SOLVING GLOBAL PROBLEMS USING COLLABORATIVE DESIGN PROCESSES

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ABSTRACT
In this paper we argue that bringing together different stakeholders with the use of collaborative design processes is a powerful means of generating ideas in complex design situations. The collaborative design process was used in a workshop with international participants where the goal was to propose new solutions that would help solve the global problem of sanitation. Lack of sanitation is a problem for 42% of the world's population but it is also a taboo topic that only very few people will engage in. In the one-day workshop participants from very different areas came together and brought forward proposed solutions for how to design, brand and make business models of how to solve aspects of the sanitation problem. The workshop showed that it was possible to work freely with such a taboo topic and that in particular the use of visualisation tools, i.e. drawing posters and building simple physical models strongly enhanced mutual understanding and exchange of ideas. Furthermore, the introduction of biological solution analogies also showed to be fruitful for the generation of new ideas for product design.

Keywords: Collaborative design, biomimicry, global problems, sanitation

1. INTRODUCTION
One of the very important global problems in the world today is the fatal lack of sanitation in third world countries. About 42% of the world's population do not have access to toilets which means that people have to defecate in the public [1]. Apart from dignity concerns there are severe security problems and maybe most important there are serious health problems caused by bad hygiene. About 1.5 million children die every year due to bad toilet habits [2]. Even though the problem is obvious and consequences are enormous only very little is done to improve the situation. The reason is probably that the topic is taboo and not a politically popular case. Mayors and ministers are often seen cutting the red ribbon at the opening of new drinking water facilities but toilets do not have the same appealing effect on the front page of a newspaper.
In order to generate ideas for how to approach this problem a number of people from the design community and from third world organisations and NGO's got together and discussed the problem. A possible solution was envisioned to be very inexpensive toilets that could be sold to people of low income in third world countries. This is an alternative approach compared to traditional third world aid, where government organisations and NGO's donate facilities to areas that have needs. A problem for the traditional approach is the lack of ownership towards the end user. Good facilities like water posts are often seen to deteriorate because no one feels it is their responsibility to do the repair work even though many people benefit from the working facility. Selling the facilities to the end users creates ownership in that they feel responsible for their own belongings and it is more likely that the facilities will function in the long run. Moreover this new approach changes the mindset from regarding people of low income as being helpless to considering them as consumers and potential entrepreneurs, who can benefit from the sanitation area by gaining better health and creating business opportunities in their societies.
There is however a number of challenges that needs to be solved to make such an approach take place:
- provision of a well functioning toilet that can be produced at a sufficiently low price
- an infrastructure that will take care of the disposal of the toilet waste
- a motivation for poor people to prioritize their very limited funds to buy toilets
- a business model including investments, distribution and selling of the toilets.

In order to bring up ideas and to facilitate the collaboration between different stakeholders an international design workshop was arranged and hosted by the Index award organisation [3]. The

workshop brought together people with expertise from product design, branding, sanitation, third world culture and business and the design processes were executed in three streams:

- Branding design
- Product design
- Business model design

This paper describes the planning, staging and execution of the workshop as a collaborative design process where people from different disciplines are brought together in order to plan the realisation of an inexpensive toilet that solves some of the present problems. The work served to throw light on three research questions namely (1) if it was possible to handle a taboo topic in a workshop where the participants did not know each other beforehand, (2) how to stage and frame such a workshop with a taboo topic and (3) how to stimulate the creative idea generation using different design tools like inspiration cards and biomimetics.

2. COLLABORATIVE DESIGN

New product ideas often come from individuals or groups that share a similar expertise. However bringing products to the marketplace require that many stakeholders are committed and that their viewpoints are considered. This has been described by Hein & Andreasen in the model for Integrated product development [4] where product design, market oriented activities and production planning is described as an ideally integrated process where people from the three areas work together. In traditional companies the marketing department has close relationships with the markets and good insight into customer practices. Another characteristic is that much development work is redesign where knowledge from existing products, markets and production form a qualifying and good starting point.

