cost equals larger spread of the product. A low-cost product could easier eliminate the need for management from NGOs and having the users buy the product themselves from local distributors, benefitting the economical growth of the society.

PRODUCTION

The production should be kept as low-tech as possible to secure the possibility of local production in as many Sub-Saharan countries as possible to limit the distance from production to implementation. This will benefit the distribution of the product and minimise transportation costs.

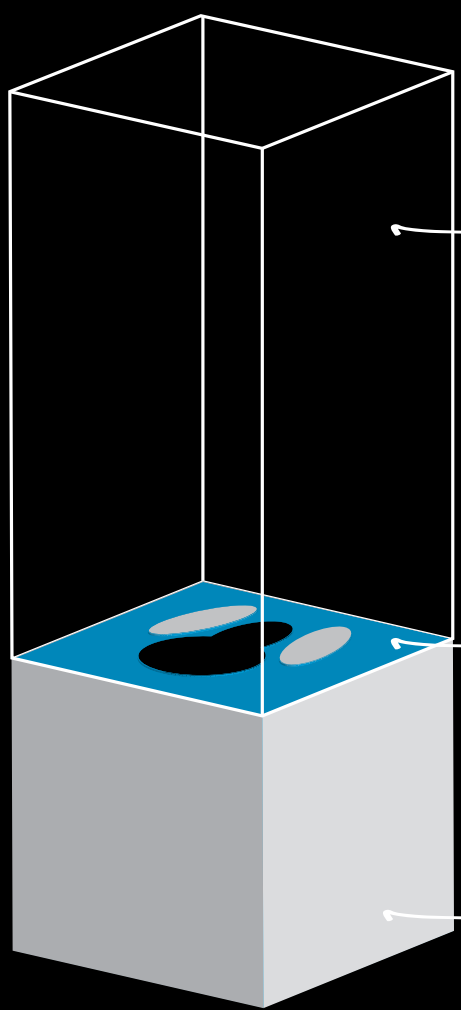
MOTIVATION

The more motivating factors the NGOs can use in the persuasion of the users to start using toilets will ease the transition period. In this case it will be the fertilizing effects of reusing urine.

FOCUS

All the specifications are not going to be equally implemented in the project but some of them are going to be leading in the development. There are also going to be a difference in focus on enclosure, the squatting area and the technology underneath. One of the main focuses which will be addressed, is the area of child safety which is one of the areas where the current version do not meet the demands of the users sufficiently.

This feature along with the obvious ones like hygiene and ease of cleaning will be the main focus when developing the squatting plate. The enclosure and toilet technology play secondary roles in this project as will the features concerning their development. The focus will be on the things that need to be done to best facilitate the squatting plate.



PRIVACY
ASSEMBLY

HYGIENE
CHILD SAFETY
CLEANING
ASSEMBLY
PRODUCTION

TOILET TECHNOLOGY
RE-USING EXCRETA

DELIMITATIONS

The things that should be implemented into the product have now been mapped and in the following some of the areas which are chosen to be worked less thoroughly with.

ECONOMICS

Throughout the project the focus will be on creating a low cost solution to secure the best possible chances for the product to reach its end-users. This will act as a guideline but the final cost analysis will not be thoroughly detailed.

CONTEXT

Though problems of no sanitation in the cities or slums becomes a health risk faster and are more apparent, this project will focus on creating a solution for rural villages in the Sub-Saharan Africa.

USERS

There are some natural limitations in the selection of users. I don't have the opportunity to personal contact the users which prompts a lot of assumptions to be taken. The main focus concerning the users is their positions as rural people and the possibilities they have to safely dispose of or reuse the excrement. In relation to this, handling of human excreta in the majority of African cultures is not accepted. But more and more NGOs are convincing rural society to start benefitting from the nutrients in human excreta, especially urine [Duncker, Matsebe & Moilwa, 2007]. And the selection of these users are also made from the fact that only 31% of rural people in the developing countries have access to sanitation [WHO, 2005].

PRODUCTION

The production should be as cost effective as possible but the process of a thorough optimising of the production method is not conducted. The production is only detail on a very general level limited to production method and a rough estimation of the cost.

INSTALLATION

It is desired that the end-users should be able to install and use the product with a minimum of assistance or none. The product should be as self-explanatory as possible. If assistance is needed, the manual or introduction material is not detailed in this project.

TOILET ENCLOSURE

Initially the toilet enclosure building will only be considered on a very conceptual level due to several factors. The main factor is the time span of this project but the toilet building is on the other hand not the main problem when improving the sanitation situation.

IMPROVED PERSONAL HYGIENE

In this project I will focus on solving the problem of safe disposal of excreta and not on improved personal hygiene which is more an educational concern.

DISPOSAL OF TOILET PAPER

There is not going to be developed a solution for the disposal of the users cleaning remedies. This problem could be solved with a simple bucket where the content could be burned when the bucket is full. The ash from the burning could be used as additives after defecation to promote the dehydration process.

PREREQUISITES

For this project to be realized there are a few prerequisites which need to be fulfilled. These prerequisites are on a less tangible level but could be affected by the physically outcome of this project.

USER ACCEPTANCE

The users should have an open mind and be willing to change their behaviour of open defecation, plus the intentions of maintaining the toilet in the years to come. It is usually a task for the NGOs to facilitate the change in people's behaviour through education and pinpointing when people keep practicing open defecation. An example of this is in the "Ten steps to total sanitation" by WaterAid [WaterAid, 2008], where they place flags in faeces near pathways to highlight when some of the inhabitants do not use the newly installed toilets.

[Screenshot from the video: "Ten steps to total sanitation" by WaterAid.org.]

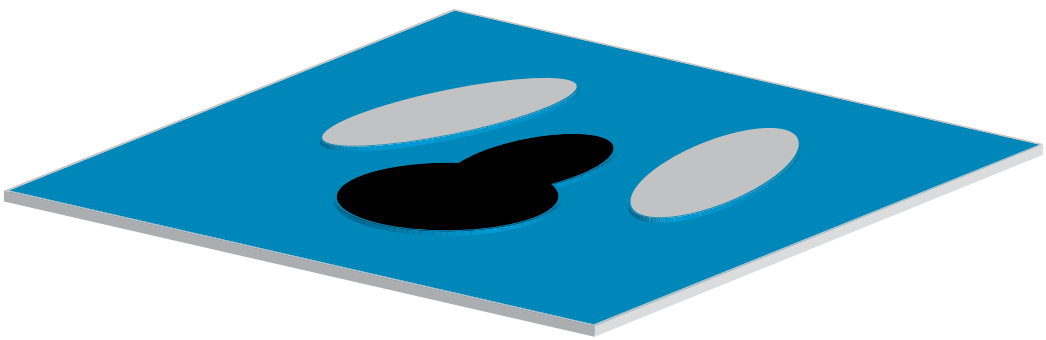
NGOS WILLINGNESS

The NGOs should be able to see the potential in the product in comparison to the usage of homemade squatting plates when installing toilets. The outcome of this project should require less effort during instalment for the users and secure a safe separation of urine and faeces. Additionally, the desired weight is going to be a lot less than the amount of cement needed for an equal homemade product, which is usually the preferred material.

SUMMARY

Before continuing to the description of the product development, a short summery of the frame around the product and the demands for the product will be presented. The frame is an updated concentrate of the initial framework on page 7 while the demands for the product are and extract from the specification and focus.

INITIAL PROBLEM	NO SANITATION
SUB PROBLEM	NO SAFE DISPOSAL OF HUMAN EXCRETA
WHERE	SUB-SAHARAN AFRICA
WHERE more	RURAL VILLAGES WITHOUT TOILETS
ORGANISER	NGO'S - WTO OR WATERAID
PRODUCTION	LOCAL PRODUCTION COMPANY
TRANSPORT	LOCAL FREIGHT COMPANY
INSTALLATION	LOCAL WORKERS
PRODUCT CONTEXT	TOILET BUILDING
PRODUCT	SQUATTING AREA



- **CHILD SAFE**
- **EASY TO CLEAN - SIMPLE AND SMOOTH SURFACE**
- **LOW COST AND LOW TECH PRODUCTION**
- **PROMOTE REUSE OF URINE**
- **SECURE SAFE DIVERSION OF URINE**
- **PROMOTE RIGHT USAGE TO AVOID SPILLAGE**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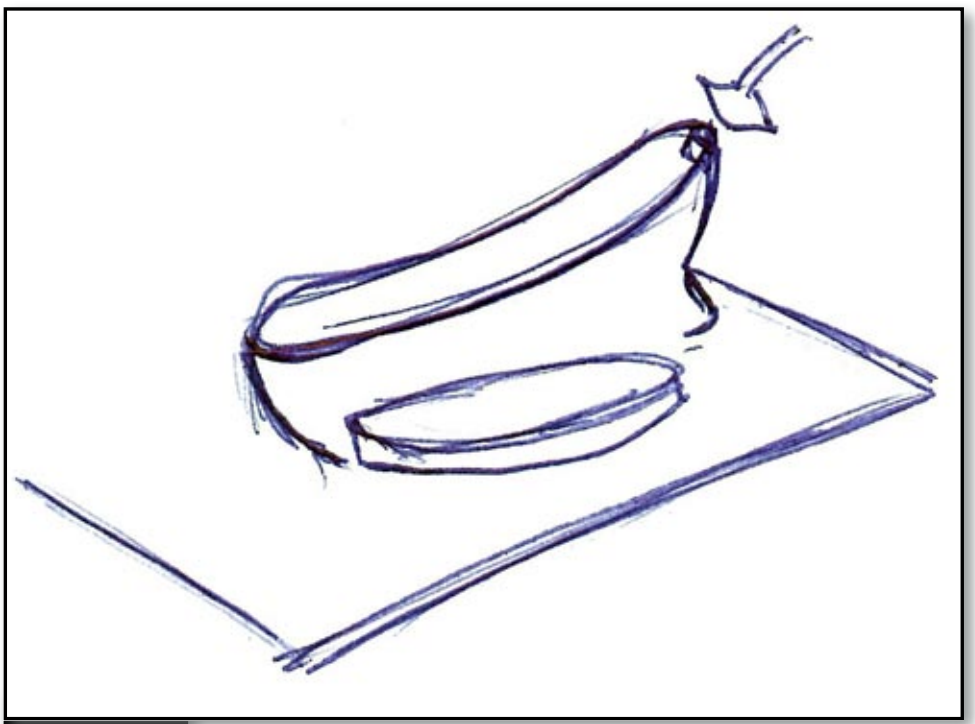
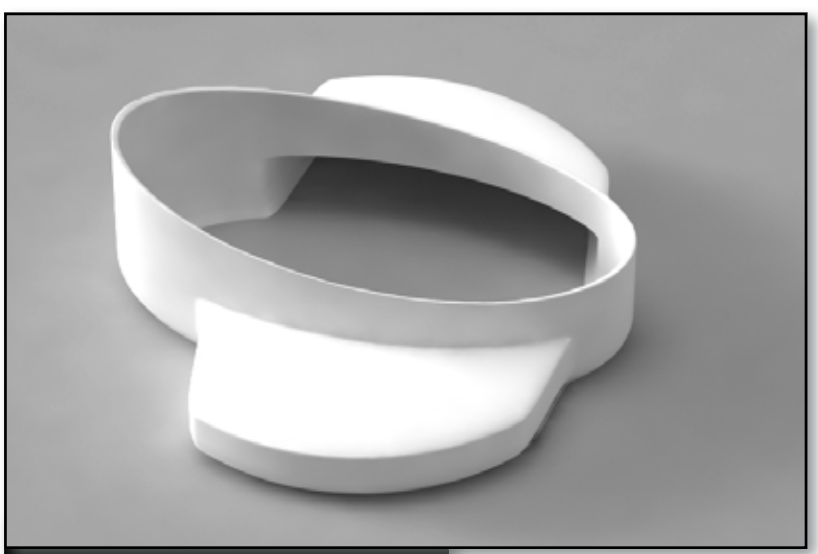
FROM IDEA TO CONCEPT

PROCESS INTRODUCTION

With the main research in place it was now time to develop ideas that would solve the problems at hand. Before staring the idea generation a small investigation [appendix 6] on the current versions of waterless squatting toilets were conducted to get an idea of what I was up against.
The iterations of different ideas usually started with an simple sketch with explaining comments. If I found the idea worth considering further the next step was a simple 3d rendering to better grasp the whole form of the concept.



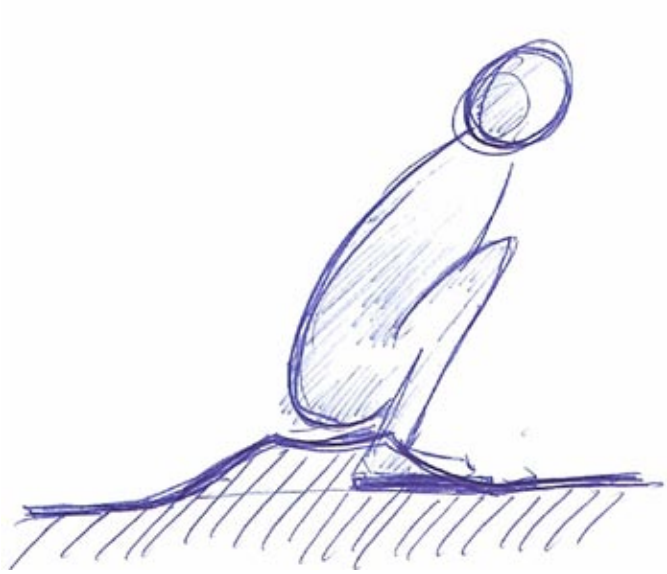
[initial sketch]



[quick 3d model of the initial sketch]

CHILD SAFETY

The point of origin for the product was the existing squatting plates with their hole and footrests or indications of where to stand. But the current footrests did not assist the children in feeling safer while defecation which was one of the main issues to address. Initially several ways of adding support for the children while squatting were tried; backrests, embracing footrests, a railing and a thigh support mechanism.



These were all ideas where the support came in contact with the user which is not desirable in toilets to keep it as hygienic as possible. Instead of assisting the users physically in better stability the idea was to move the hole closer to the user and give them the feeling of support. The shape of the toilet pan should embrace the users while squatting and make them feel more secure while helping them position themselves over the hole without touching the toilet with other than their feet. This idea was tried incorporated into the following development.

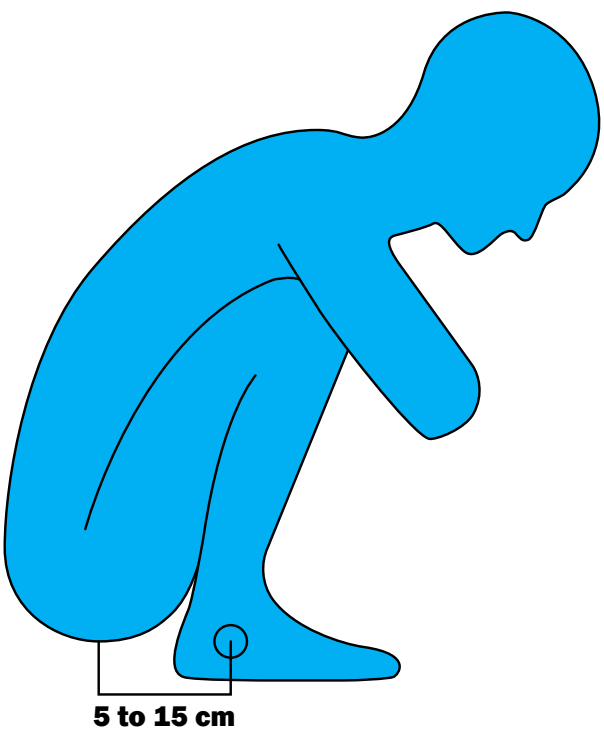
FOOTRESTS

The main task for the footrest is to give the users a more hygienic feel when using the squatting plate. This is done be elevating them above the floor to make sure urine and cleaning water runs off and the users do not have to step in it afterwards. To determine how high the elevation needed to be to secure a feeling of being off the floor level but without getting up so high that it might feel unstable, a few test where conducted.

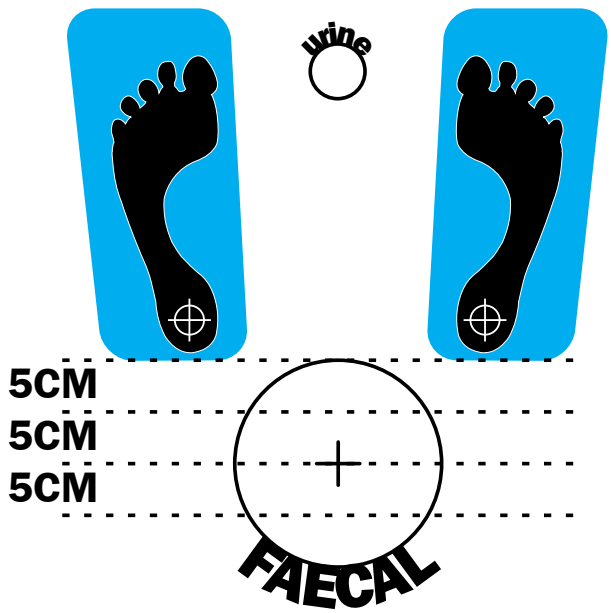
The height was determined to be able to be limited to approximately 2,0cm.

POSITION OF THE HOLE

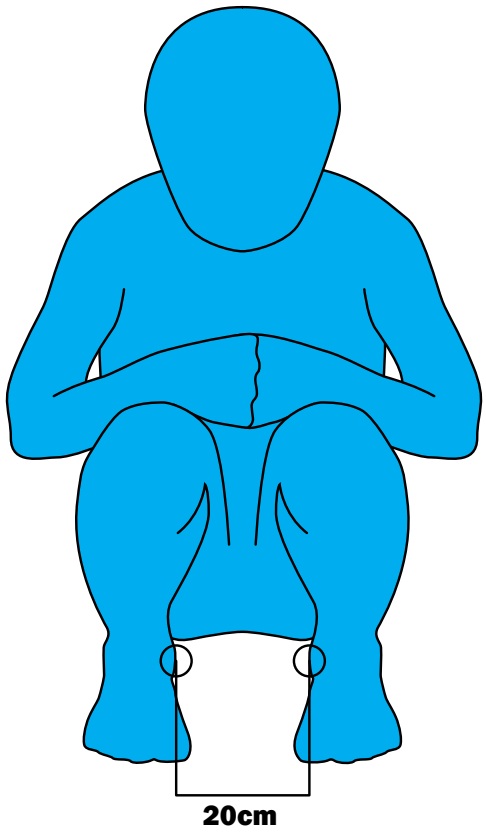
Another main feature of the product is the urine and faecal separation which enables the users to benefit from the fertilizing effects of urine. But since the action of urinating usually happens at the same time as defecation, the risk of contaminating the urine with pathogens from the faecal is high. The idea is therefore to secure safe urine diversion by limiting the chances of defecating where one should urinate. The problem here is getting ones rectum placed correctly over the designated hole before defecating. Before trying to assist the users in correct placement, I had to find out where their rectum where placed when squatting. Observation of the end users could not be conducted which limited the investigation to co-students in all sizes and a rough estimation of distances on pictures found on the internet [appendix 8]. The pictures were the main source of measurements due to the little squatting experience of my co-student and myself, who therefore were not correct representatives for the end-users. But the investigation of my co-students was not completely without results; giving me several insights on squatting from experiences gathered on trekking tours, military training tours, music festivals and travels in developing countries. This brief study showed that the distance from the heel to their rectum ranged from 5cm to 15cm.

