Designing for Informal Contexts: *A Case Study of Enkanini Sanitation Intervention*

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Increasing social agency in the design profession corresponds to the call for greater participation of science in solving complex social problems. We analyse the complex problem of informal urban sanitation in the Enkanini informal settlement in South Africa to articulate the facilitatory role of design in the collaborative effort to improve sanitation in the settlement. More specifically, an in-depth understanding of the multi-stakeholder collaboration in the case offers solutions for designing in complex social contexts. In the discussion, we expound on the methodological concerns of designing in an informal settlement context by analysing the role of the design ethnographer and articulating core design competencies. This leads to the conceptualisation of *infrastructuring* as an open-ended model for design facilitation in informal contexts, in which challenges and inconsistencies have to be dealt with. We also contrast the open-ended, multidisciplinary approach of infrastructuring with the more design-centred participatory approaches that are better suited to literate participants. In the Enkanini case, we had to adopt a narrative-style participatory approach to capture the rich tacit knowledge of participants. The paper thus answers to the need for both technological and social innovation while contributing to the methodological understanding of design as a collaborative, long-term process.

Keywords **–** Design Ethnography, Informal Settlements, Infrastructuring, Sanitation.

Relevance to Design Practice **–** The contextualised methodological perspective presented in this paper is useful for design practice in informal contexts, and for design pedagogy in the Global South, given that informality is becoming the dominant reality of urbanisation in the Global South.

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Introduction

This paper articulates the widening social agenda of design, in which the focus of design is shifting from object to process, and designers are giving greater attention to the philosophical underpinnings of design practice (Papanek & Fuller, 1972). For instance, designers are getting more involved in multi-actor engagements that aim to implement processes of change, as opposed to simply offering technological product solutions (Ceschin, 2014). In multidisciplinary research contexts, designers can become design ethnographers (Gunn & Donovan, 2012) who explore diverse processes such as informal urban sanitation, while employing both traditional and emerging design methods.

Informal urban sanitation is an apt context for researching the expanding social role of design and innovation, given that purely technocratic approaches have failed to meet the complex needs of providing sanitation in informal contexts (McFarlane, Desai, & Graham, 2014). The complexity of informal contexts emanates from their deviance from conventional methods—methods that have been successful in mainstream urbanisation trajectories in the Global North, but are incongruent with the rapidly emerging waves of urbanisation in the Global South (Swilling, 2013). In Sub-Saharan Africa, for example, informal settlements are fast becoming the dominant urban reality and governments are unable to provide adequate infrastructure and services for the burgeoning populations in informal urban settlements (United Nations Human Settlements Programme, 2014).

Accordingly, designers need to focus greater attention on informal contexts if they are to contribute to the next urbanisation wave that will largely take place in Africa. Some authors in architectural design have already made great strides by articulating the significance of informality as a narrative in architectural design (Dovey, 2013; Kellet, 2005) and introducing simulations of informal settlement practices in design studios (Owen, Dovey, & Raharjo, 2013). In these approaches, emphasis is laid on the need for alternative innovation frameworks that can accelerate the inclusion of informal contexts in development (Cozzens & Sutz, 2014). In this paper, the involvement of the corresponding

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author as a design ethnographer in a sanitation intervention in the Enkanini informal settlement is used to expound on the methodological concerns of design, in which infrastructuring is proposed as a conceptual model for design facilitation in informal contexts.

Study Method

The corresponding author carried out an ethnographic study by actively participating in the Enkanini sanitation intervention between 2012 and 2014. The data used in this paper is derived from her observations and participation in focus-group sessions as well as from email communications between the participants in the intervention. User-generated data was also collected in the form of cartoon-strip drawings. Secondary data from the Maluti GSM report (Maluti GSM Consulting Engineers, 2014) on the intervention is also used.