For global problems like third world sanitation even more stakeholders have to be considered due to the geographical distances and differences in culture and habits [5]. Global problems often also require completely new products to be developed. It is possible that similar products exist in other contexts but in general the experience from previous products is not available and the development has to start more or less from scratch. The involvement of the different stakeholders early on in the development work is therefore crucial for the success of the product.

Many different terms such as co-design, co-creation, and participatory design are being used about the involvement of different stakeholders in a design process. In the present work we look at collaborative design as a way of bringing designers and people that are not trained in design together on an equal level in a creative manner with the purpose of developing a new product design.

To this purpose Halskov and Dalsgaard list a number of different tools that can be used: scenarios, mock-ups, prototyping, metaphors, future workshops and interaction relabeling [6]. Based on experiences from participatory design events Dalsgaard and Halskov [7] describe how four characteristics have a strong influence on innovation in such events. The characteristics include tradition and transcendence, convergence and divergence, degree of structure and sources of inspiration. The term transcendence means that design is rooted in the tradition of current activities and solutions. Divergence is often seen early in the design process where the design space is expanded and new options and alternatives beyond the immediate design space are identified, e.g. through brainstorming. Convergence refers to the process of narrowing down the list of potential options to focus or zoom in on a particular aspect. Degree of structure refers to the ways in which rules determine the setup and progression of the methods. Structured methods may be preferable for less experienced designers whereas more experienced designers can settle with more unstructured processes. Conscious use of sources of inspiration plays a great role in creativity in general and is the most prominent feature of Dalsgaard and Halskovs method called the Inspiration Card Workshops [6]. By comparison of different methods and techniques they accentuate that it is productive to include inspiration from both close and remote sources of inspiration and that physical materials are essential means of supporting language as a tool during the design process.

Eriksen [8] stresses the importance of making small-scale material methodological decisions, when planning and preparing co-design activities, formats and design materials for a workshop. Shared ownership and engagement of co-designers can be created by involving them in the preparation of the design process, so some elements have been designed by the organizers "for" co-designers while other elements are prepared "by" the co-designers.

Sanders [9] points at the importance of people's training and background. Roughly speaking people with an academic research background tend to focus on collecting and understanding information while people with design backgrounds often are more focused on inspiration and on creating new solutions. This is important to remember when setting up co-creation teams. With these aspects in mind tools and materials for the workshop were selected that would be most suitable to incite engagement and collaboration between apparently disparate participants with different areas of expertise.

Figure 1. Two posters used to brief the participants on the need

2.1 The organisation and setting

The project was initiated by a mutual desire from DTU and the Index Award organisation [3] to use knowledge, design methods and student labour from DTU to solve global problems identified by Index. Several global problems were considered (UN millennium goals [1]) and sanitary challenges were selected because of the potentials and the remarkably poor interest the area has got. The World Toilet Organization (WTO [10]) and the environmental department at Hamburg University [11] were contacted and joined the project. They represented knowledge of sanitation, treatment of human waste and third world markets.

The selected focus was to explore the possibilities of how to create inexpensive toilets that can be sold to poor people in third world countries. India was selected as a good starting point. Because of a general shortage of pure drinking water throughout the world it was a constraint for the project that the toilets should not depend on a water infrastructure like sewers but waste should be collected and transported in containers. Separation toilets that keep liquid and solid fractions apart were to be considered for logistic and hygienic purposes. Furthermore the integration of a fermentation technique developed at Hamburg University was to be investigated since it could reduce smell problems and improve the fertiliser value.