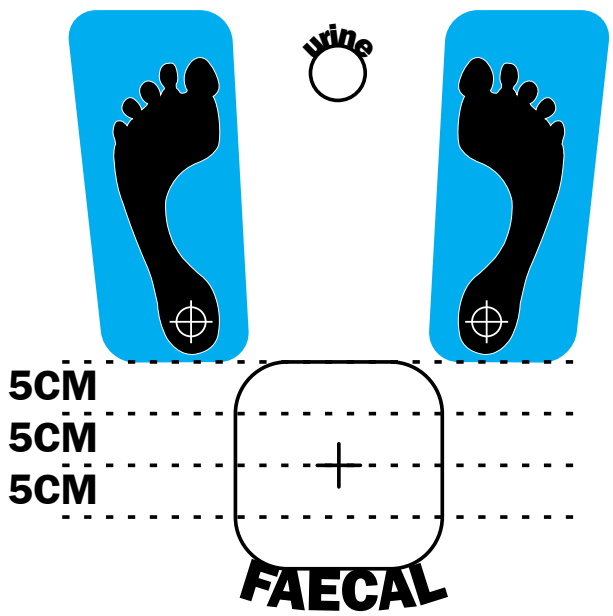


This helped determine the placement of the footrest and the length of the hole on the squatting plate. People always position their rectum behind their heel prompting the position of the footrests to be in front of the hole. The fact that the range was from 5 to 15cm behind the heels made me decide to make the length of the hole 20 cm. The 20cm were chosen to secure a margin of error in both the front and in the back. The front margin would limit the changes of defecating in the urine section and the back margin would assist the users with less agility to be able to squat within the 10cm limit and thereby limiting the chances of spillage on the squatting plate.



The width of the hole was determined from the same investigation of people squatting but this time focusing on the distance in between their heels. Additionally the investigation of the distances on current waterless squatting toilets was also taking into consideration [appendix 6]. The main constrains on the determination of the width of the hole, was considerations to the children not wanting to use squatting toilets in fear of falling down the pit. The hole should be as narrow as possible to facilitate the children to use the toilet and on the other hand the hole should be as wide as possible to limit spillage during defecation. The distance was decided through looking at children squatting in a very relaxed position to secure that they could achieve a balanced position over the hole. The width, as the length, was decided to be 20 cm.

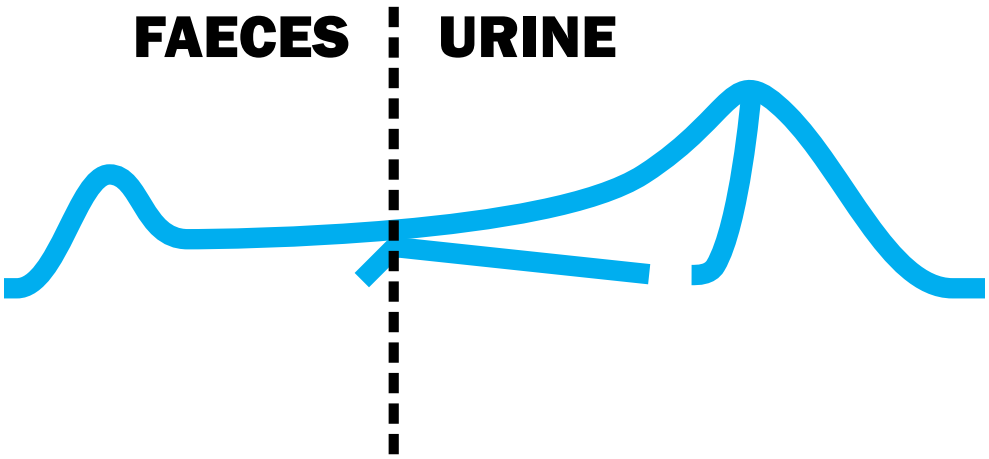




As an extra precaution against spillage; fillets was added at the back of the hole to widen the area of defecation. The hole is decided not to be entirely square to ease the cleaning and avoiding spillage to easier collect in the corners

URINE SLOPE

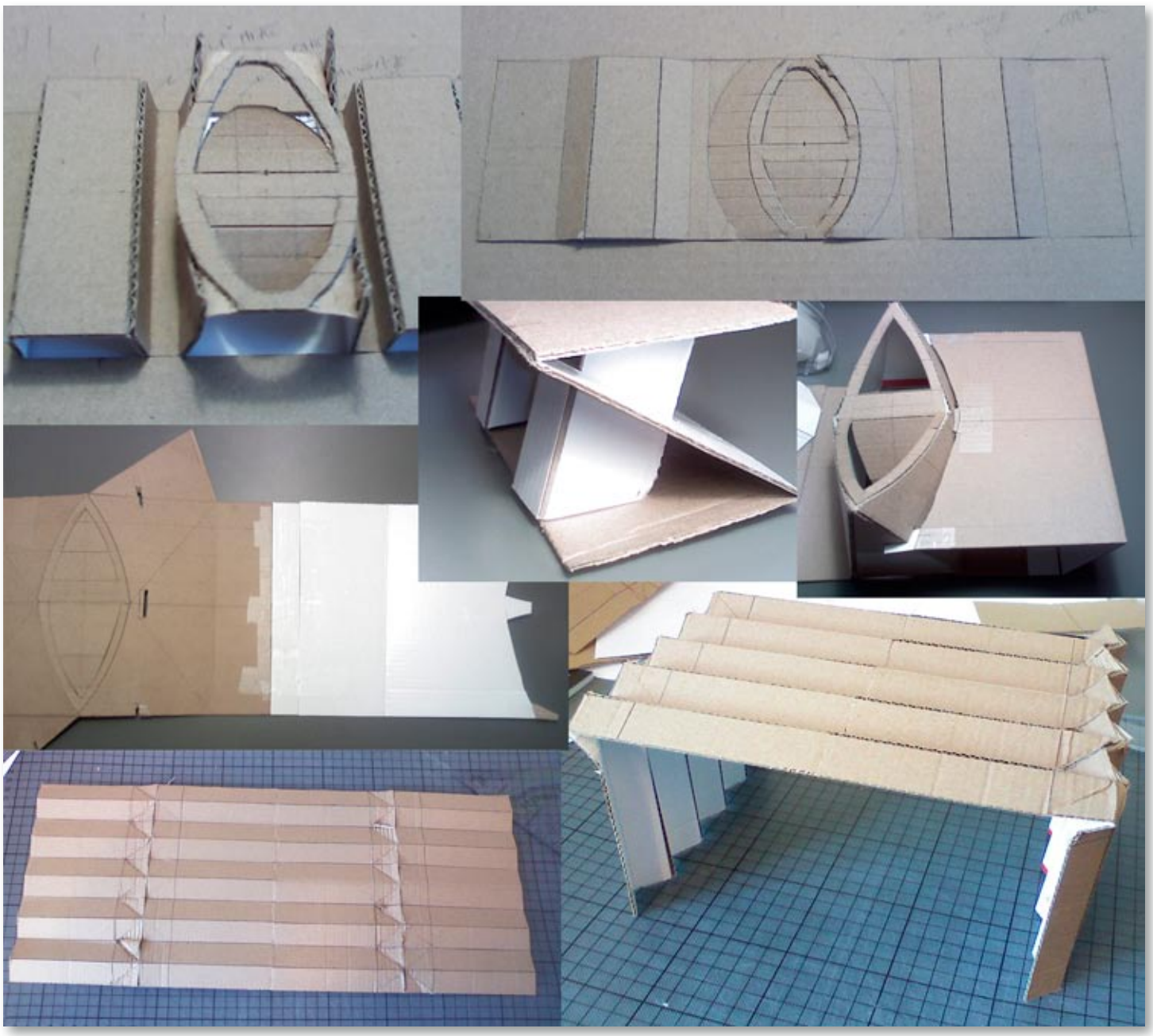
The urine diversion section also had to assist in limiting the risks of defecation in the wrong section. The idea was to make an acute separation of the faecal and the urine section with two opposite slopes. The urine slope was made less acute to make it easier to scrape any faecal that might end on the slope back towards the faecal hole. The opposing slope was very acute and short to guide the faeces that might just be near the peak down the hole. Additionally the shape of the embracing toilet pan prevents the users from placing their rectum too far forward with its rising edges towards the front, which also assist in capturing urine and avoid spillage.



FOLDING

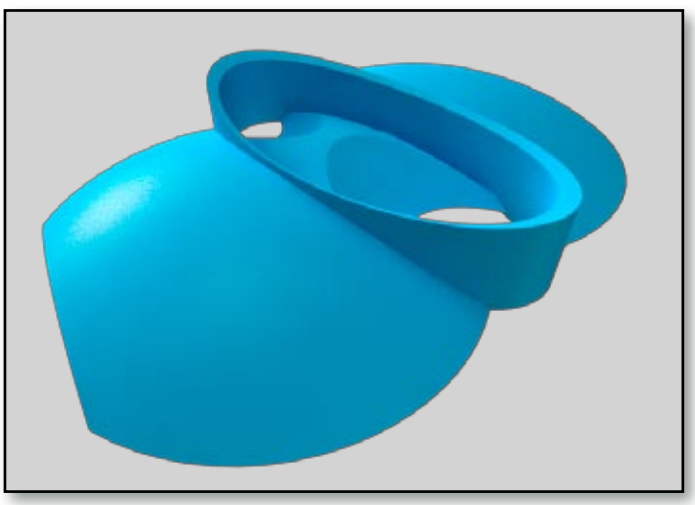
One of the initial ideas was to make the transportation of the squatting plate very easy. The idea was to unfold the squatting plate flat during transportation and fold it back up when at the place of usage. The idea of moving the hole closer to the users were tried to be embodied into a folding principle concurrently with the task of making foldable footrest that would withstand the weight of a person. This idea pursued me for quite a while, probably for its obvious fascinating properties of raising a useful form from something flat. I also tried to work this idea into the enclosure of the toilet; creating a foldable plastic enclosure that could be compared to a solid tent without the usage of peg and strings.

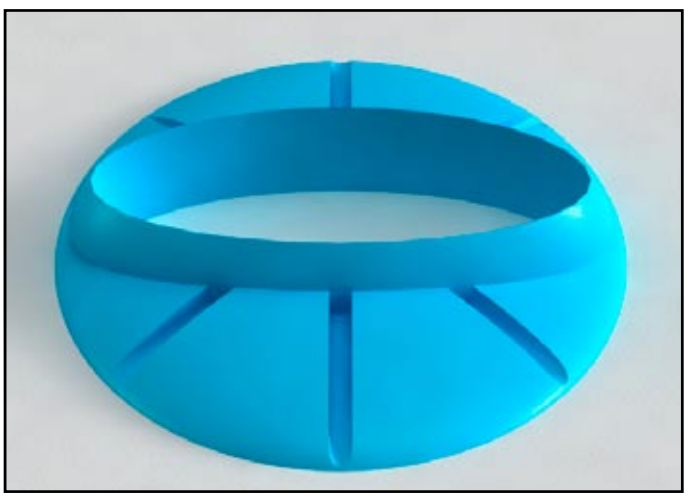
My fascination blocked working on other ways to facilitate the problems for a while. But after stepping back and looking at the concept from a distance I found it to require too much effort during installation and the joints from the assembly might gather spilled excreta. The concept was great for transportation and fascinating during assembly, but would have too many drawbacks during usage which is an essential part of the task at hand.

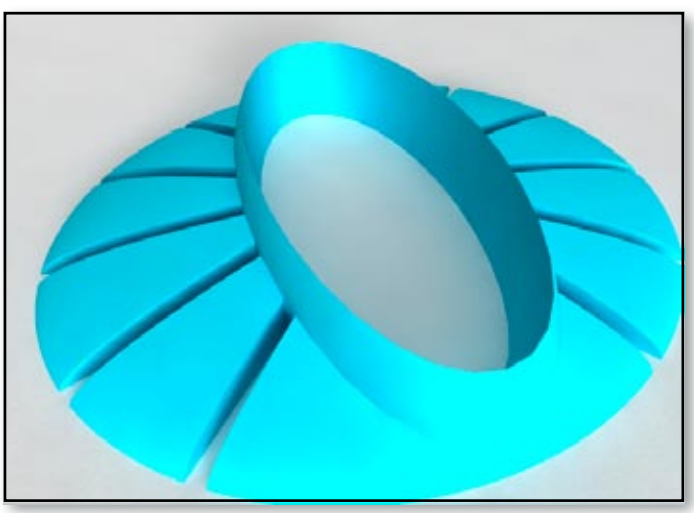


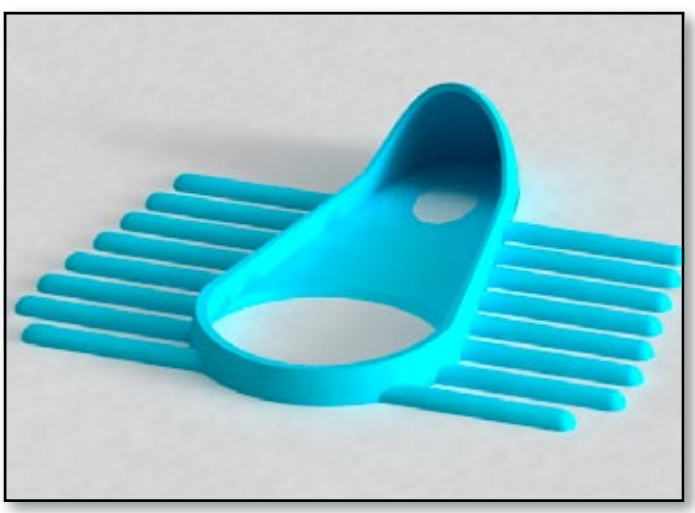
UNIFORM SHAPE

I then turned to concepts with a simpler and smoother surface to facilitate the hygienic and usage parts of the problem. Already here the thought of low cost and simple production were in mind with soft corner requirements both concerning cleaning purposes and to facilitate the use of vacuum forming. The renderings might not all consist of soft edges to save time during 3D sketching but were always kept in mind. It was now decided that the product should consist of a plate, a hole in the middle with urine diversion, a footrest on either side of the hole and an embracing edge around the hole. But I needed a bit more structure to make decisions on how to shape these elements. I therefore started to dissect the product into parts and focused on their individual detailing in the search for some information to set a frame set for the product.









FOOTREST SLOPE

To further assist the users in placing their rectum correctly above the hole an iteration of trying to direct the users with the placement of their heels on the footrest, was initiated. To limit the usage of visual semiotics like colour and pictograms, which might be difficult for me to direct for the users due to cultural difference in perception of these, I decided to try to work with the shape of the footrests. The Monarflex plate has a very strong indication of where the users should position their feet. But I wanted the footrest to be more flexible in the width when the users are positioning their feet to facilitate different levels of agility.

[merged ellipse shaped footrest]

This is a quick 3D rendering where the footrests are three ellipse-shaped volume merged together. This only added flexibility of the angle of the foot and not on the distance between the feet and were not further processed.

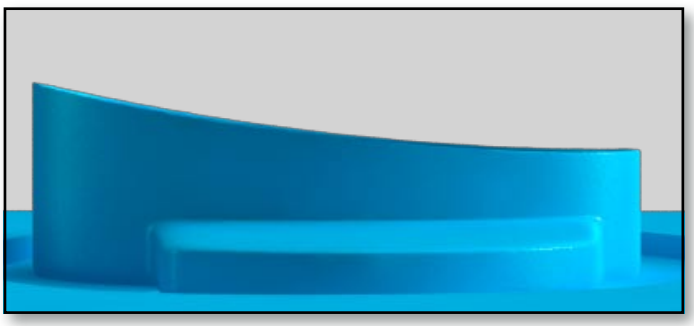
Another more organic attempt was tried. Here the idea was to make a rounded elevation that would follow the round shape of the foot sole and make the users place themselves on the peak of the elevation (see opposite page). This on the other hand lacks a directional guidance to make sure the users positioned themselves turning the right way.

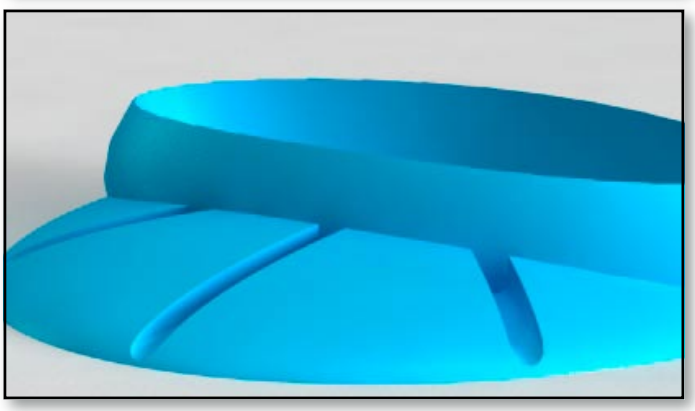
Finally I tried to use a slope to guide the users to the correct position. The footrests now had a horizontal area on top for the heel and a forward slope for the rest of the foot. The slope made it very difficult to squat the wrong way without falling backwards and assisted the users in feeling where the right place to positioning was with their feet. I tried a few different angles through some fast models made from stacked paper, cardboard and plastic [appendix 9]. After this fast iteration of different slopes I found this to be the right solution and I initiated a more thorough investigation in the search of the right amount of slope. This was done with the building of different angled footrests made in wood.

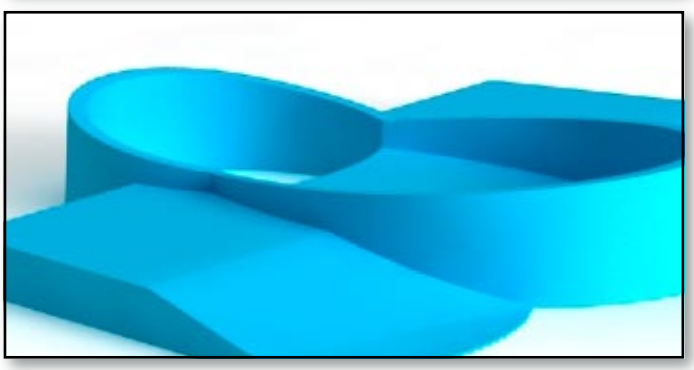
These different angles were tested on some of my fellow students who were asked to try to find the most stabile position on the footrest before squatting down. The angle should not be too acute or too soft so the users cannot feel where to place their feet. The investigation also led to determination of how long the horizontal area for the heel should be. The goal was to limit this space as much as possible to help the users place themselves on the right spot for placing their rectum over the hole. The space was limited to 10cm and the slope was set to fall forward along the following 15cm giving the preferred angle from the testing.

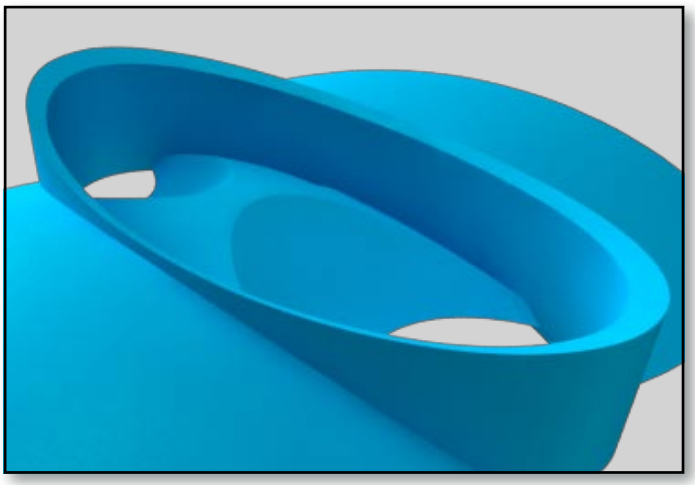
MID SECTION

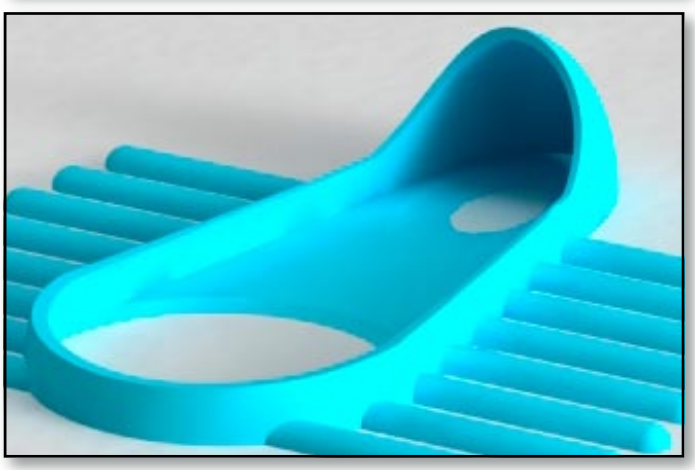
The midsections embracing edges were always seen as soft edges but to save time during modelling these stood sharp. The edges should be soft for several reasons; to be easy to clean and not collect spillage, to seem inviting for the users to squat down upon and not hurt them if they fall and as an additional yield the shape facilitated vacuum forming.
The edges elevates towards the front to help avoid spillage during urination there are also a small elevation at the back to help guide the positioning of the rectum over the hole.