In order to abstract themes from the data, the findings were interpreted within a hypothetic overarching pattern of design as an open-ended process. The informal situation in Enkanini is the quintessential open-ended process, in which thematic analysis was used to unearth the implicit meaning behind the empirical material, by identifying themes within the framework of an overall story (Vaismoradi, Turunen, & Bondas, 2013). Carrying out such an analysis is dependent on the researcher's knowledge of the language and its social meaning (Neuman, 2011). The corresponding author's understanding of the "language" in the Enkanini case was possible given her two-year involvement in the sanitation intervention. The knowledge produced is therefore admittedly subjective, which this paper posits as a valid research outcome since knowledge is in fact situated and contextualized; subjectivity and objectivity are not dichotomous as the former is a significant path towards the latter (Letherby, Scott, & Williams, 2013). The findings are nevertheless theoretically significant for other socially complex contexts.

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Theoretical Framing: *Methodological Concerns in Design*

In this paper, three methodological concepts are discussed and used to frame the case study. They are: *infrastructuring*, *design ethnography* and *core design competencies* in multidisciplinary research settings. In the analyses, infrastructuring is presented as the overarching framework within which the design ethnographer unveils the core competencies of design.

The concept of infrastructuring is used to explain how collaborative design exercises can be sustained to achieve long-term social change (Hillgren, Seravalli, & Emilson, 2011). In infrastructuring, the design process is an open-ended network that allows participants to visualize social and technical arrangements that can be tested and improved collaboratively over time. Open-ended engagements give room for flexibility so that changes can be absorbed in real time and continual learning is ensured if it is accompanied by a high frequency of decision making. In industrial and engineering design, such option spaces are referred to as *probes* for social organisation (Sengers, Boehner, David, & Kaye, 2005).

In an emerging context, design ethnography as an approach can be used to create option spaces and technological probes for social organisation. In the Enkanini case, the sanitation system could be conceptualised as a probe that drew in participation and allowed for a better understanding of the social practices in the settlement. In this way, technology mediated the relationship between humans and their social world while creating option spaces for innovation.

In design ethnography, the designer takes on the role of a change agent and provocateur who critically examines the role of design in complex real-world situations (Barab, Thomas, Dodge, Squire, & Newell, 2004; Gunn & Donovan, 2012). In this emerging field, the prescriptive approach of design as a problem-solving profession is interlaced with the descriptive approach of ethnography and anthropology to arrive at a holistic reframing of design as an exercise that is embedded in social contexts (Kjærsgaard & Otto, 2012). Using anthropological techniques, the designer can interrogate encounters that intersect the categories between production and consumption; further, design ethnography is especially useful in complex social contexts where design ideas lie in the collective imagination rather than with the individual designer (Halse, 2012). In effect, therefore, the designer facilitates a collective design process aimed at providing contextualized solutions and situated knowledge.

One example is articulated by Judice (2014) in work carried out in Brazil. The disadvantaged community involved in the case allows for comparisons with the Enkanini case discussed in this paper. In the case, Judice describes a participatory design approach used as an empathetic process aimed at gaining design insights

from the needs and experiences of people in the community. The process, which is clearly articulated, appears to be strongly design centred, with the use of standard design probing methods such as photography, diaries and visual questionnaires, which are geared towards a standard design outcome, namely communication material. Other studies by Nugraha (2012) and Sarantou (2014) in Namibia have a similar design-centred approach with a focus on traditional craft design and production. This is in sharp contrast to the Enkanini case, in which the design ethnographer was involved in a multidisciplinary process that had a broad agenda beyond design.

Hence this paper contributes significantly to design methodology in two ways: Firstly by providing an alternative design narrative better suited to multidisciplinary cases where designers may have less control over a complex, long-term process, and secondly by using the challenges faced in the Enkanini case to build a case for infrastructuring as a flexible framework in which challenges and inconsistencies can be tolerated and learned from.

The Case Study: *Enkanini Sanitation Intervention*

Figure 1. Map of Enkanini informal settlement in Stellenbosch, 33° 55′ 12″ S, 18° 51′ 36″ E
(image taken from Google Earth, 2015).