The purpose of the workshop was to bring together different stakeholders and generate ideas of how to realise the toilet. The workshop was named Sanitation Design Lab and was planned to be a full day event. Invitations were sent to stakeholder groups like industrial designers, third world organisations and NGO’s. Thus the sanitation workshop brought together people with expertise from product design,

branding, sanitation, third world culture and business. The stakeholders in the workshop included people who where qualified to identify themselves with third world sanitation problems either through expertise or first hand experience but the participants did not include stakeholders representing the actual end users from developing countries.
There were about 60 participants of whom most people participated in their spare time and it is therefore interesting to analyse their motivation for participation. A dominant reason is probably self-interest as much as altruism, the desire to make a difference and make a small contribution for a better world. But other reasons are also likely namely the membership of a group or movement and the option of getting enriched by the knowledge and insight of recognised key players.
Part of the staging of the event was done through the invitation that prepared the participants for the workshop format of the arrangement, the three working streams - branding design, product design and business model design - and the expected results. These points were of course repeated at the workshop.
The overall design brief for the product design stream was described on posters shown in Figure 1 and by oral instructions. Materials for the workshop were chosen to be inspirational issue cards, a poster with biomimetical inspiration and a prototype toolkit for making drawings and 3 dimensional simple models. Inspirational posters pinpointed the relevance of the project (Figure 1) and four posters with visual representations and questions concerning the rituals related to toilet visits were used to give the participants an understanding of the context of use (Figure 2). The intention of the factual posters was to frame the workshop with a common platform of relevant information that provided key notions to support choices done throughout the design process, whereas the inspirational issue cards (Figure 3) and the biomimetical poster (Figure 4) was intended to bring forward metaphors and analogies to open up for unexpected ways of applying knowledge to the design.

3. THE DESIGN PROCESS IN THE 3 STREAMS

The participants split up into the three streams ‘branding design’, ‘product design’ and ‘business model design’ after own choice after listening to the introduction from the three stream leaders. Each stream took place in a different room. Everyone joined a plenary session at the end of the day where ideas and concepts from the different streams were presented. Since the authors were only present in the product design stream and the plenary session, only observations from these two are described here. The organisers of the three streams came from very different backgrounds. The branding design stream organisers came from a consultancy firm that specialises in corporate identity, branding and communication. The product design stream was organised by people from engineering and industrial design and the business model design stream was organised by a businessman with experience from third world markets.

3.1 The product design stream

The product design stream was divided into two assignments. Beforehand the facilitators had prepared inspirational design tools that included:

- oral instructions
- three posters briefing the importance of the project and providing biological inspiration (Figure 1 an 4)
- four posters with questions related to toilet visits (Figure 2)
- a separation toilet with concomitant boxes representing the quantity of human waste per week and per month (Figure 3)
- inspirational cards (Figure 3)
- prototyping toolkits in order for the participants to do mock-ups of their concepts

The participants in the product design stream were instructed to split further up in to 4 smaller teams each concentrating on one of four phases related to toilet visits: 1) The urge, 2) the first impression, 3) the act and 4) after the act. The first assignment was to brainstorm on a question formulated for each phase and to display the findings on post-it notes that were placed on a poster as shown in figure 2.
After the brainstorm all groups circulated and marked with red circles the most important statements for each phase. The results are shown in Figure 2 and Table 1. This evaluation of different rituals related to toilet visits was intended for the participants to fully understand and put words on the design challenges and the activity helped to expand the design space by identifying different design options. The purpose of this first assignment was to direct the thoughts on the design object and focus the effort

for the later design phase. Furthermore it forced the participants in the smaller groups to talk with each other and in this way helped 'braking the ice' of the taboo topic.

Figure 2. The four posters (the urge, first impression, the act and after the act) with post-it notes used for the first assignment.

The participants were then introduced to the German fermentation technology [12] in order to give them more knowledge of treatment of toilet waste. An existing separating dry toilet was displayed together with card boxes illustrating the volumes of one person's weekly and monthly waste products, see Figure 3.