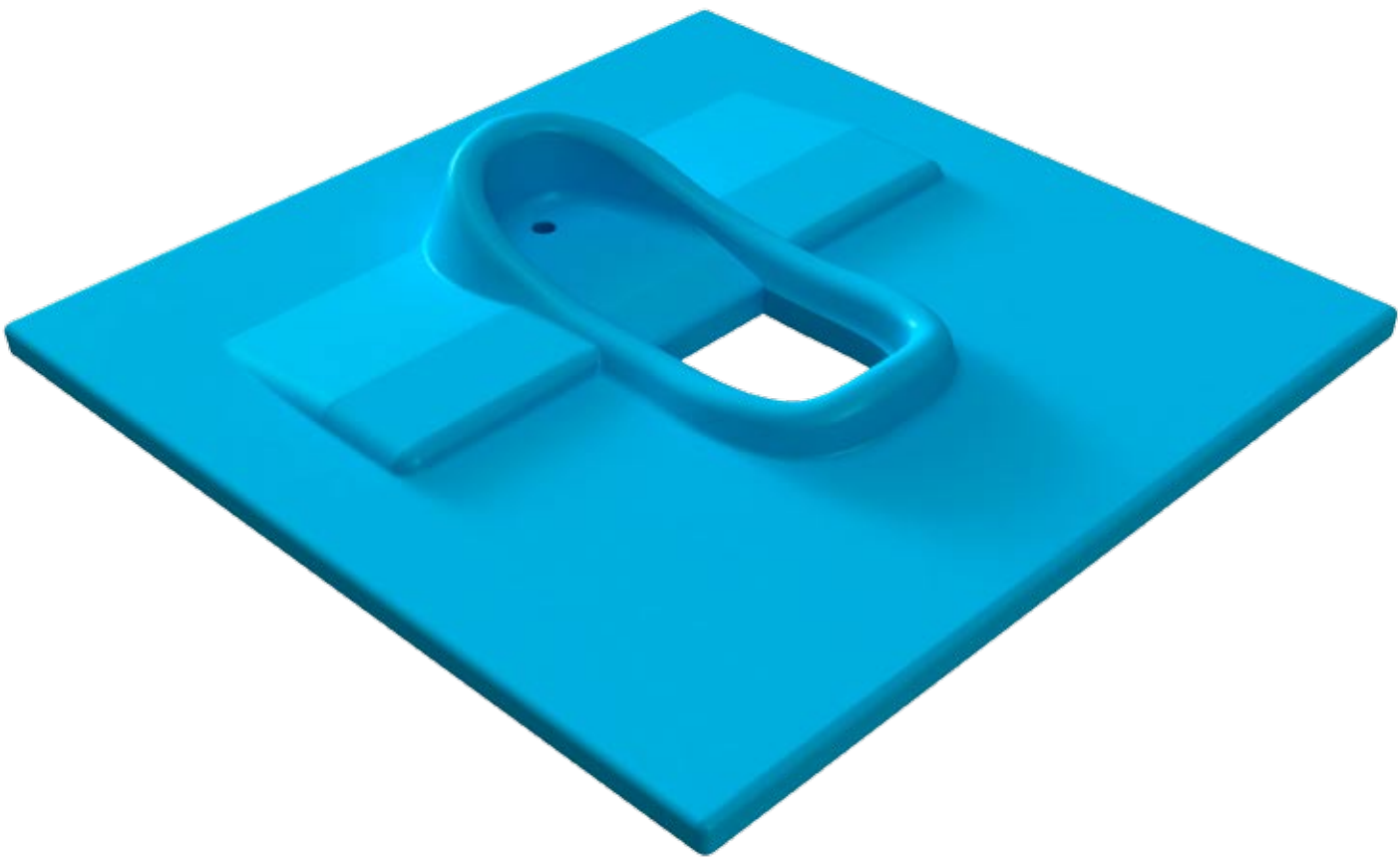
SELECTION OF CONCEPT

The configuration of the concept is now in place and is now ready for further detailing. The plate consists of the following:

DIRECTIONAL FOOTRESTS:
the footrest guides the users in correct positioning over the hole. The slopes help the users face the right way while giving them the experience of overbalancing if placing their toes on the horizontal area instead of their heel. Furthermore, the width of the footrests adds flexibility of usage by enabling less agile people to use the plate as well.

ELEVATED EDGES:
the elevated edges in the mid section helps guide the users to place their rectum in the right spot over the hole and gives children a feeling of the hole being smaller and less frightening.

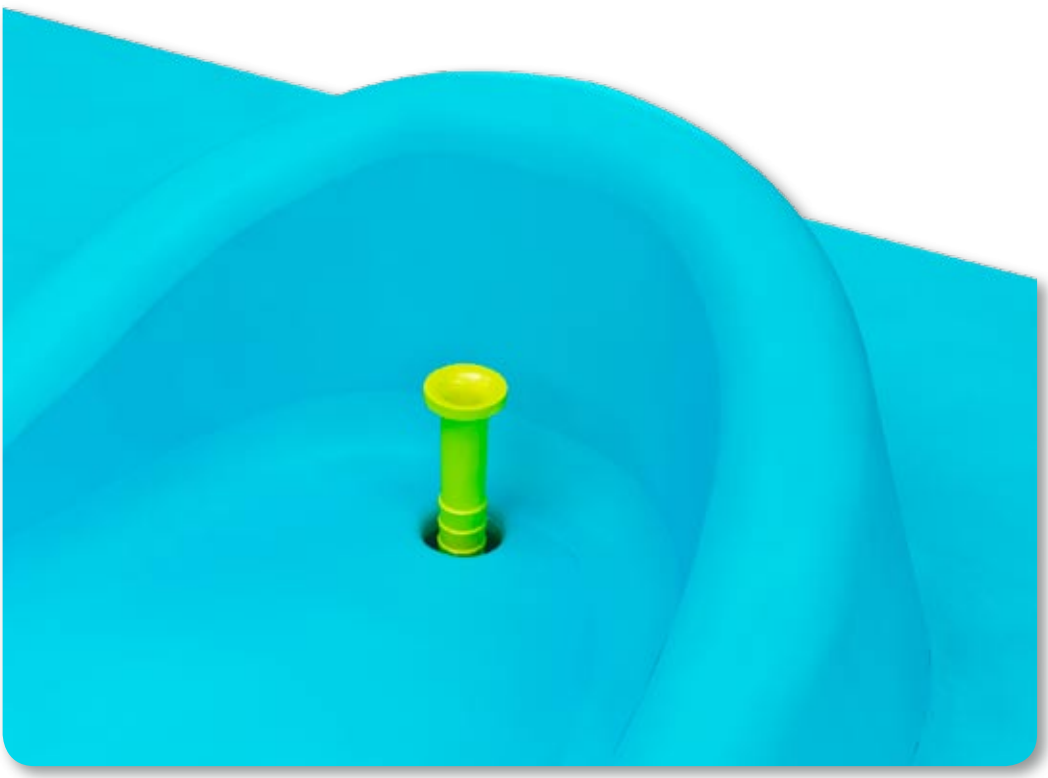
URINE DIVERSION:
the urine diversion will facilitate the use of urine as fertiliser and be the main motivating factor for the NGOs to promote the use of toilets.

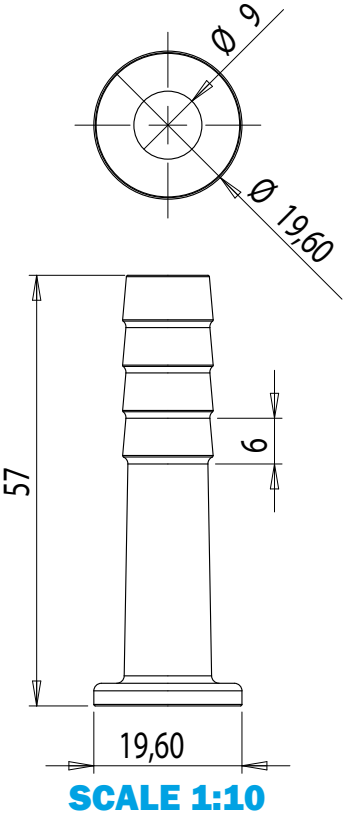


URINE OUTLET FITTING

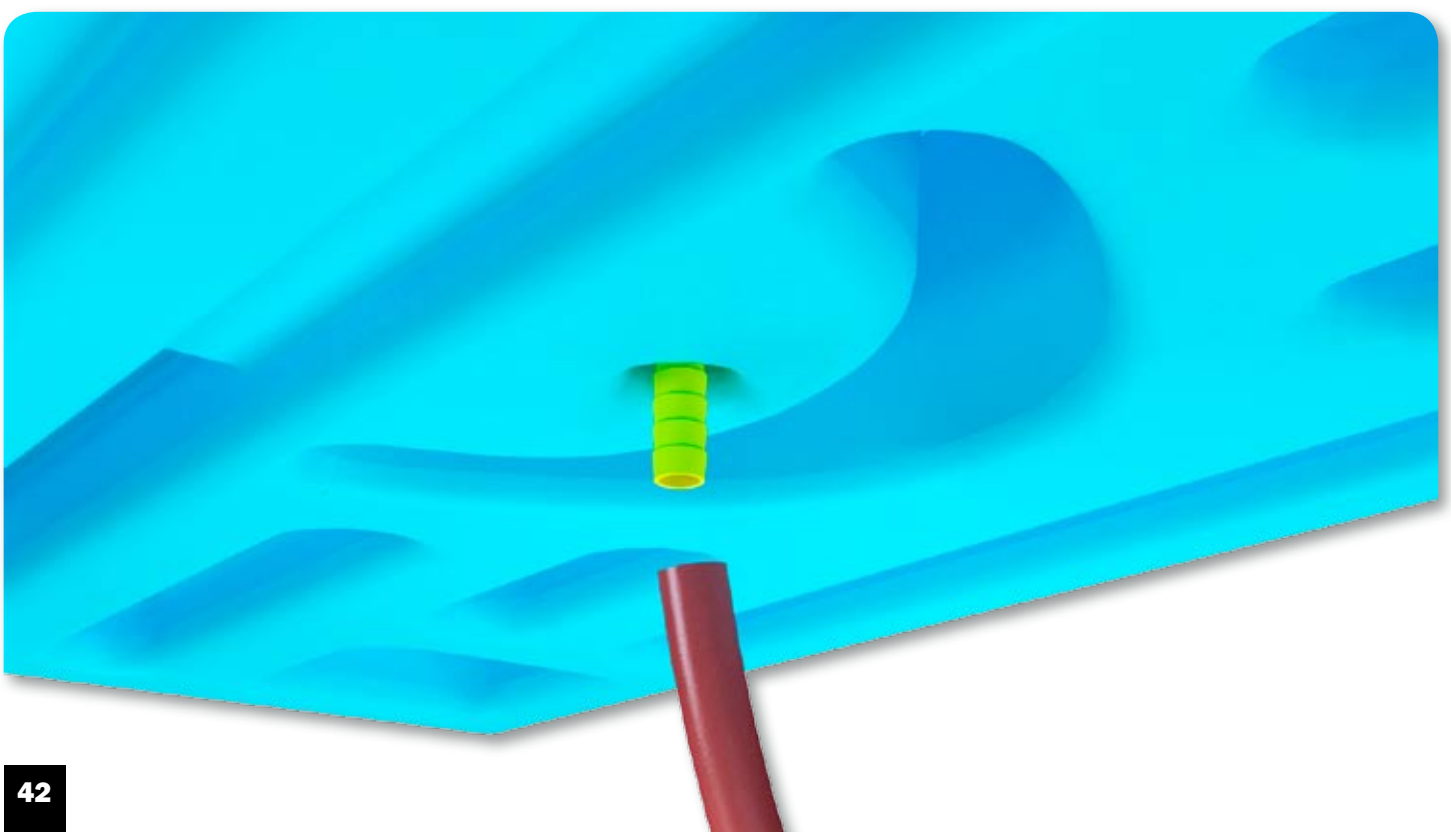
The urine outlet should guide the urine to a container underneath the plate. It is very difficult to incorporate a barbed hose fitting when the production is vacuum forming which requires soft bevels to slip after forming.

Instead I decided to add a separate barbed hose fitting which would fit into the groove at the end of the urine slope. The hose fitting would then be fastened when it is put through the hole and a hose is attached on the other side.





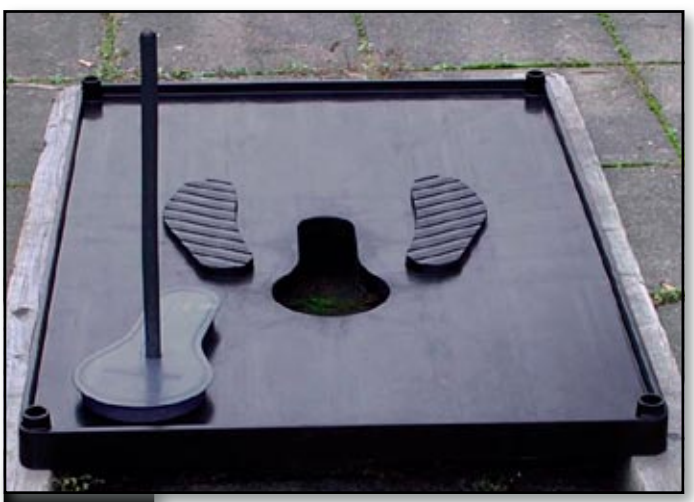
SCALE 1:10



MATERIAL

From the very beginning of the concept development plastic has been the desired material for the squatting plate for its properties concerning cleaning, as well as urine and faecal resistance, production and weight in relation to transport of the product. To further determine which specific plastic type to use; plastics fulfilling the previous mentioned properties were investigated. Polypropylene (PP) was selected mainly for its excellent resistance toward acids, alcohols and bases, but also for its good impact resistance, light weight properties and very low moisture absorption [PlasticDome, 2008].

PP is along with Polyethylene(PE) the building blocks for the plastic industry, making up more than half of the total global production [Thompson, 2007]. This also makes the material very affordable and accessible for production within developing countries. Further validation of the choice of material has been the discovery of the material used in similar product from Monarflex, HSNDS and Sanis.



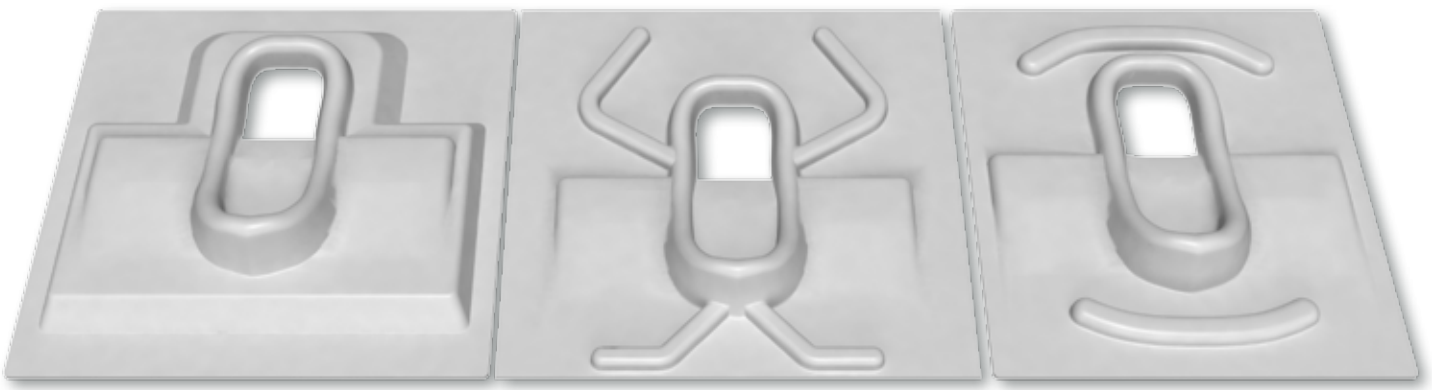
[Monarflex]

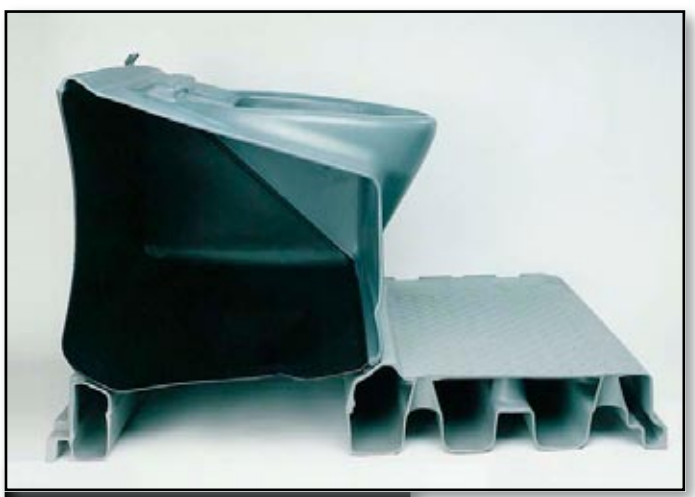
[HSNDS]

[Sanis]

PRODUCTION

To determine how to produce the squatting plate the most influential factors have been financing and complexity of production which is often in tight relation to each other. One of the simplest and low cost production methods in the plastic industry is thermoforming, which consists of vacuum, pressure, plug-assisted and twin sheet forming. Vacuum forming is the simplest and least expensive and provides the foundation for the other thermoforming techniques. Additionally PP is also a widely used material for thermoforming [VINK, 2006]. The simplicity and cost of this method and the knowledge of existing plastic production companies placed in Sub-Saharan Africa [Qdrum, 2002] initially made me decide on vacuum forming which also would facilitate easier transportation due to the stackable properties of products from this production method. SolidWorks and CosmosXpress were then used to estimate the weight and strength of the squatting plate when produced through single sheet vacuum forming. This investigation [appendix 10] quickly clarified that the single sheet vacuum needed a material thickness that would make the plate quite heavy if it should withstand the force from a person. Reinforcements were then tried incorporated in to the shape of the squatting plate to enhance the stiffness without increasing the weight significantly. Some of the reinforcements seem to do the job of strengthening the plate enough to limit the displacement, but I found the reinforcement to disturb the simplicity of the form which might complicate the usage of the plate.