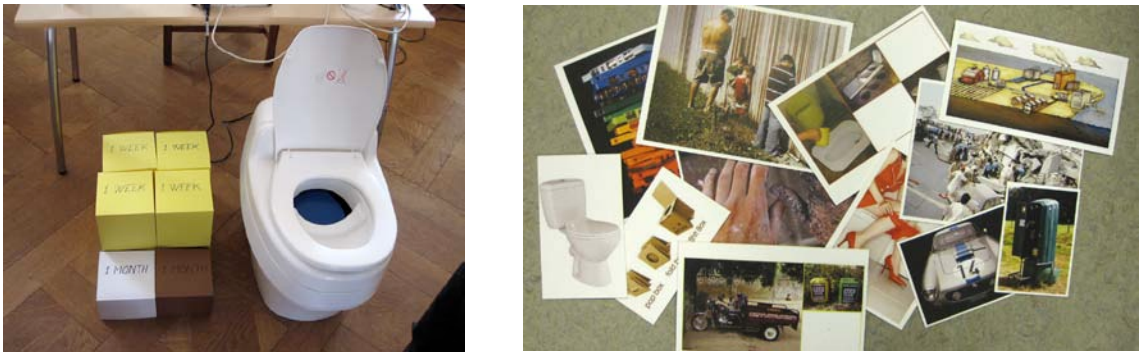

Figure 3. A separating dry toilet and card boxes illustrating the volumes of one person's weekly and monthly waste products (left) and examples of inspirational issue cards (right)

The second assignment then followed and was identical for the four groups: propose a solution for a toilet and/or the pickup system that satisfies at least one of the important statements that was found in the first assignment. To support this idea generation and the design activity a large number of inspiration cards and a poster showing biological solution analogies were prepared beforehand by the organisers. The inspiration cards functioned as a sort of fragmented mood-board and showed pictures of existing dry toilets, Indian slum areas, existing Indian households, technical, graphic and aesthetic inspiration etc. and the biological poster showed biological solutions for selected challenges like cleaning, smell and flies [13]. The idea of using biological inspiration is described by Lenau [14]. In both assignments there were four instructors circulating among the groups in order to speed up the process and keep it on track. The groups were also encouraged to formulate team roles like driver (focus on goals), timekeeper, documenter, presenter and scout. The scout should 'spy' on the other groups work to get inspiration and to facilitate knowledge sharing.

About 20 persons participated in the product design stream. The majority had industrial design or engineering design backgrounds and there were a few representatives from third world organizations. The first assignment functioned well and produced a fair number of good important statements (Figure 2 and Table 1) and people seemed enthusiastic about the work. The second assignment showed to be more difficult since the task was much more open. Some of the groups used a long time on discussing different possible approaches instead of just quickly choosing one of the options and then detail it (which was the advise given by the instructors). The difficulties on finding a focus point reflect the complexity of the assignment. Other groups however got far and produced mock-ups from the supplied building materials like cardboard and tinfoil.

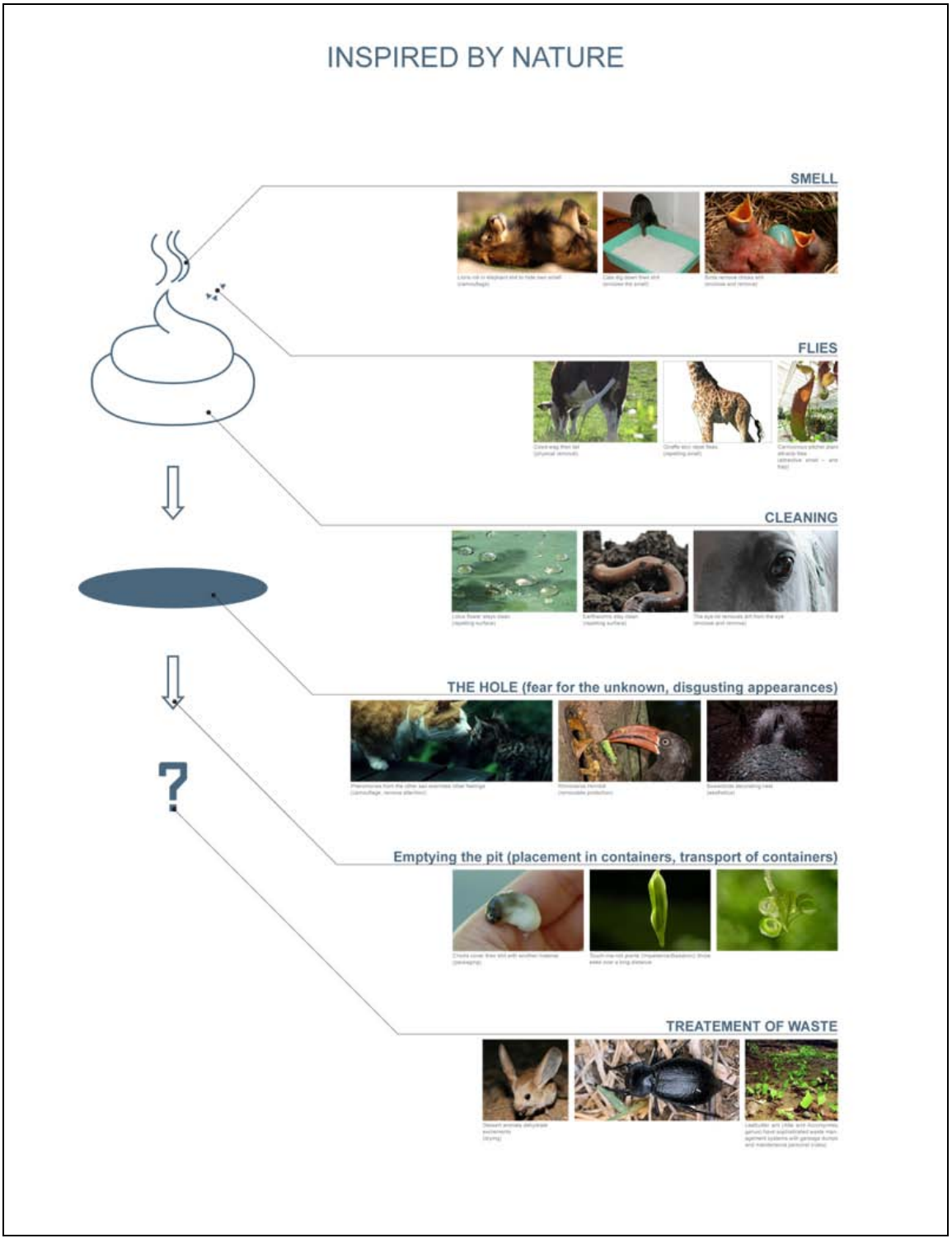

Figure 4. Biological inspiration to improved toilet design

Two of the groups were inspired by biological analogies like the cat tray or the phenomena where bird chicks cover their shit in a dry membrane so the parent birds can transport it away easily.

4. THE RESULTS

The results from the three streams were presented in a plenary session and the most important statements are described in the following.

4.1 Branding dry toilets in India

The branding design group focused on public toilets and on how potential users should become interested in the toilets and be willing to pay for the service they represent. An important element is here the mental image that users get when thinking of or talking about the toilets. Since the word toilet is closely associated with taboo topics it would be advisable to think of a new name. The new name should cover more than the toilet service; otherwise it will quickly deteriorate and have the same drawbacks as the original name. A good analogy is how a bathroom is a place with several functions and talking about it therefore is less taboo. A new name should signal something glamorous and could include that the place gives you the luxury of privacy. It should be a place where you can be alone and are allowed to have dreams. This could be a way to assign more status to the toilet.

Table 1. Questions and answers for the first assignment in the design stream.