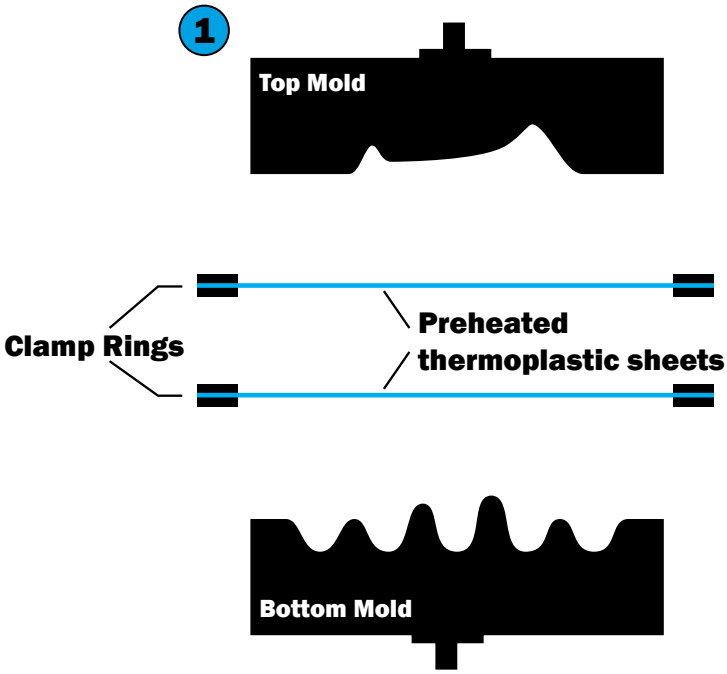


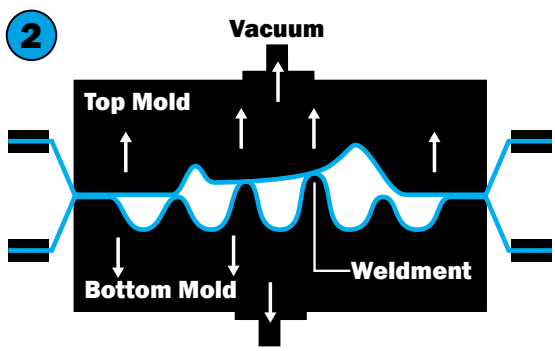
[Twin sheet formed portable toilet]

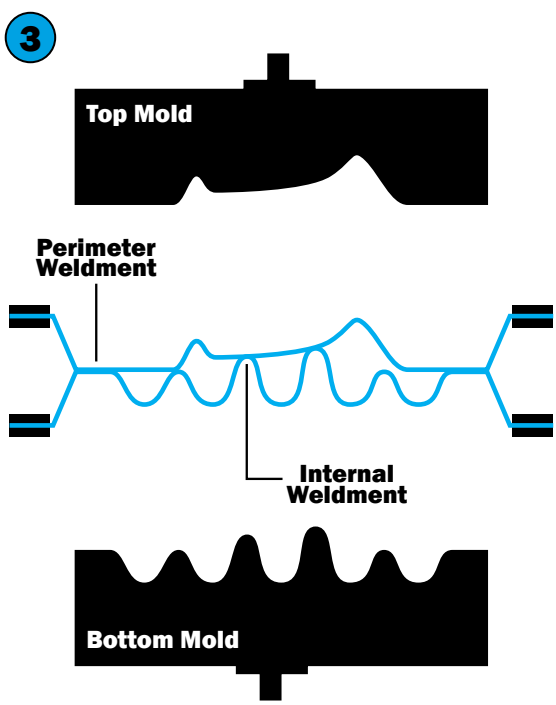
I therefore decided to look into one of the other thermoforming techniques; twin sheet forming which is a bit more complex than single sheet forming but increases the stiffness significantly and is still a fraction of the cost of injection moulding [Kintz Plastics Inc., 2007]. The advantages with twin sheet forming are the possibilities of formed features on both sides of a hollow body which makes it stronger and stiffer while keeping it light-weight. Additional the cavity can be filled with structural foam to further increase the stiffness. There are some drawbacks from choosing a different production method. The squatting plate is not going to be as stackable as before which will limit the first transportation step from the factory to the larger village. But from the larger village and onwards, where the transportation is going to be on foot or on a bike, the number of units is not going to exceed 5 units (approx 25kg). This compromise is considered an acceptable measure to keep the interacting surface clean of extra features while keeping the weight and complexity of production down.

TWIN SHEET FORMING

The twin sheet forming starts with two sheets getting heated simultaneously to their softening point (PP 143-165˚C) between the top and bottom moulds until they are entirely plasticised. The moulds are then moved toward each other and the vacuum is applied. To assist the air flow of the vacuum, air channels are drilled through the moulds. These channels are placed in grooves and across the tool to extract the air as efficiently as possible. The two sheets are now pressure welded at designated points around the surface [Thompson, 2007].



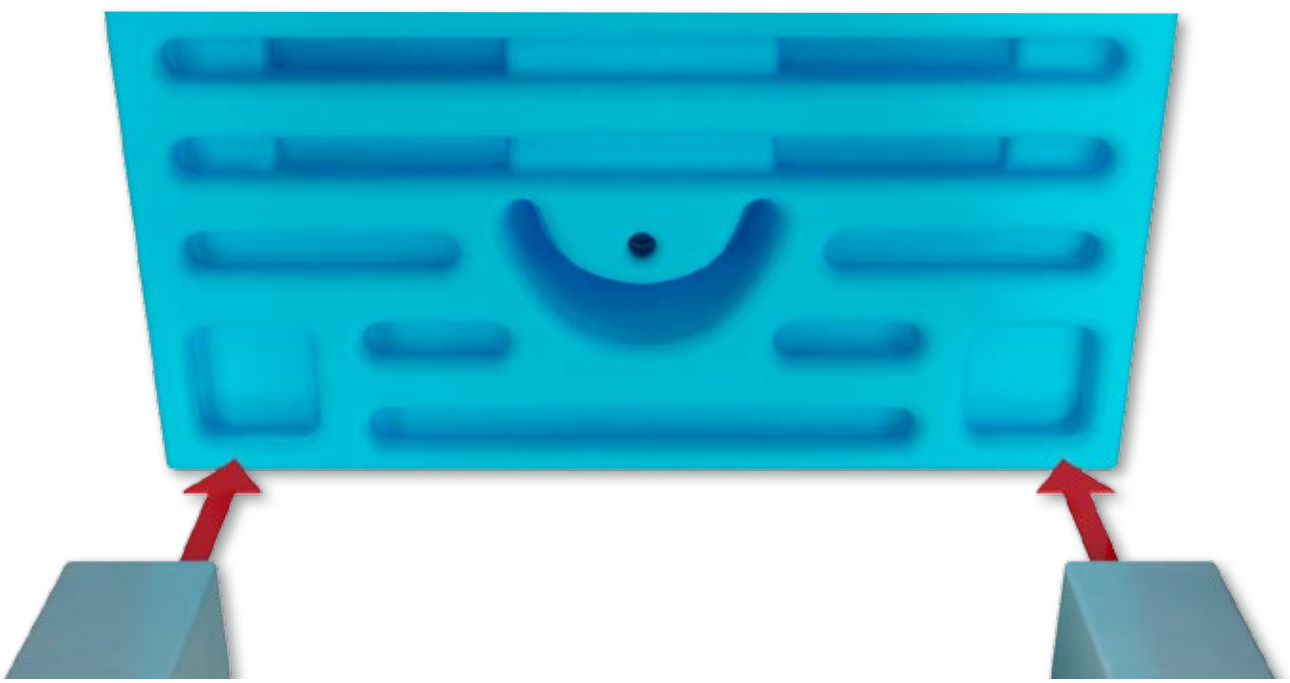




REFINING REINFORCEMENTS

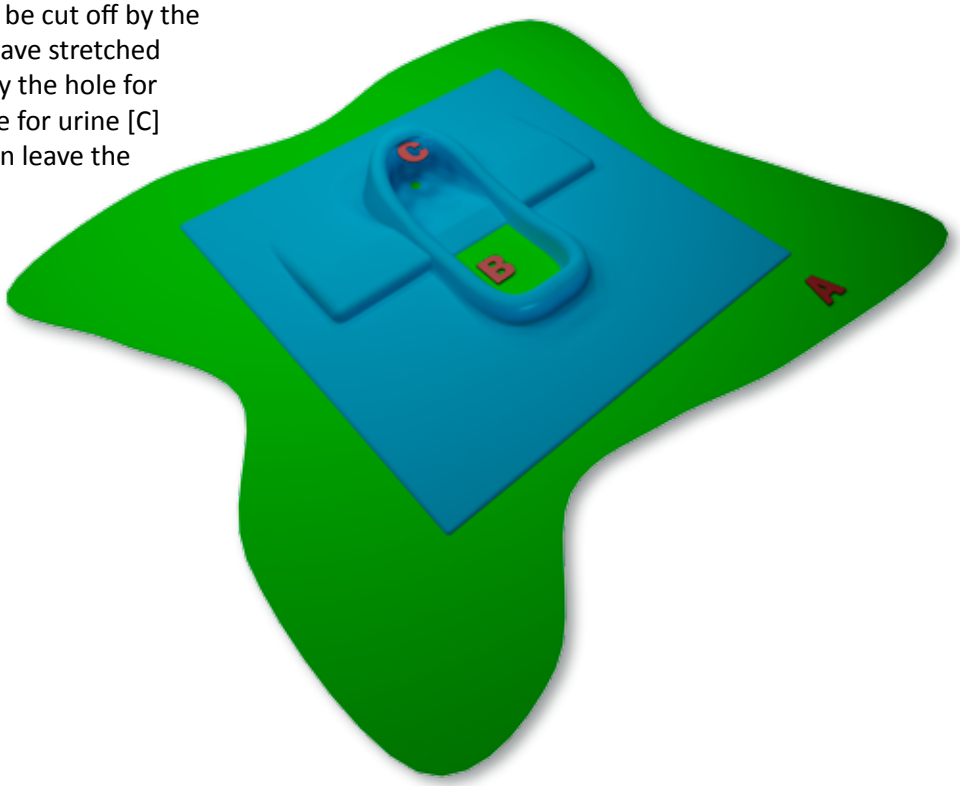
As mentioned earlier, the twin sheet forming process makes it possible to incorporate formed features on both sides of the assembled body. This attribute was used to make the plate more stackable, with the addition of a depression underneath the peak of the elevated edge. This enabled the peak to be inserted into the depression of the plate which is placed above it.

Another feature that is incorporated in the reinforcements is square depressions placed in each corner to facilitate the instalment of the plate. The depressions fit a standard 10x10cm pole which could be used to install the plate with.



FINAL PROCESSING

After the twin sheet forming, the squatting plate needs a bit of processing. The edges[A] needs to be cut off by the perimeter weldment after the forming have stretched the plate and reshaped the edges. Finally the hole for faeces [B] should be cut out and the hole for urine [C] should be drilled out before the plate can leave the factory.



COST ESTIMATION

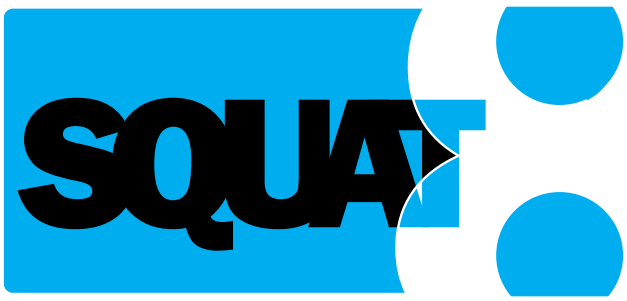
To estimate the price of the squatting plate I looked at products with similar complexity and production method since the existing plate were all injection moulded. The twin sheet pallet is a bit bigger and uses a greater material thickness to withstand the dynamic load of more than a ton, but could still be comparable with the squatting plate. The pallets are like the plate made with reinforcements to make the structure more rigid. Twin sheet pallets range in prices from $13 to $30, depending on size, material thickness, shape and supplier [Knights, 1995]/[Doba, 2001]. Since the squatting plate is smaller and have thinner material thickness it would properly range below the pricing of the twin sheet pallets which approximately would be around $10 to $15. The only price I could find for another squatting plate was through Red Cross which provides a similar plate to the one from Monarflex at $17.33 [ICRC, 2008]. Considering the added value and low-cost production upstart for the squatting plate in this project, it is estimated that it would be very competitive compared to the existing squatting plates. Additionally, a comparison could be made with the Q-drum which surprisingly is more pricy, though it seems less complex. The Q-drum costs $46.25 per unit.

PRODUCT TITLE

In the search for a proper title for the product I listed some of the properties associated with the product:

- Fertiliser
- Hygiene
- Child Safe
- Urine diversion
- Sanitation
- Squatting plate
- Health
- Aid product

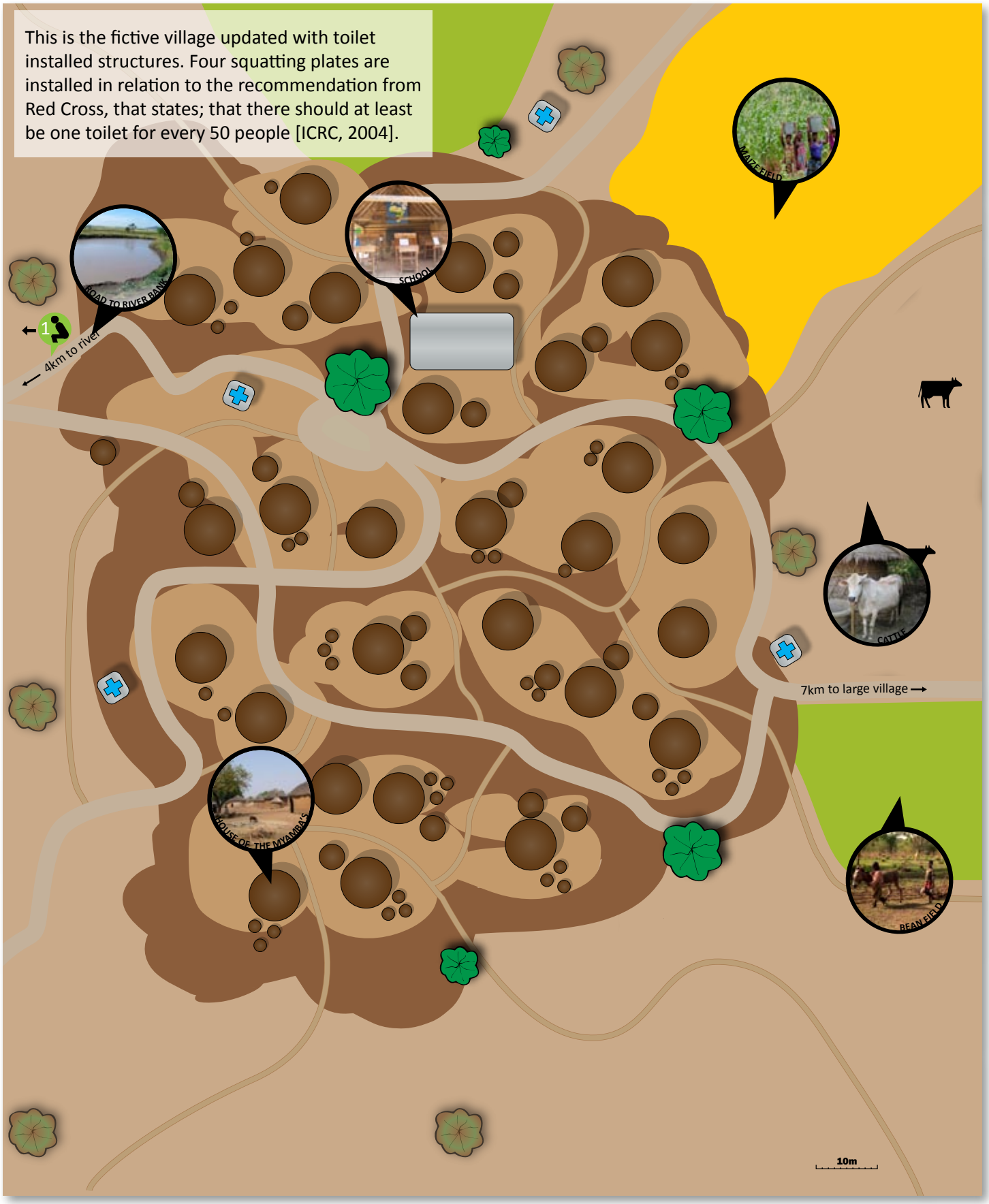
On this page are some of the attempts of making a catchy name which would help describe what it is the product is and what it does. Some of them were focusing on the assistance with collecting fertiliser for the agriculture, like; FERGI and AGRIplate. I decided not to try to incorporate the Child Safety and Urine diversion to avoid the product appearing childish, playful, repulsive or unhygienic. Instead I wanted the name to tell more about the squatting plate, sanitation and aid product. The chosen name is squat8, which is a decoction of squat aid. Eight was chosen instead of aid to appear less intrusive upon the users.



TOILET ENCLOSURE

For a short time I worked with the toilet enclosure along with the folding concepts [appendix 7], but during some further research I found the enclosure to be less important in the transition from open defecation to toilets. There were several examples of home-made enclosures that seemed to work fine, and on second thought there might be some beneficial values in letting the users make their own enclosure. This might result in a larger sense of ownership in the project and seem less intrusive in the villages. So the intention of developing the enclosure were reassessed and found to be redundant in this project both in terms of time and relevance.

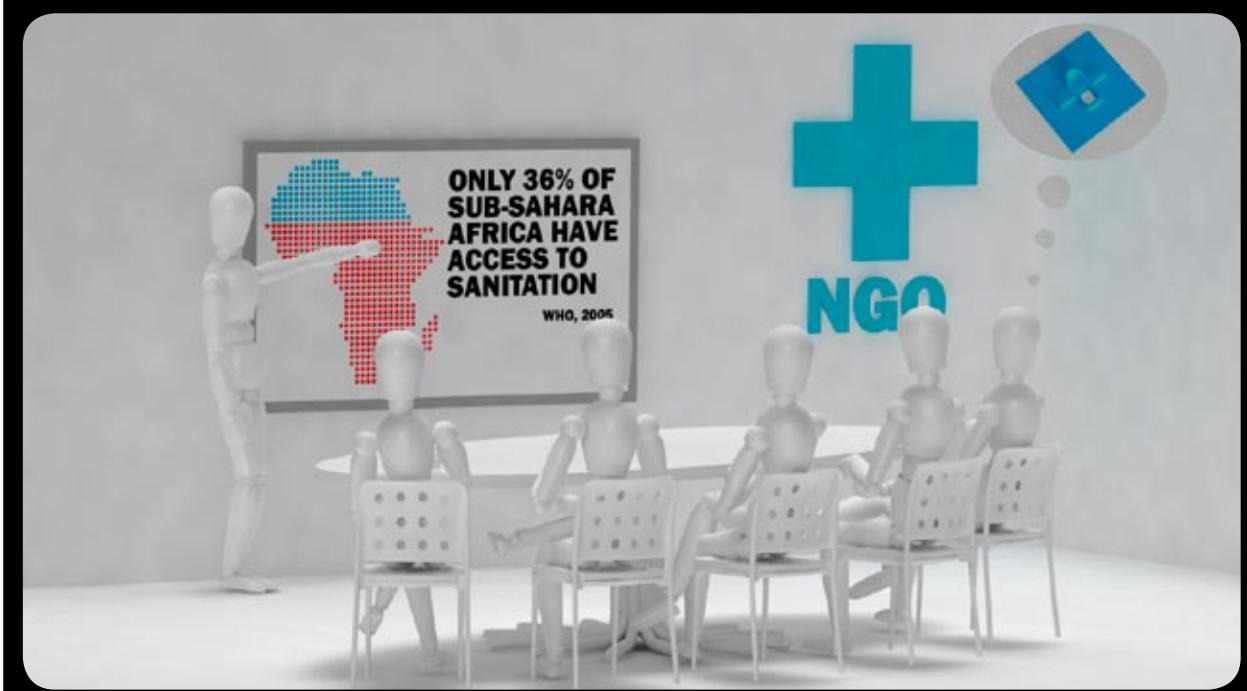
CONTEXT IMPLEMENTATION



PRODUCT SCENARIO

To understand the implementation of the product a scenario of this is presented in the following. The scenario is fairly objective and is not seen from either the users' or the NGO's point of view. A scenario seen from Mekana and his family is displayed in the following product report. In this scenario the squatting plate is on the market and known to the NGO.