Question	Selected most important statements
1. The urge: What is important for you when you need to go to the toilet?	Accessible, private, safe, ownership
2. The first impression: Which words describe an attractive toilet?	Private, clean, no smell, safe, dry function
3. The act: State some keywords that represent comfort under the act of going to the toilet.	No sound, peace and safety, comfort (touch/no touch), no contact to other peoples waste, dry flush, cleaning, no effort
4. After the act: Consider an efficient non-water consuming way of handling faeces and urine as an alternative to water driven sewers.	Dignity (what you leave behind you), no contact to waste, clean feeling, long treatment time, transform into useful soil

To support the new name the physical public rooms should reflect these mental images. This can be supported by easy recognisable designs of the toilet houses, of uniforms for the caretakers and through a special key to the toilet that you can wear visible around your neck signalling that you belong to sort of an exclusive club.

It was considered to have a mascot called Suni which was a cartoon drawing of a small boy. Suni should be associated with attractive activities like cricket and should be comprehended as strong and healthy.

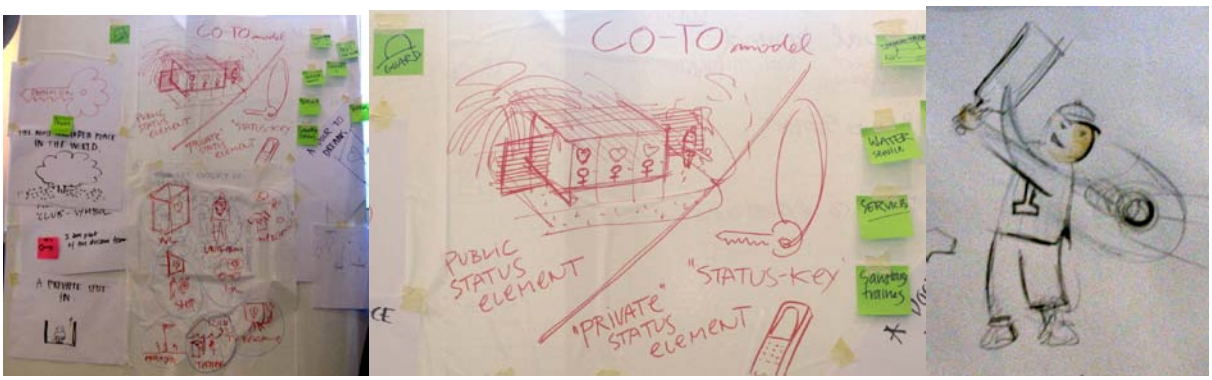

Figure 4. Poster from the branding group (left), detail of poster (middle) and the cricket playing mascot Suni (right)

4.2 The proposed product designs

The product design stream resulted in 3 proposals for product designs. One proposed solution was a dry toilet to be used in higher buildings with several stories. The idea was to have a toilet with a swinging lid and a small container on wheels underneath that can hold the toilet waste. The container can be removed from outside the toilet room by service personnel and emptied in a tube system similar to the one used for garbage bags. Smell problems can be handled by ventilation, even though this does not help the working environment for the service personnel. It was also considered if handling and smell could be improved using encapsulations of the toilet waste using analogies to cat trays or diaper bags.

The second solution focused on the transportation of waste done either by the users or by professional personnel. The user operated system required that the user applied a sort of waste bag that either could

be dropped in a container or if valuable enough as fertiliser sold to a collection place. An alternative was that the droppings were stored in a larger container that was emptied at regular intervals by professional personnel.
The third solution was called Encapsulate and was inspired by the biological principle from bird chicks. The chicks deliver their droppings wrapped in a dry membrane, which makes it easy for the parent birds to grab the package in their beak and transport it away. The nest is therefore less exposed to predators. The idea was that two sheets of foil form a bag that is placed in the toilet bowl. When 'flushing' the bag is closed and automatically placed in a wastebasket while a new bag is placed in the toilet. The principle was presented in drawing and a physical mock-up that showed the movement of the foils using tinfoil as model material. Drawings and modelling for Encapsulate is shown in figure 5.