NGO MEETING



After research and trips to the target area the NGO decides to initiate the programmes to improve the sanitation. They want to use the newly developed squatting plate and its feature which the previous lacked; intuitive use, child safety, urine division and simple production.

PRODUCTION

The NGO contact a plastic factory near the area where they are going to deploy the squatting plates and make an order for the number of units they need.

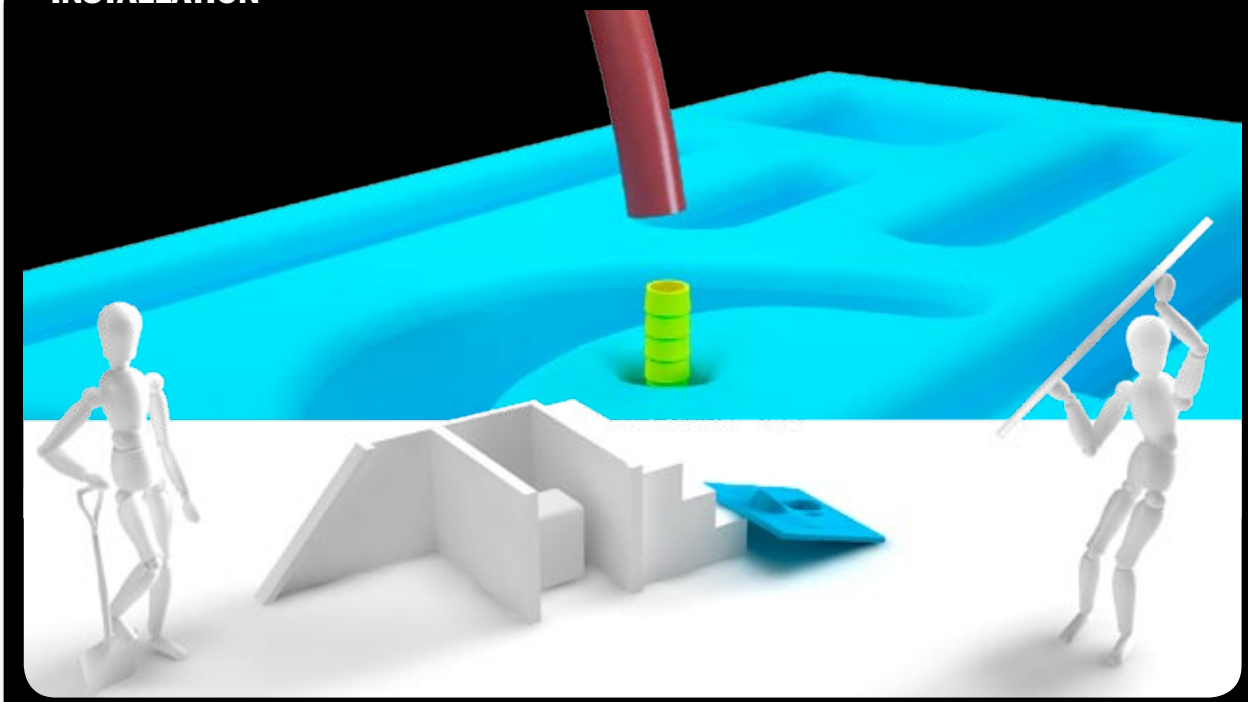
A local freight company freights the squatting plate as close to the designated village as possible.

TRANSPORTATION 1.0

The users and people from the NGO carries the plates the last kilometres out to the village using the means of transportation they have access to.

In the village the NGO educate the villagers in the installation, usage, cleaning and safe reuse of urine.

INSTALLATION

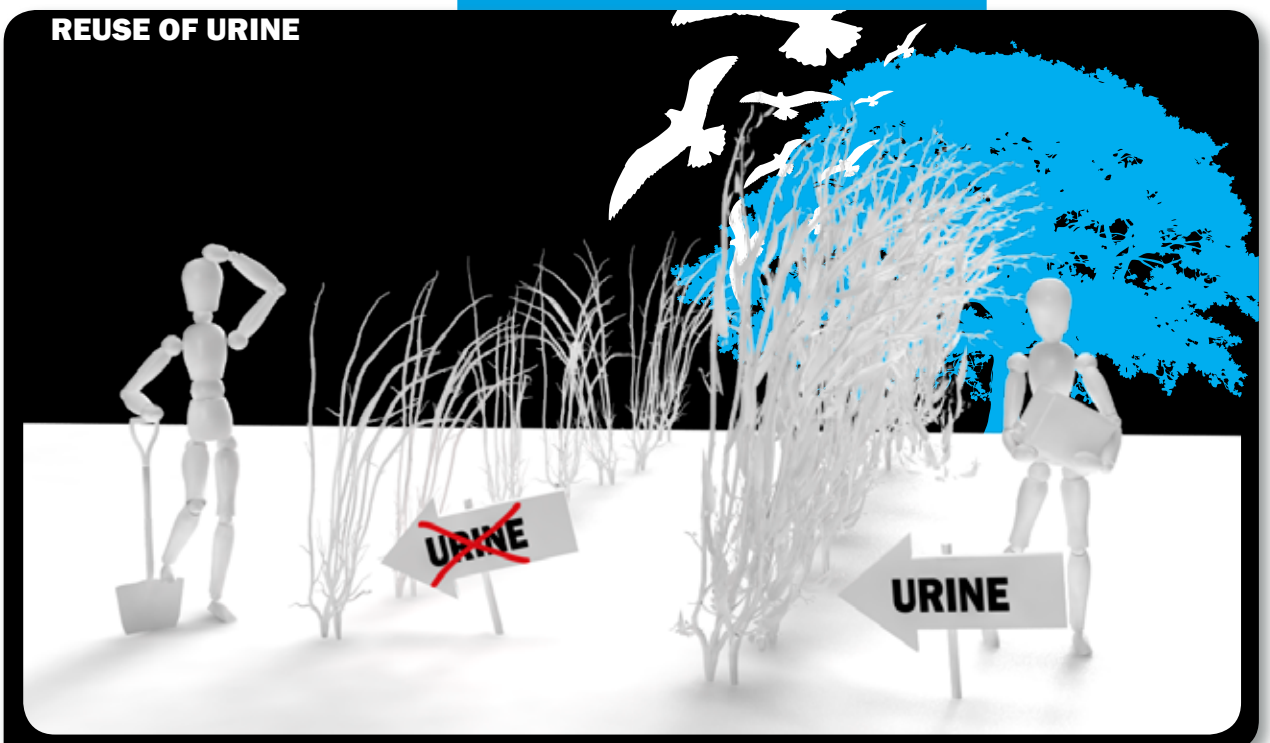


In collaboration with the NGO the users install the toilet structure.

The NGO is no longer present in the village and the users are using the toilet as they should

USAGE

REUSE OF URINE



The effects from using urine as fertiliser are starting to show in the field.

PRODUCT SUMMARY

CHILD SAFE:
The child safety has been improved with elevated edges that makes the distance to the hole smaller and provides an enhanced feeling of security by hedging the hole. The width of the footrests is increased to further add to the feeling of stability during usage.

SEMIOTICS:
The elevated edges and the sloped footrests indicate which direction to position over the hole. If positioned in the wrong direction the peak of the elevated edge in the front makes impossible to squat all the way down to where you feel relaxed while the footrest makes squatting even more difficult by increasing the distance which the Achilles heel should stretch.

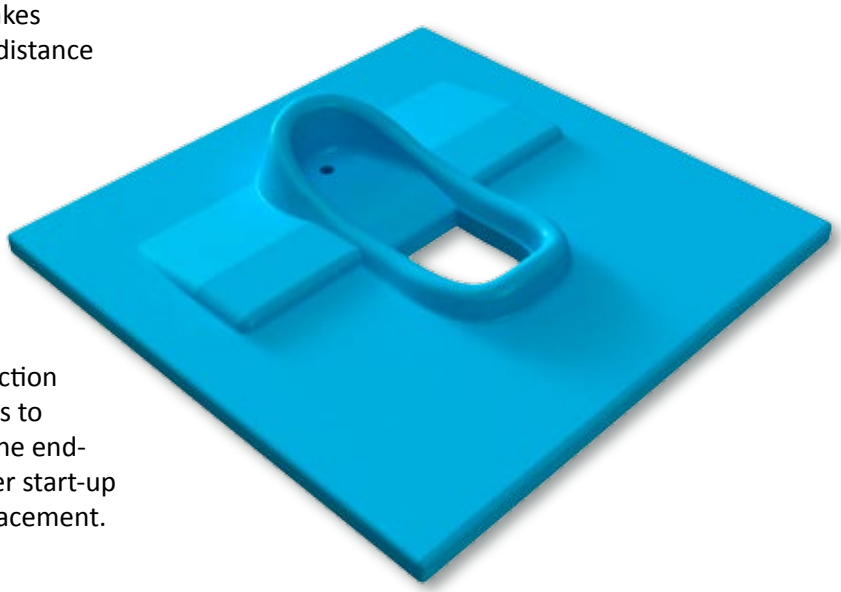
PRODUCTION:
Compared to the existing squatting plates, the production method has been simplified while adding unique selling properties to the product and thereby decreasing the cost for product but increasing the value. The selection of twin sheet forming in comparison to the injection moulding process enables smaller manufactures to produce the product and limit the distance to the end-users while its shorter start-up time and cheaper start-up cost enables fast delivery from time or order placement.

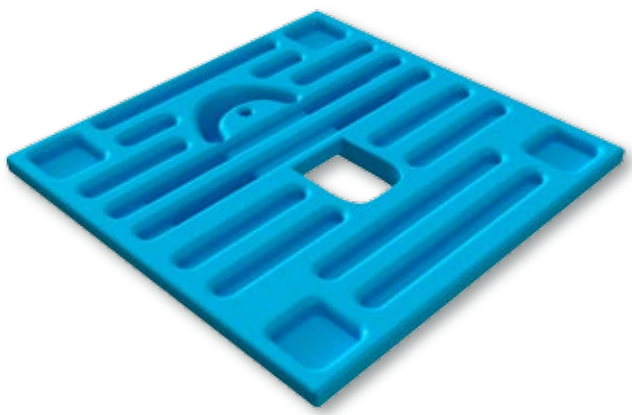
ASSEMBLY:
The square depressions in each corner of the plate's underside make instalment of four poles easy.

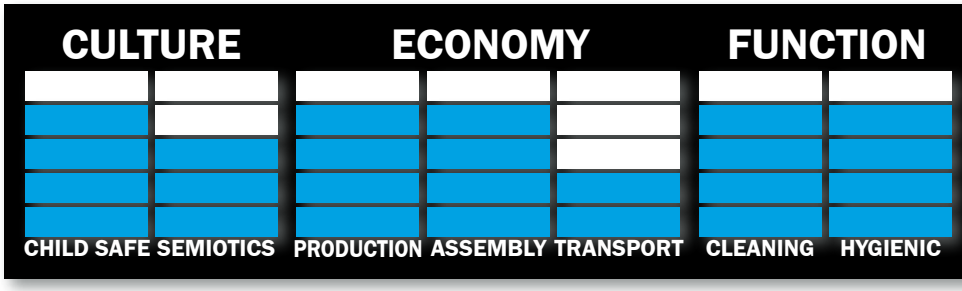
TRANSPORTATION:
Transportation of the plate has not been improved since the ability to stack the plates is not as good as before with the addition of the elevated edges. But to limit the increase of stacking height a depression underneath the peak has been made.

CLEANING:
The fillets and soft edges of the plate's surface make collection of spillage difficult and facilitate water runoff during cleaning.

HYGIENIC:
The sloped urine diversion secures safe and hygienic separation of faeces and urine to provide an uncontaminated fertiliser. The elevated footrests raise the users above the plate and any drained spillage.

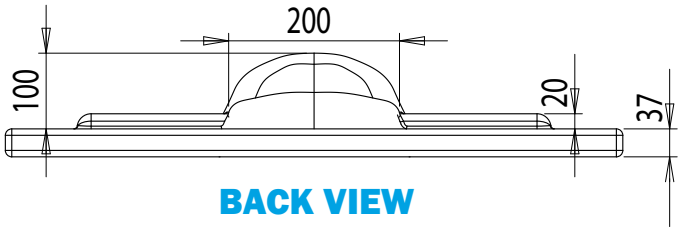




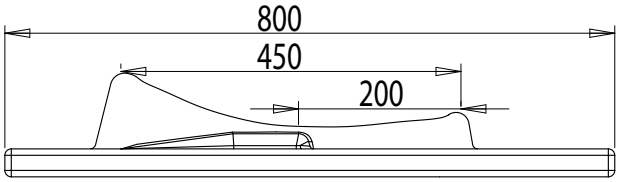


MEASUREMENTS: 80x80x13.7cm
SHEET THICKNESS: 3.5mm.
WEIGHT: 5.379kg
MATERIAL: Polypropylene.

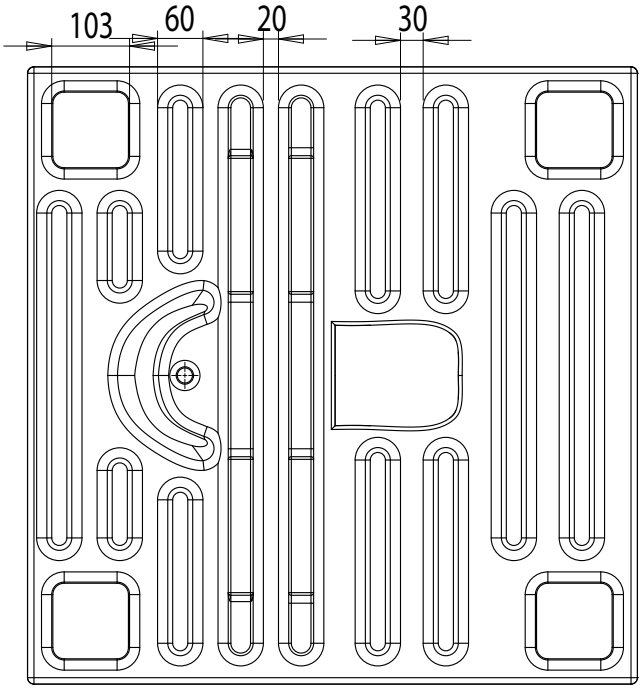
TECHNICAL DRAWINGS



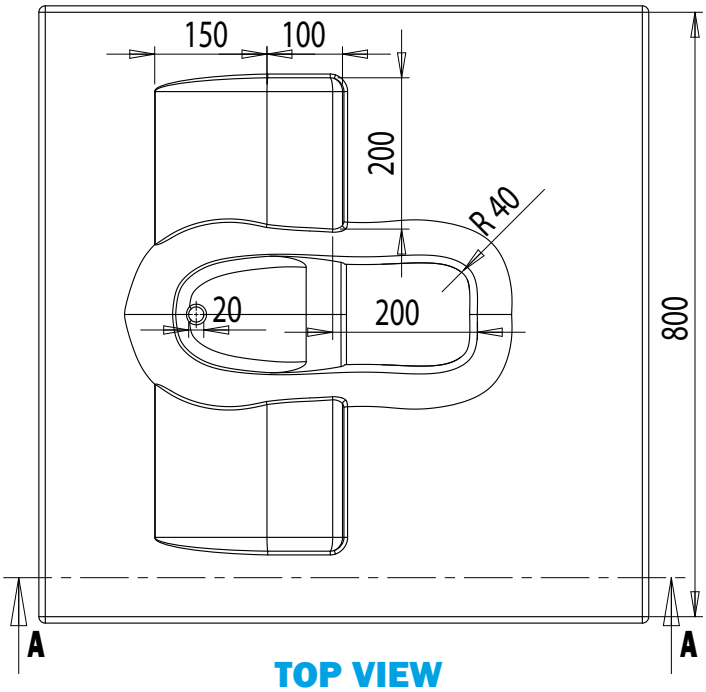
BACK VIEW



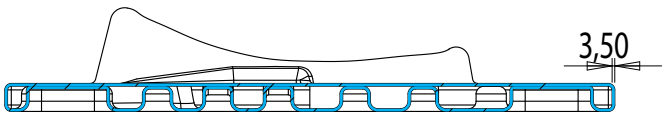
SIDE VIEW



BOTTOM VIEW



TOP VIEW



SECTION A-A

SCALE 1:10

REFLECTION

The process report is now at its end and I hope you found this brief project concerning the problem with no sanitation interesting and relevant. A short abstract of the process will be described followed by reflections on the theoretical foundation for the project and the product related outcome.

Seeking information for projects that could fit within the frame of design for the other 90%, the sanitation problem was difficult to overlook. With more than 40 percent of the world's population living without proper sanitation this problem was quite large. Maybe there was a reason for this problem not being solved ages ago? This thought seemed to slip my mind when deciding on the topic. Even though I did not set out to save the world I picked a fairly large topic which others have tried to solve for a while. I therefore lowered my ambitions and decided to take the product related approach on the problem and focused on the part of sanitation which concerned safe disposal of excreta. As my context I chose one of the areas in the world with less access to proper sanitation; the rural areas in Sub-Saharan Africa. The goal was now to design a toilet structure which could facilitate the change from open defecation to safe disposal of excreta for the inhabitants in a small fictive village. My focus quickly turned to the squatting area which seemed to be the part of the system which was most interesting with its role as contact surface for the users and the link between the enclosure and the technology. (Forstår ikke helt denne sætning)

THEORETICAL REFLECTION:

The research for this project was based primarily upon information found on the internet with the addition of a few directional expert statements. This was a very time consuming task which also put my emphatic skill to the test with the task of putting together the context and its users through the wire on the other side of the world (Forstår jeg heller ikke helt). I needed to gather enough information to get a diverse sense of what the daily life and challenges was for the potential users of the product to be. This process could have been dramatically shortened if I was in range of the context and had the opportunity of following the users and the chance of getting their personal statements of how they perceived their situation. This was a critical part of the process where a lot of needs and behavioural patterns were decided through assumptions (Måske diskutere mere om hvorvidt du benyttede dine kilder til at af- og bekræfte dine antagelser og hvorvidt dette var en holdbar måde at udføre research på). This does on the other hand not diminish the fact that, open defecation is an existing health risk and the cause of many diseases and deaths. Additionally the fact that even anthropologists, who are supposed to be unprejudiced and blunt, found the topic of excrement a taboo did not make it easier to find valid information about Africans everyday life concerning defecation [van der Geest, 2007]. This made me see the project as a small campaign for getting people around me; family, friends, co-students and supervisors, to notice the problems concerning the lack of access to proper sanitation. A problem which affected more than 40 percent of the world's population yet I had never heard of it [WHO, 2005] (Tror faktisk ikke det er meningen at der må/bør være kildehenvisninger i reflektionen/konklusionen, da du i princippet ikke må introducere nye ting her men kun diskutere hvad du allerede har fremlagt).

But the fact that I, a Danish design student, took on this project got me thinking about Victor Papanek's advice on how to design for the needs of an under-developed country from his book "Design for the Real World" [Papanek, 1985]. Here he lists the way that I've conducted this project, sitting as far away as possible from the users, as one of the least favourable ways of doing it, while recommending going to the country and educated designers to educate designers (huh?), so that one would create a group of designers committed to their own cultural heritage, life-style and needs. But I still found the project interesting and worth giving a try - and I am glad I did.

PRODUCT REFLECTION:

One of the major challenges through the product development phase was keeping the feature-adding geek inside me down. The task was to make a simple and low cost product possible while still adding features that would be of value to the users. But the product ended up a bit more complex than first intended. The initial idea of producing the product through the simple and very low-cost single vacuum forming turned out to be insufficient in terms of weight and strength. In addition the plate lost a lot of its stackable properties. On the other hand the addition of the extra sheet made it possible to better facilitate instalment by adding depressions in the corners for poles to be placed in. Ideally this additional complexity should have been discovered earlier on but I overestimated my technical abilities. Despite this minor setback I feel the outcome of this project to be satisfactory when considering the time and abilities

at hand. There still are though a few things that might need further development of the product. In this project I focused on incorporating enhanced usability for children while other exposed groups in the society should in retrospect have been considered as well. I am thinking of the elderly and the disabled who indeed would need special attention concerning the usage of squatting toilets. (God pointe. havde været rart hvis den prioritering havde været nævnt tidligere i rapporten, men fedt den kommer med :))
Another feature that could have been incorporated is some sort if drainage which was tried with some of the initial ideas to make cleaning water run of the plate without effecting the drying process of the faeces of contaminating the urine with pathogens washed down the urine diversion.

(Er nogle gode observationer du kommer med. Jeg savner dog lidt en lidt mere dybdegående sammenligning med det/de nuværende produkter, og sammenholdning af slutresultatet med dine succeskriterier. Især research metoden med en fiktiv landsby måtte gerne gå mere i dybden. Du nævner hvad Victor Papanek mener om sagen, men det er egentlig mere interessant at få noget indsigt i hvad du synes da det er dit projekt man læser :)

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ILLUSTRATION LIST

Illustrations that are not present on this list are own creations

PAGE 4: UNinvolded in Africa: http://knarrnia.wordpress.com/2008/06/19/uninvolved-in-africa

PAGE 11: http://www.thisfabtrek.com/journey/africa/mali/20060123-djenne/woman-4.jpg

PAGE12: flickr.com

PAGE13: http://flickr.com/photos/85606678@N00/248857055
http://www.monarflex.com/upload/Products/96B7DC93AD018BC6C1257496003C23BC/Large%20Squatting%20Plate.pdf

PAGE14: www.ecosanres.org

PAGE16: http://www.monarflex.com/upload/Products/96B7DC93AD018BC6C1257496003C23BC/Large%20Squatting%20Plate.pdf

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http://design.walkerart.org/detail.wac?id=4376&title=&style=images
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PAGE30: www.zoomdoggle.com

PAGE43: http://en.wikipedia.org/wiki/File:Resin-identification-code-5-PP.svg
http://www.monarflex.com/upload/Products/96B7DC93AD018BC6C1257496003C23BC/Large%20Squatting%20Plate.pdf
http://www.dinsons.com/product_squatting.htm
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PAGE44: http://www.ameriform.us/images/toiletlg.jpg

PAGE47: http://www.usplasticpallets.com/Granville/grinest_4030.htm
http://projecthdesign.com/2007/10/31/the-q-drum-making-water-transportable/

PAGE49: http://www.ecosanres.org/pdf_files/ToiletsThatMakeCompost.pdf
http://www.bbc.co.uk/radio4/womanshour/gallery/media/WaterAid-Zambia360x270.jpg
http://www.ecosanres.org/pdf_files/ToiletsThatMakeCompost.pdf
http://www.ehproject.org/PDF/phe/terrefe-safe.pdf
http://www.ecosanres.org/pdf_files/ToiletsThatMakeCompost.pdf

APPENDIX 1 - DAILY REPORT

Print Form

Daily Report

Date:

Topic:

Outcome:

next step:

Topic:

Outcome:

next step:

Aha Experiences/ Reflection:

Tomorrows to-dos:

Design for the other 90%
Rene Damborg Jensen
Industrial Design, Aalborg University

Upload photo here: 150x400

APPENDIX 2 - AID PROGRAMMES

	REBUILDING WELL	FOOD RELIEF PROJECT
WHERE:	OpanaiyalPuram village in India.	Refugees camp in Benin.
WHO:	800 rural people.	8.000 refugees from Togo.
PROBLEM:	No regular and safe water supply.	Violent riots after political crisis in connection to the election in Togo 2005.
ORGANISER:	The Water Project & Thirst Relief International.	World Food Programme(WFP) in partnership with UNICEF and UNHCR
PRODUCT:	Drilling 65m to the water source and establishing a hand pump.	Daily ration: 420g Cereals, 50g pulses, 50g Corn soya blend, 30g vegetable oil, 5g salt
PRODUCTION PROVIDER:	Hired local construction company	Food companies around the world that fulfill the demands from WFP.
FINANCIAL PROVIDER:	2/3 The Water Project (Donations) 1/3 local contributions.	Entirely donations; governments, corporations or individuals. Cash or goods.
TRANSPORTATION:	Building materials moved by trucks	Aircraft, truck, ship, camel, elephant,
INSTALLATION PEOPLE AND TIME:	Three consultants and local hired crew - approx. a day.	Red Cross and Caritas - distributions twice a month.
LIVE SPAN:	approx. 50 years with proper mantainance	six months
MAINTENANCE:	Training of three local people	Médecins Sans Frontières (MSF) checks for malnutrition.
	Source: TheWaterProject.org	Source: WFP.org

APPENDIX 3 - TOILET TECHNOLOGY

PIT LATRINE:

They are principally based on hiding human excreta in deep pits. Drop-and-store systems can be simple and relatively low cost but have many drawbacks. Pit latrines fail to recycle since the excreta are too deep for plants to make use of the nutrients. Pits are prone to periodic flooding, causing them to spill their contents. In general, pits are smelly, are often infested with flies, and in most parts of the world are poorly maintained and continue to be a source of disease and pollution.

Pit latrines are designed for the onsite disposal of human excreta, with no or very little water use. The design life varies, depending on the number of users (several years to 10 years or more). Often, the pits fill up faster than originally expected. The depth of the pit is at least 2 m, but usually more than 3 m. The top (0.5 m of the pit) always requires lining. In loose soil, the entire pit should be lined in order to prevent collapse. The liquid is normally designed to be absorbed into the soil. One unit can serve one or several households. If constructed properly, pit latrines can be regarded as superior to the other alternative of open defecation. A conventional pit latrine can be upgraded to a ventilated improved pit (VIP). The VIP latrine has a vent pipe to improve ventilation. These types of latrines are also often designed as a double-vault system, where one vault is left to dry, while the other vault is being filled. The double-vault VIP latrines have some similarities with the dehydrating urine-diversion toilets, except that the urine is not collected and can therefore not be reused. Drying of the faeces is also much less effective[UNEP, 2006].

PROs
+ Waterless toilet system.
+ Safer disposal of human excreta than open defecation.
+ Low maintenance.
+Low Cost
CONs
- Obnoxious smell
- Risk of ground water contamination.
- Cannot be used on rocky ground.

DEHYDRATION TOILET:

In a dehydration toilet the excreta is collected in a chamber below the toilet pan where it is dried. Ventilation and high temperature in the chamber are the most important mechanisms during the drying process. Urine diversion is recommended to allow sufficient drying of the faeces. This also allows the usage of the highly nutrient and sterile urine as fertiliser. When the moisture level in the excreta drops below 25% the pathogens are rapidly diminished. Absorbents such as; dry earth, ash or lime, should be added after each defecation to accelerate the dehydration of the excreta. These additives also reduce bad odours and flies, plus make it less unsightly for the next user. Breaking down organic material in dehydration conditions is slow. Toilet paper should therefore be separated either for composting in a secondary treatment process or burned when dried. When the chamber is almost full, it needs to be emptied. The content can be further stored and used as soil conditioner, buried or composted[GTZ, 2006].

PROs
+ W aterless toilet system.
+ Safe handling of human excreta.
+ Low maintenance in dry/hot climate.
+ Reuse of urine and dry excreta.
CONs
- Bulking agents needed.
- Regular empting of the collection chamber.
- For urine separation to work; separate urinal for men is needed if they don't have to sit down.

COMPOSTING TOILET:

The basic principle of a composting toilet system is the biological degradation of excreta and toilet paper in a specially designed container. Urine is usually collected separately, or in some types of composting toilets collected and treated together with faeces. If the urine is collected separately it can be used immediately. Organic food waste can be added too. Additives are needed to start the degradation process given the fact that human excreta and food waste does not possess the right carbon to nitrogen ratio(C/N ratio). So bulking agents such as; wood or bark chips, saw dust, paper etc. are used to raise the carbon level. Besides the right C/N ratio, the composting process relies on good aeration and the optimal moisture content. The end product of a composting toilet is an odourless stabilized material, which is very valuable as soil conditioner. It can be used for non-food plants or for agriculture. But further storage and heating might be needed to secure sufficient destruction of pathogens and increase the hygienic conditions.

PROs
+ Waterless toilet system.
+ Possibility of treating solid bio-waste as well.
+ Easy maintenance in cool and humid climates.
+ Reuse of urine and composted excreta.
CONs
- Bulking agents needed.
- Higher cost compared to dehydration toilets in concern to excreta management.
- Requires more committed users than dehydration toilets – due to the operation and extra maintenance.

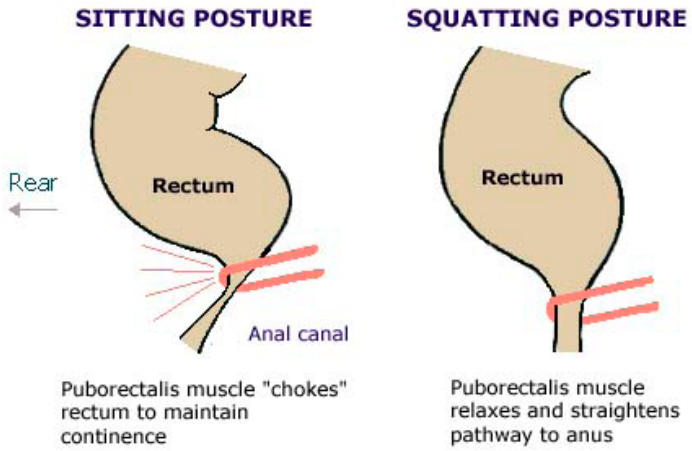
Conclusion:

The most important difference between composting toilets and dehydration is the moisture content of faeces within the vault (around 50% comparing to 25% in dehydration toilet). Composting toilets need organic bulking materials to increase carbon content whereas dehydration toilet can use also other dry absorbents such as ash or dry soil to lower the moisture content. The nutrients in products from composting toilet are on the other hand more readily available to plants than those from dehydration toilet. The selection of which technology to use in this project has been decided with consideration to the level of maintenance, complexity of the process and climate related cons. In all of these criteria the dehydration toilet is the preferred solution.

It is not as complex as the composting process and does not need as much looking after to keep the process running. The climate of Sub-Saharan Africa also promotes the dehydration process.

APPENDIX 4 - SQAUTTING VS. SITTING

Problems with defecating sitting compare to squatting are widely discussed.
The problem is that while sitting it is impossible to completely empty the colon and the residue hardens, this is a process known as faecal stagnation.



The proper sqautting position

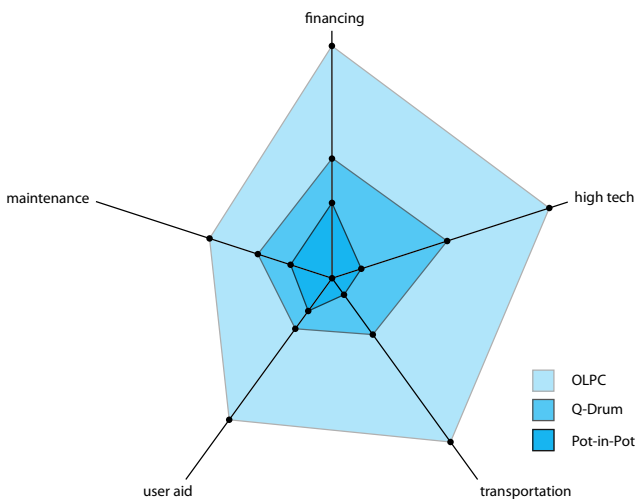
1.
Makes elimination faster, easier and more complete. This helps prevent “fecal stagnation,” a prime factor in colon cancer, appendicitis and inflammatory bowel disease.
2.
Protects the nerves that control the prostate, bladder and uterus from becoming stretched and damaged.
3.
Securely seals the ileocecal valve, between the colon and the small intestine. In the conventional sitting position, this valve is unsupported and often leaks during evacuation, contaminating the small intestine.
4.
Relaxes the puborectalis muscle which normally chokes the rectum in order to maintain continence.
5.
Uses the thighs to support the colon and prevent straining. Chronic straining on the toilet can cause hernias, diverticulosis, and pelvic organ prolapse.
6.
A highly effective, non-invasive treatment for hemorrhoids, as shown by published clinical research.
7.
For pregnant women, squatting avoids pressure on the uterus when using the toilet. Daily squatting helps prepare one for a more natural delivery.

http://www.naturesplatform.com/health_benefits.html

APPENDIX 5 - AID PRODUCTS

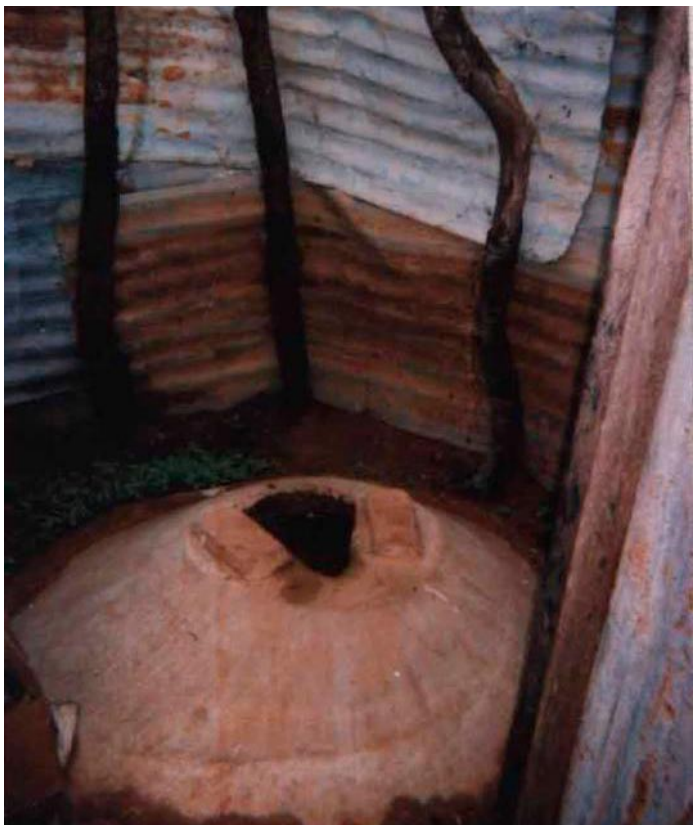
Product:	OLPC	Q-drum	Pot-in-Pot
Description	The laptop is Linux-based and has 1 GB of Flash memory; it does not have a hard disk, but it have three USB ports and a SD-card slot for expansion. The laptops have wireless broadband that allows them to work as a mesh network; each laptop is able to talk to its nearest neighbours, creating an ad hoc, local area network. The laptops are designed to be extremely power efficient, enabling the use of innovative power systems such as; solar, hand-crank and pedal-power. [laptop.org]	The Q-drum accommodates the rural people's need for easy conveying of drinking water to their villages. The Q-drum is a cylindrical container with a donut hole in the centre. A rope is placed through the hole which enables the container to be dragged during transportation. This solution makes it possible for a child to transport 50 litres of water over flat terrain for several kilometres without undue strain. [qdrum.co.za]	The Pot-in-Pot Cooler, is as the name indicates constructed by a pot placed inside another. Wetted sand is placed in the space between the pots and whatever needs to be refrigerated is placed in the inner pot. The water in the sand needs energy to evaporate which it pulls from the heat in the inner pot and thereby cooling down the content. The product was designed by Nigerian Mohammed Bah Abba to assist farmers in keeping their crops fresh while transporting them to the markets and generating more income for the farmers. [other90.cooperhewitt.org]
Problem targeting	Lack of educational opportunities for the world's poorest children.	Water conveying in rural areas.	Food preservation, mostly vegetable.
Technological level	High tech	low mid tech	Low tech
Production	Quanta Computer, Taiwan	Rotational Moulding by Kaymac Rotomoulders, South Africa.	Local potters.
Deployment	OLPC sets up a core country teams which include; technical, pedagogical, logistics, and political responsibilities.	Can be bought by users or distributed to special needing users for free by aid organisation	Sold for very little or given away to local peasants. Or made by the users themselves.
Financing	Donation and "get one – give one" campaign.	Users or Donations	Sold for very little by the originator Mohammed Bah Abba, through donations or made by the users themselves.

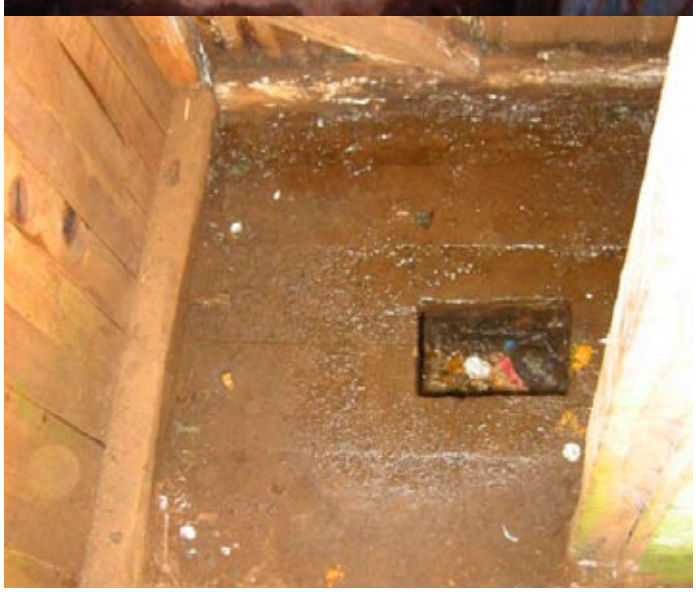
The complexity of the three products has been assembled in a spider diagram. They are compared in five categories; how much financing that is needed for the product to be (financing), how much technology is embedded in the product (high tech), how far from the end-user the product is produced (transportation), how much introduction is needed for the users to start using the product (user aid), and finally the level of maintenance to keep the product "running".