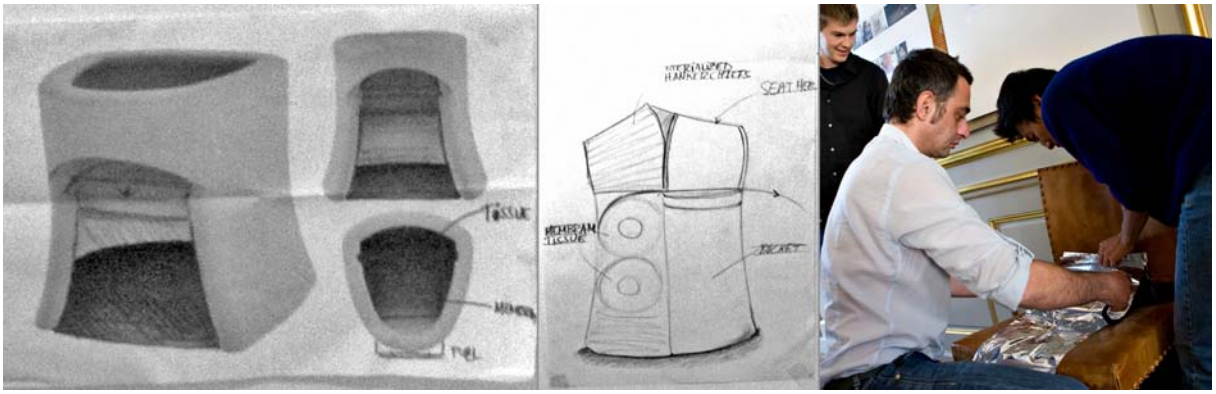

Figure 5. One of the proposed solutions for a dry toilet using the biological encapsulation principle from bird chicks. The tinfoil at right is used to illustrate the encapsulation principle.

4.1 Business model design for dry toilets

One of the initial considerations for a business model was presented by the instructor as the basic motivation for toilet users to pay for a toilet solution. The idea was to address people's self esteem and position in the society. Having a toilet should be a status symbol. It was also formulated as a statement from a family father: He was not willing to marry his daughter to someone without a toilet. Once toilets become an important social factor the will to use money on toilets becomes more realistic.
Another instruction was that toilets should be sold through a franchise system called Sanishop where a local tradesman sells toilets and related products under the Sanishop brand.
The business model design group split up into 3 subgroups that looked at 1) an economic sustainable solution 2) the maintenance and service and 3) how to maintain a high quality of the facilities.
The first group divided the toilet into a shelter, a seating device and a sewer tank (Figure 6 left) and considered three stakeholders that were personalised using personas: A user called Ajanta, a sales person and maintainer called Hitash and a financial sponsor called Shika. The business model was that Ajanta could either buy a basic toilet for 25$ or he could lease it for a micropayment. A business narrative could be to deliver the shelter in a blue Ikea style bag and after assembly Hitash would come and install the toilet. Hitash furthermore sells the emptying service and can offer additional products like solar power, water collection system or a more luxury version of the toilet. Shika would supply Hitash with all the hardware. The finance is partly payments from Hitash and partly sponsorships from major suppliers of hygienic articles.
The maintenance and service group proposed a solution that benefitted the local community (Figure 6 right). Local schools should collect faeces to fertilise vegetable gardens and the whole service would be part of the educational school programme. Basically the idea was to find revenue a different place than the toilet itself. Another idea was to couple the use of the toilets with free phones. The income would partly come from the fertiliser and partly from a sponsoring option where different companies could advertise to the many users. The third idea was to combine the emptying service on a truck with other services that were attractive to the local community for example a cinema or a health clinic. Again extra income could be generated from advertising on the truck and through the films shown in the cinema.
The third group listed the criteria for quality control by stating that franchising ensures quality. The franchise is a community based selection that could include rating systems with smileys (like they use

in restaurants in Denmark) and fixed recommended prices. The emptying service, which is part of the franchise, would furthermore have the learning perspective that users will experience and learn about new higher hygienic standards.

Figure 6. Posters from the business model session, group 1 (left) and groups 2 and 3 (right).