APPENDIX 6 - SQAUTTING TOILETS

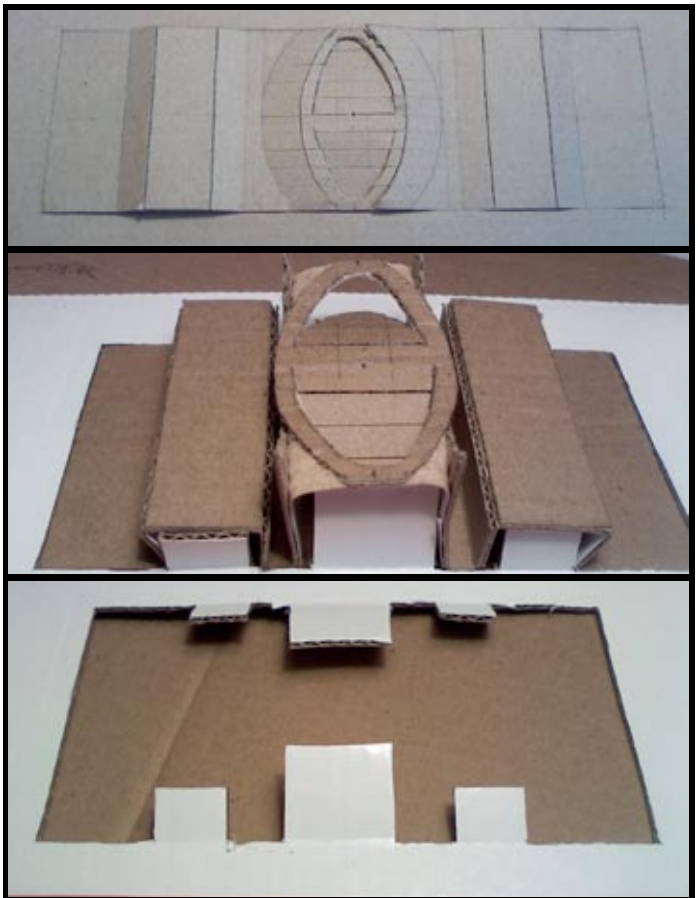
To map the current standard of squatting toilets in the developing countries and internet search have been conducted. The following pictures are examples of waterless toilets in the developing countries.



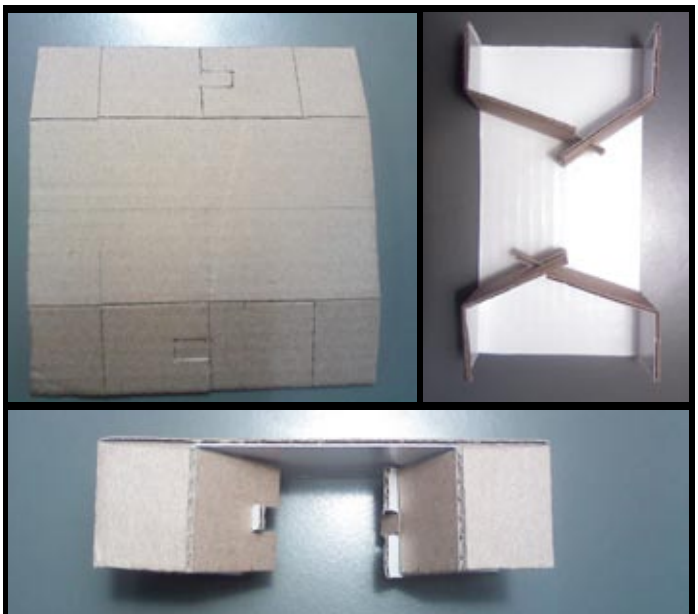



SELF HELP
2-11-2004

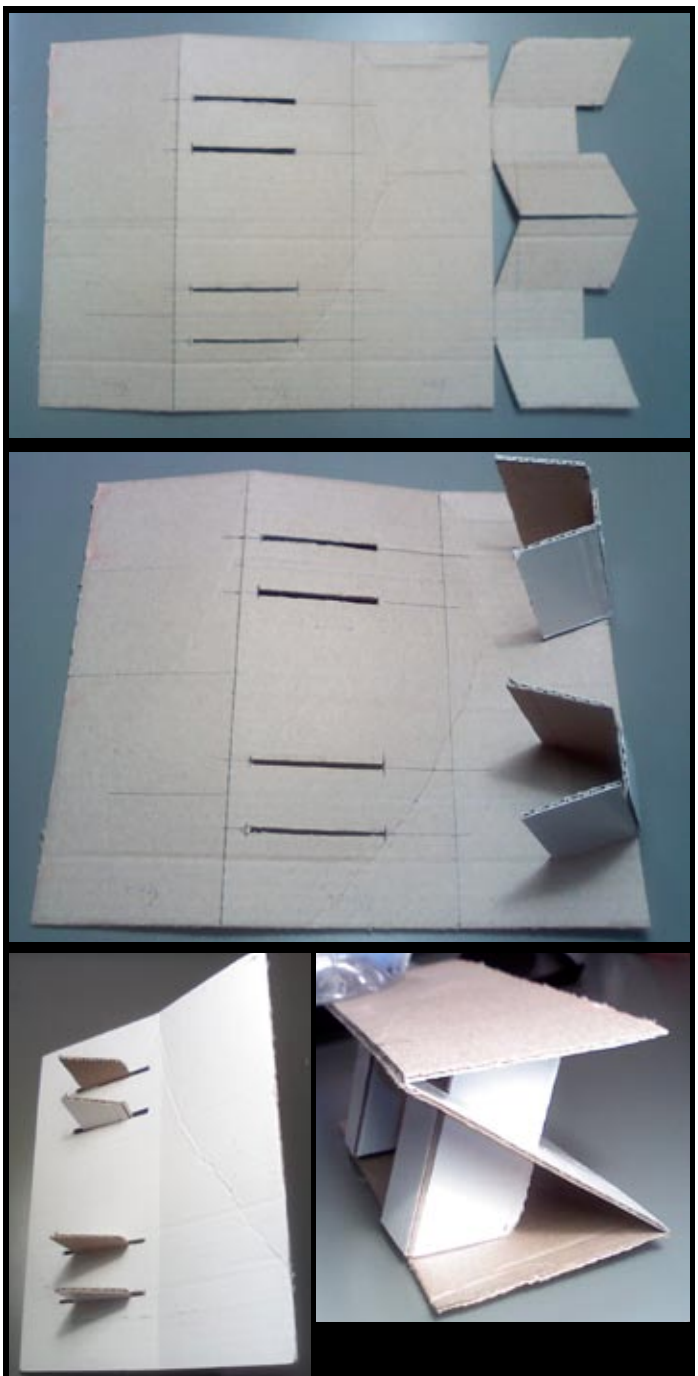
APPENDIX 7 - CARDBOARD MODELS



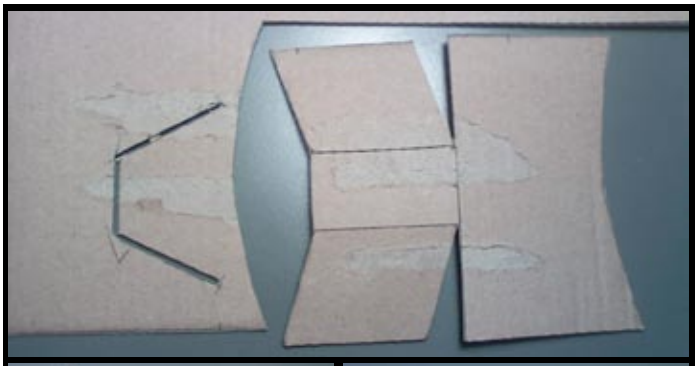
Foot rest and squatting area v. 1.0:
Folding process/principle for the foot rest.
Problems: Does it hold in the right scale? Material??

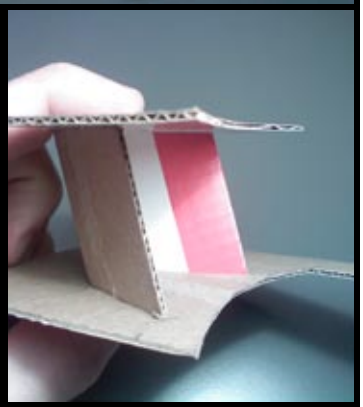


Foot rest no. 2:
Collapsable foot rest with sides pressed in.

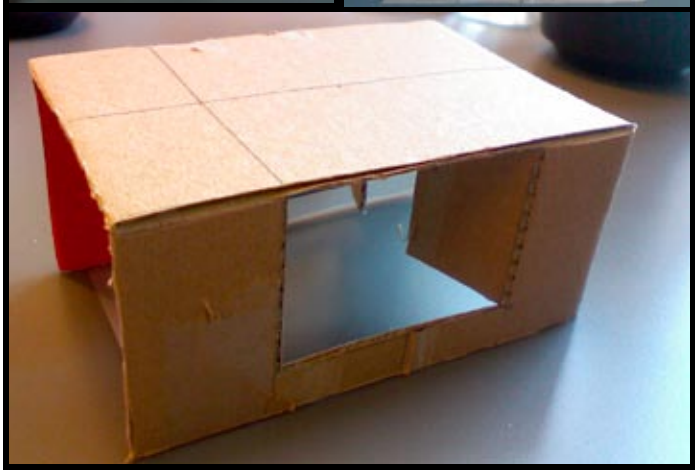


Foot rest no. 3 :
Folding process/principle for the foot rest.
Problems: Does it hold in the right scale? Material??
Complexity to many narrow passages for cleaning.

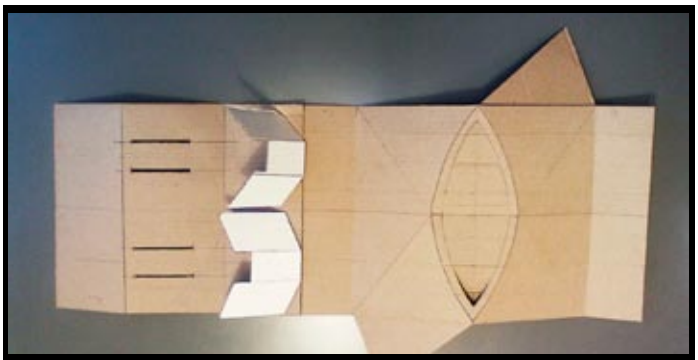


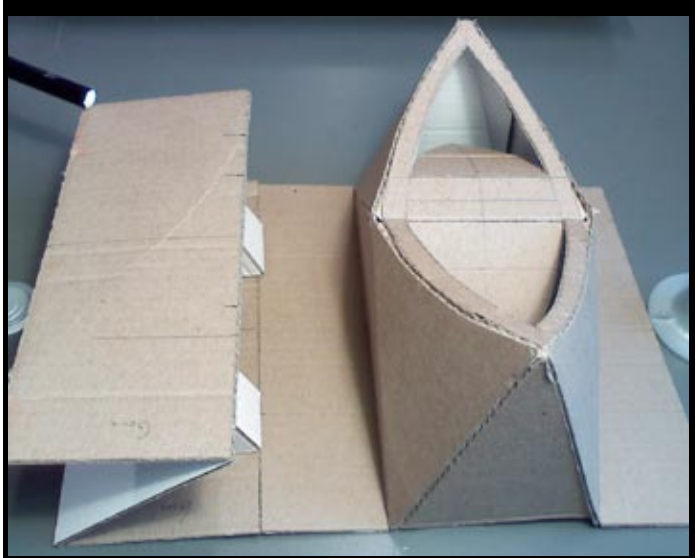


Foot rest no. 4:
Similar to foot rest no 3 but with less material and complex installation

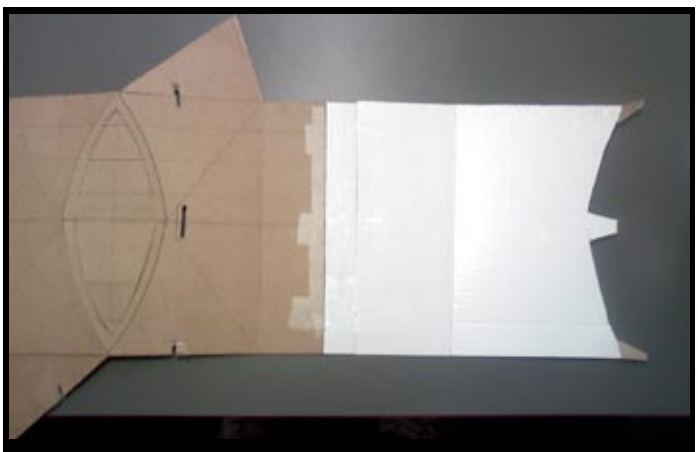


Foot rest no. 1:
Collapsable foot rest with sides pressed in.

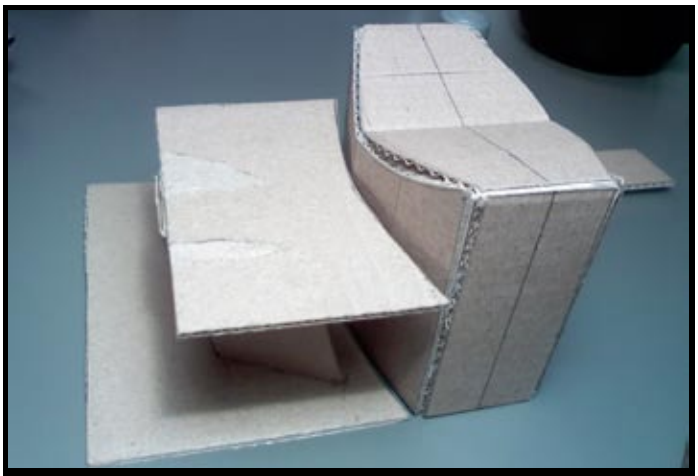


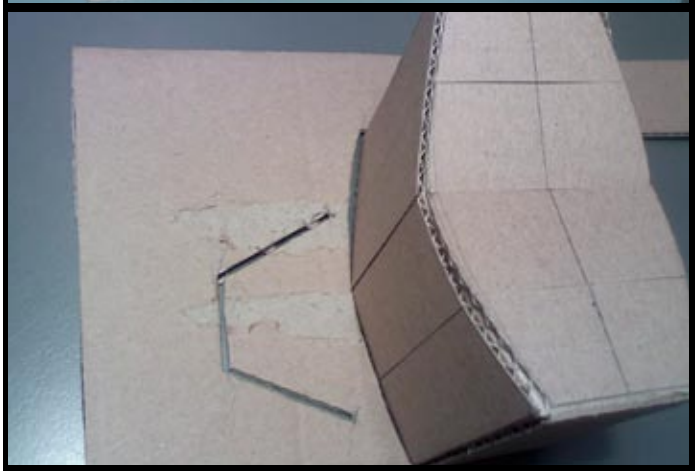


Foot rest and squatting area v. 2.0 :
Folding process/principle for the foot rest.

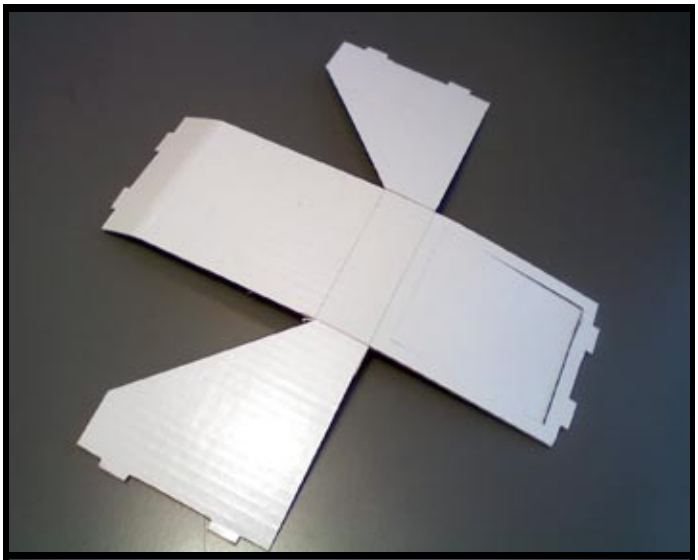


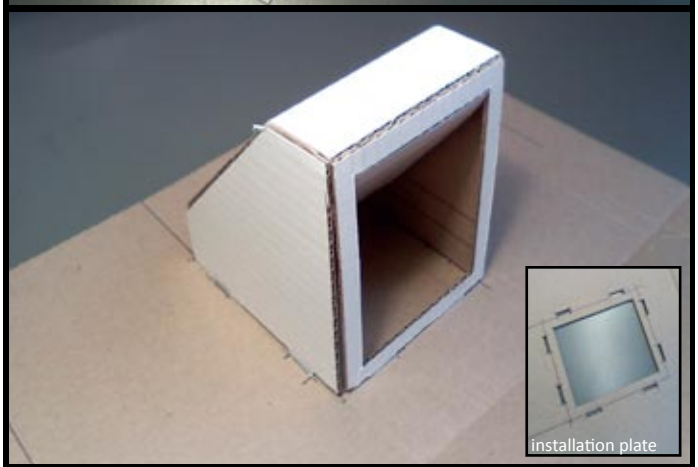
Foot rest no. 5 :
Folding process/principle for the foot rest.



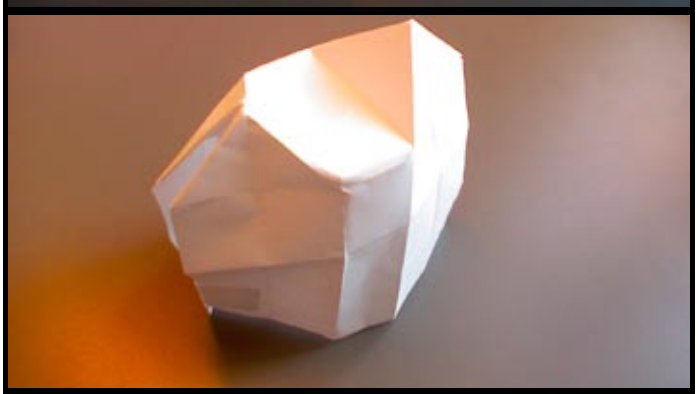


Foot rest and squatting area v. 3.0:
more square shape

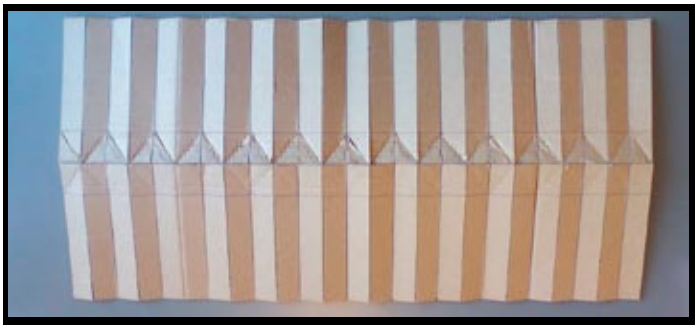


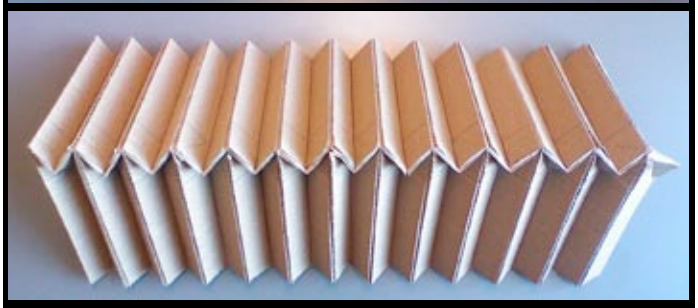


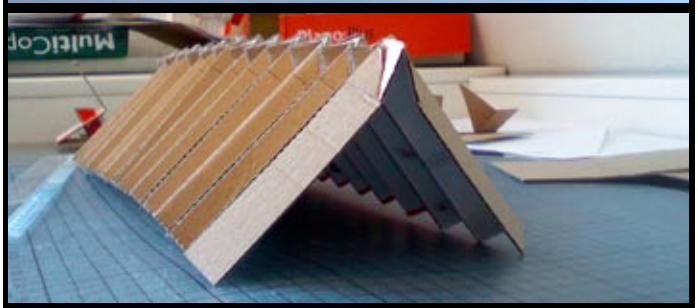
Toilet paper disposal:
- Foldable cover for the hole for toilet paper disposal.
- Lid or not? Hand transmission when touch the lid/ handle versus the confinement of smell/vision?
+ Sealing of hole for paper disposal.
+ flat transportation.