5. DISCUSSION

The intention of The Sanitation Design Lab was to consider viewpoints from different stakeholders by bringing them together at one place and generate ideas to sanitation solutions. The work within each of the three streams showed that it is possible and that constructive ideas can emerge when people with different backgrounds are brought together in spite of the taboo topic. Our concern that was formulated in the first research question was if a taboo topic could be handled in this type of open workshop. Interestingly enough did the taboo element not play any significant role. People very quickly got used to talk about sanitation topics including toilet habits, the droppings, etc. It helped using less incriminated words and phrases from other daily routines. The workshop showed that it was possible to work freely with such a taboo topic.

The participants had very different backgrounds ranging from design, engineering, business & entrepreneurship and communication/advertisement. The diversity of people certainly encouraged lively and very qualified discussions but it is difficult to assess if people's background defined their roles in the groups. People with apparently different backgrounds made drawings and came up with many interesting ideas.

Our second research question was how to frame and stage a workshop with a taboo topic. The initial framing in the product design stream using four posters with visual representations and questions concerning the rituals related to toilet visits showed to be fruitful. When people worked in the smaller groups of 5-6 people focusing on one of the four rituals everybody contributed by writing relevant topics on post-its. The participants got involved and the taboo barrier was broken. For the concept generation it was particularly the use of visualisation tools, i.e. drawing posters and building simple physical models that enhanced the mutual understanding and exchange of ideas.

In practice the three streams of branding design, product design and business model design were executed in separate rooms and there was not much chance to interlace findings and conclusions from one group to another during the full day event. Therefore the final plenary session was primarily presentations that revealed different concepts from one stream to another. The three streams never got the chance to bring back concepts from the other streams in order to incorporate branding, product design or business considerations in their own idea generation process. A solution to the problem would have been to have two plenary sessions. However the presentations from the three streams during the plenary session brought forward an interesting assortment of solutions to the overall sanitation problem that reflects different scales and perspectives of interest. While the industrial design team was primarily focusing on technical and practical solutions to the physical appearance of the toilet, the branding and business teams brought the attention towards socio-cultural and economical impacts on a wider scale. The various scales of input from the three streams insured that the proposed solutions contoured a broad field of interest (hygienic, practical, economic, cultural) for the end user that might otherwise seam too complex to cope with for a single stakeholder.

The third research question concerned the stimulation of the creative idea generation using different design tools. The introduction of biological solution analogies showed to be fruitful for the generation of new ideas for product design – two of the 3 proposed solutions were directly inspired by the

biological analogy from bird chicks and cat trays. The format of the poster where the toilet problems were represented graphically on the left side and biological solutions listed with pictures on the right side showed to be easy to understand. The biological solution analogy approach correlates well to the essential concept that cross-pollination of bringing together hitherto unrelated elements is relevant to successful innovation processes, as described by Dalsgaard and Halskov [6].
The inspirational issue cards were placed on the tables for the co-designers to include in their discussions but they were only used to a very limited degree. Possible reasons could be that they were not introduced properly so the participants might not have been fully aware of their existence and use. Another reason could be that the cards had status of an additional offer one could use if necessary and not as an important or maybe even compulsory element.
The four posters showing the rituals related to toilet visits with their corresponding questions incorporated the co-designers in to the contextual design universe that they would later make proposals to as recommended by Dalsgaard and Halskov [6]. The posters together with Post-its were physical tools that revealed design challenges brought forward by the co-designers themselves. Empty posters were planned as being a domain belonging to the co-designers that was open to attack with lively proposals. However we found out there was a sort of hesitation in doing that.
The result of the workshop was many good and fragmented ideas. If we had added an extra day for the workshop we might have been able to evaluate and condense these ideas to a common concept that could be worked further on by each stream.
In future workshops it would also be interesting to employ online digital tools for co-creation and user participation. Various means of communication could be explored and the workshop could be introduced through a real time online chat with a stakeholder from India. Digital platforms could help us get closer to first hand actors despite the geographical distance. The end user could thus give feedback to some of the thoughts and concepts that rises during a workshop.

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