Enclosure 2:







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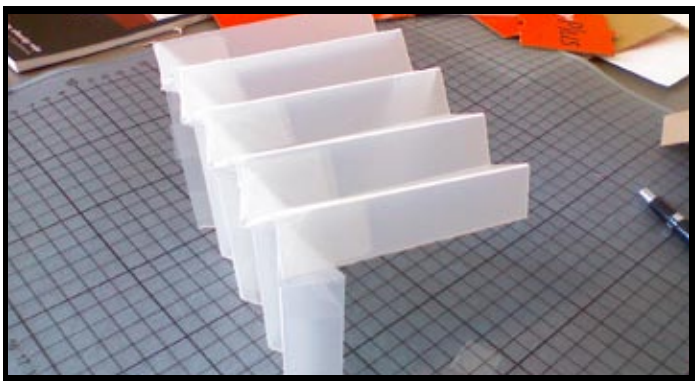

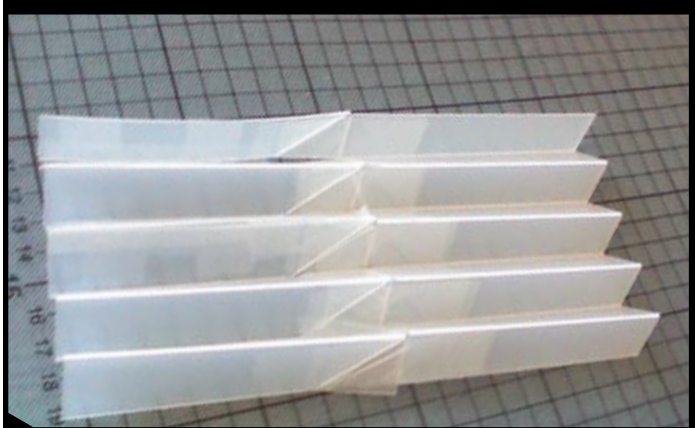

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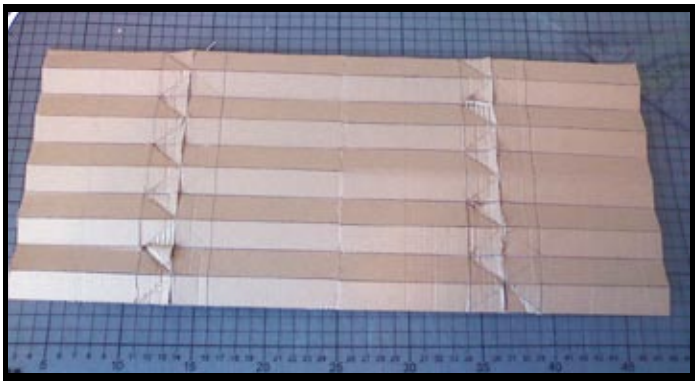
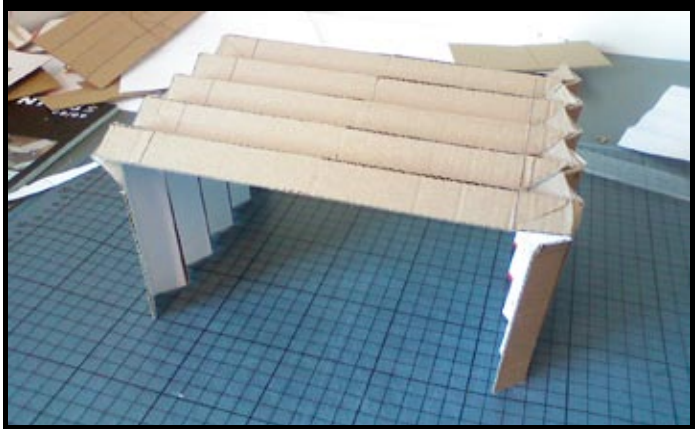


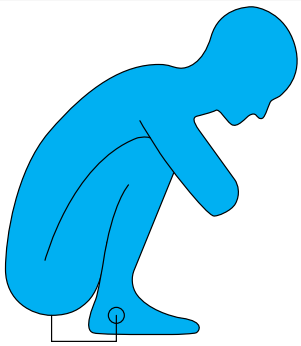


Enclosure 3:

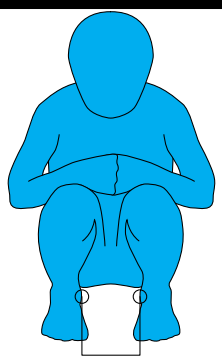
Enclosure 4:

APPENDIX 8 - PEOPLE SQAUTTING

To help determine some of the measurements for the squatting plate an internet investigation, spiced with a squatting trial from a few colleagues, was conducted. The investigation resulted in an array of people sizes which should be able to use the squatting plate.



A Distance from angle to rectum.



B Distance from angle to angle.

A: 10cm B: 20cm

A: ? B: 20cm

A:5cm B: 15cm

A: 10cm B: 25cm

A: 5cm B: 25cm

A: 10cm B: 20cm

A: 10cm B: 20cm

A: 10cm B: ?

A: 5cm B: 20cm

A: 15cm B: 25cm

A: 5cm B: 3cm

A: 10cm B: 35cm

A: 5cm B: 25cm

A: 15cm B: 25cm

A: 12cm B: 40cm

A: 5cm B: 25cm

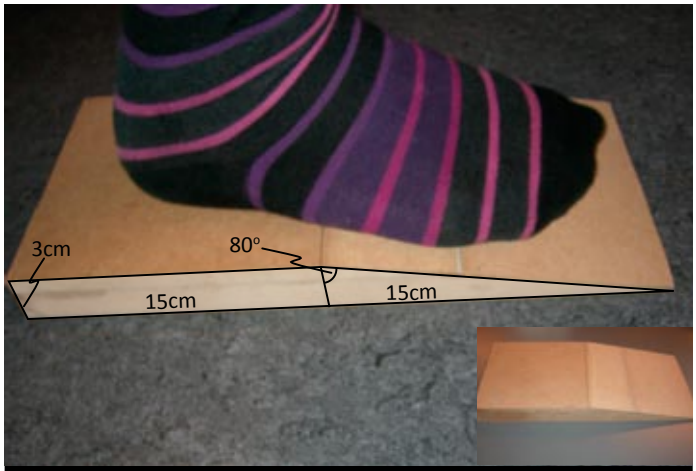
APPENDIX 9 - SLOPE TESTING

Slope testing with stacked A4 sheets spread on an even slope. The sheet where place on different angles to test the sturdiness and the position of the heel on the top of the slope.

Similar test to the one displayed above. Here the edges of the levels are sharper to try to simulate the feeling if the final footrest would be in plastic. It is made from cardboard and strengthened at the edges with plastic. Problems were discovered with the cardboard giving in when stepping on it.

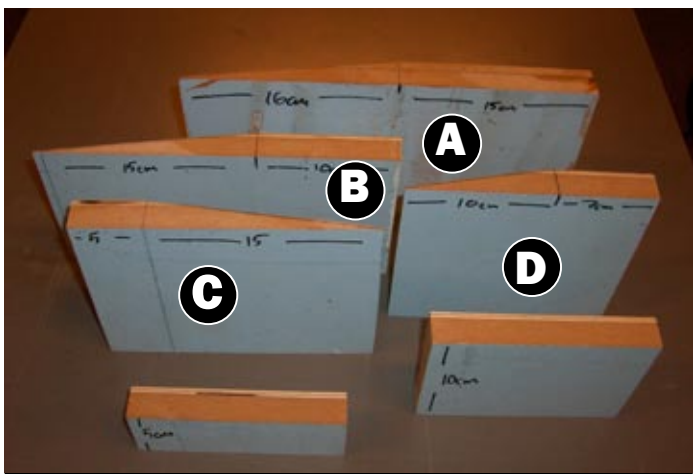
Testing the slope with stacked magazines to investigate if dividing the slope in separate levels would help the feeling of stability and grip. This didn't help the grip when the angle of the slope is not more acute – 10 degrees.

Test of the placement of the heel on the level piece above the slope. Where would one place the heel to feel balanced before squatting down? Made from a stack of paper and a stiff piece of cardboard.



Test of the desired slope in solid material. Gave a good indication of where to position ones the angle.

Person two: Size 37. Likes to have the start of the slope where the toes start to bend. Likes the 2,5x10x15cm slope.



Models for testing more angles and sizes of the flat top piece. The two pieces in the front is extensions to further investigate the desired placement of the heel.

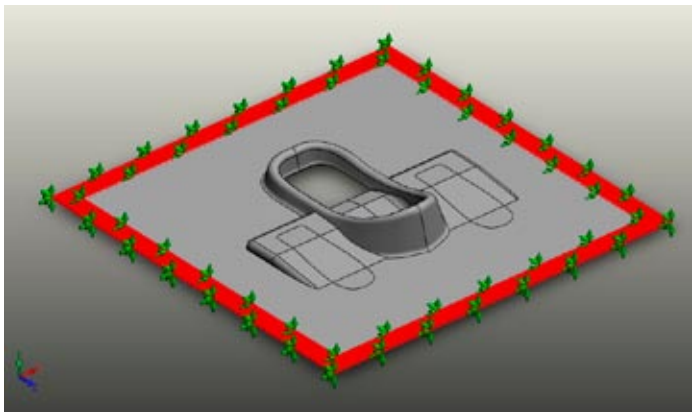
Person three: Size 44,5. Follows the midsole of the feet to find his balance. Likes the 2,5x10x15cm slope.

Person One: Size 44,5. Likes notable edge on slope, searches for support of the foot midsole. Likes the 2,5x10x15cm slope.

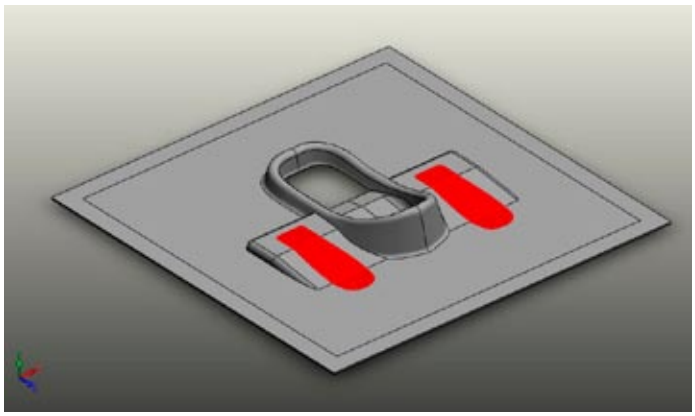
Person four: Size 42. Follows the midsole of the feet to find his balance. Experienced that the footrests helped positioning him over the hole. Likes the 2,5x10x15cm slope.

APPENDIX 10 - CALCULATIONS

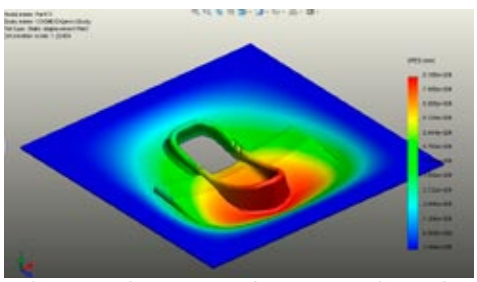
To estimate the strength and material thickness of the plate a quick test was conducted in CosmosXpress. Restrains were placed around the edge of the plate to simulate the plated mounted on a square structure for collection of urine and faeces. Foot-shaped loads are applied to the footrest to simulate the weight of a person weighing 150kg. In the following different parameters are changed to find the best solution in terms of shape, weight and use of material.

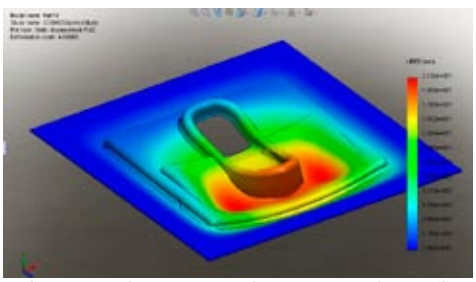


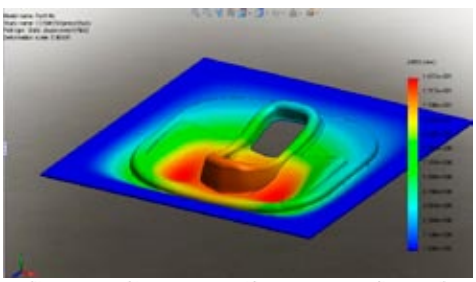
ill 1: restrains applied to the plate.



ill 1: loads applied to the footrest.







1x1m No Reinforcements		
	Weight:	Displacement:
5mm	4,996Kg	81,66mm
6mm	5,634Kg	50mm
7mm	6,577Kg	32,79mm
8mm	7,514Kg	22,62mm

0,9x0,9m No Reinforcement		
	Weight:	Displacement:
5mm	3,85Kg	30,73mm
6mm	4,619Kg	20,01mm
7mm	5,394Kg	13,98mm
8mm		10,32mm

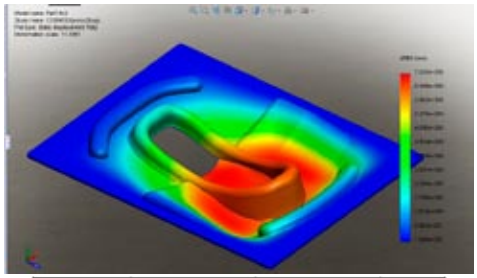
0,8x0,8 No Reinforcement		
	Weight:	Displacement:
5mm	3,093Kg	14,32mm
6mm	3,712Kg	9,704mm
7mm	4,335Kg	7,03mm
8mm	4,951Kg	5,32mm

1x1m Reinforcements 1		
	Weight:	Displacement:
5mm	4,877Kg	21,36mm
6mm	5,870Kg	14,15mm
7mm	6,927Kg	10,21mm
8mm	7,921Kg	7,435mm

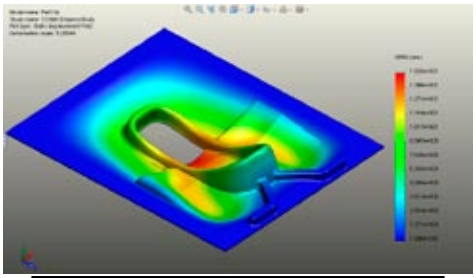
0,8x0,8m Reinforcements 1		
	Weight:	Displacement:
5mm	3,362Kg	11,18mm
6mm	4,035Kg	7,13mm
7mm	4,708Kg	5,098mm
8mm	5,393Kg	3,652mm

1x1m Reinforcements 2		
	Weight:	Displacement:
5mm	4,877Kg	22,62mm
6mm	5,883Kg	14,37mm
7mm	6,869Kg	9,951mm
8mm	7,856Kg	7,205mm

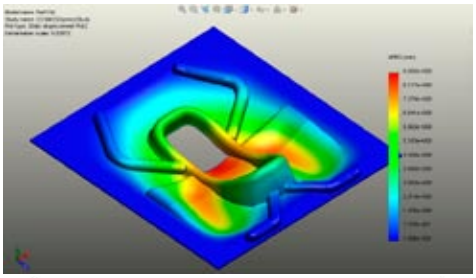
0,8x0,8m Reinforcements 2		
	Weight:	Displacement:
5mm	3,299Kg	11,61mm
6mm	3,959Kg	7,628mm
7mm	4,620Kg	5,330mm
8mm	5,292Kg	3,945mm



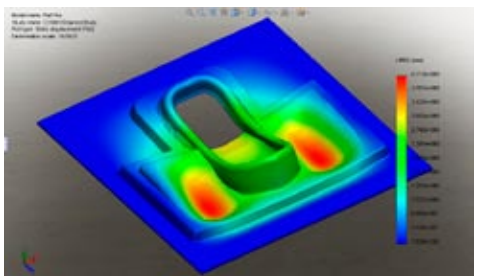
0,7x0,8m Reinforcements 3		
	Weight:	Displacement:
7mm	4,023Kg	7,035mm
8mm	4,699Kg	5,021mm



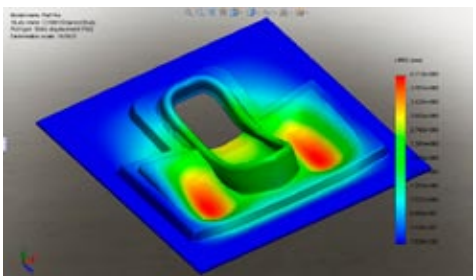
0,7x0,8m Reinforcements 4		
	Weight:	Displacement
5mm	3,164Kg	15,25mm
6mm	3,796Kg	10,03mm
7mm	4,430Kg	7,636mm
8mm	5,947Kg	2,952mm



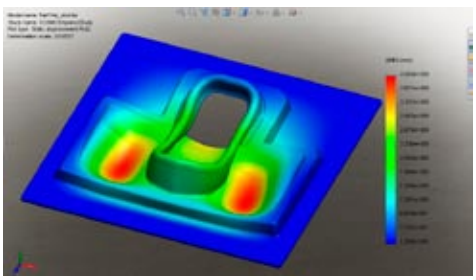
0,7x0,8m Reinforcements 5		
	Weight:	Displacement
5mm	3,299Kg	12,65mm
6mm	3,957Kg	8,855mm



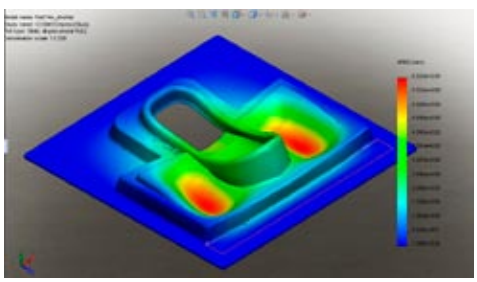
0,8x0,8m Reinforcement 6 - 2cm		
	Weight:	Displacement:
5mm	3,206Kg	11,12mm
6mm	3,845Kg	6,88mm
7mm	4,490Kg	4,702mm
8mm	5,13Kg	



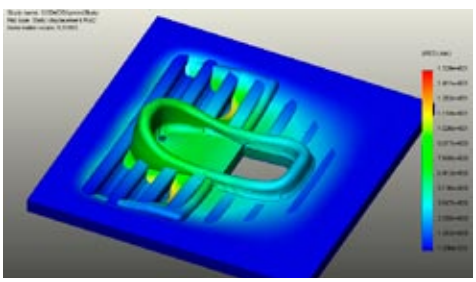
0,8x0,8m Reinforcements 6 - 3cm		
	Weight:	Displacement:
5mm	3,307Kg	10,08mm
6mm	3,919Kg	6,396mm
7mm	4,633Kg	4,11mm
8mm	5,947Kg	2,952mm



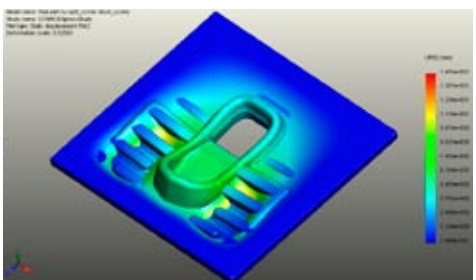
0,8x0,8m Reinforcement 6 - 4cm		
	Weight:	Displacement:
5mm	3,393Kg	9,286mm
6mm	4,069Kg	5,909mm
7mm	4,751Kg	4,004mm
8mm	5,426Kg	2,839mm



0,8x0,8m Reinforcement 6 - 5cm		
	Weight:	Displacement:
5mm	3,491kg	9,075mm
6mm	4,187kg	6,024mm
7mm	4,889kg	3,945mm
8mm	5,585kg	2,799mm



0,8x0,8m Twin Sheet06		
	Weight:	Displacement:
3mm	4,384Kg	27,80mm
3,5mm	5,123Kg	16,86mm
4mm	5,865Kg	15,01mm
5mm	7,354Kg	8,068mm



0,8x0,8m Twin Sheet07		
	Weight:	Displacement:
3mm	4,604Kg	23,22mm
3,5mm	5,485Kg	14,81mm
4mm	6,157Kg	11,48mm
4,5mm	6,936Kg	10,12mm