Enkanini settlement is in Stellenbosch town in the Western Cape Province of South Africa. It falls under Stellenbosch Municipality, which has so far installed 80 communal toilets and a few waste skips to service about 4449 residents in the settlement (Stellenbosch Municipality, 2012). A team of Stellenbosch University (SU) researchers, funded by the National Research Fund (NRF) of South Africa, have been involved in a variety of research projects in the settlement since 2011. The corresponding author joined this team of researchers in 2012 and worked in the Enkanini sanitation intervention up to 2014. In 2013, five shared pour-flush toilets were installed and connected to an anaerobic digester via simplified sewerage in Phase 1 of the intervention. The toilet and pipe installations were funded by the Water Research Commission (WRC) of South Africa through Maluti GSM Consulting Engineers, who did the installations. The digester was funded by the NRF. In 2014, a Phase 2 of the sanitation intervention was launched with additional funding from the Wihelm Frank Trust to redesign the pour-flush toilet into a micro-flush toilet.

Prior to the launch of the pilot system in early 2013, two SU doctoral candidates (including the corresponding author) organised several workshops to brief the potential Enkanini users about the sanitation intervention. In these briefings, would-be users, who were residents from Section E of Enkanini, were informed on how the technical system would operate and what institutional and financial arrangements would be required to manage the system. The hope was also to encourage a self-selection process so that residents would voluntarily agree to be users as well as participants in the research of the two SU doctoral candidates.

While participating in these pre-pilot exercises of the intervention, the corresponding author observed that the design team composed of SU researchers and an engineering expert shaped the agenda of the intervention, whereas the would-be users and co-researchers from Enkanini played a less active role. For instance, the technical aspects of the sanitation system were largely dictated by the engineer who had funding specifically to experiment with pour-flush and micro-flush toilets. The SU researchers, meanwhile, controlled the funding from the university, as well as the general running of the intervention.

Additionally, observations from the workshops with the would-be users showed that the would-be users were not contributing meaningfully to the dialogue on the sanitation intervention. The corresponding author therefore identified the need to facilitate exercises that would empower the would-be users to contribute more to the dialogue and the design process of the intervention by articulating their needs and interacting better with the researchers and experts. Subsequently, the corresponding author set out to achieve what were regarded as empowering outcomes by enhancing the participation of the would-be users. Improving the interactions between the Enkanini co-researchers and the SU researchers was also regarded as a way to redistribute power within the sanitation working-group. To achieve these aims in the field, focus-group sessions were organised around what were termed design facilitation aspects: *mobilisation*, *interaction* and *user experience*. Accordingly, the objectives of the focus-group sessions were:

- To enhance participation by mobilising would-be users at the beginning of Phase 1
- To improve the interactions between the co-researchers and the researchers towards the end of Phase 1
- To reveal the user experience from Phase 1, to inform Phase 2 of the intervention

Additionally, the focus-group sessions were motivated by social considerations from literature on user participation and mobilisation of communities in the design of sanitation systems in unserviced areas. In such areas, it has been shown that the meaningful participation of users in the implementation of sanitation systems saves costs and contributes to the sustainability of the system (McGranahan, 2013; Nance & Ortolano, 2007). It is further emphasised that sanitation technologies need to be "socialised" and design methods can facilitate that socialisation (Lopes, Fam, & Williams, 2012).

Focus-Group Session 1: Mobilisation of Users

The would-be users in the Enkanini sanitation intervention were drawn from Section E of Enkanini, where an anaerobic digester had already been installed in early 2013. The digester was installed at the Enkanini Research Centre (ERC), which had been constructed with funds from the NRF. The toilets had to be installed close to the digester so that they would drain into it by gravity. Accordingly, 42 households near the ERC were invited to meet with the group of university researchers and the engineering expert who would implement the intervention. As mentioned above, the researcher had observed that the would-be users were not active participants in the implementation process. For instance, in the briefing workshops, many of the would-be users were not comfortable speaking in English, and they therefore kept quiet or only gave very short answers to questions. Only a few residents, who appeared to be more articulate, were able to air their concerns about the intervention to a much greater extent. Only two residents raised several objections in two of the workshops. The conclusion was that verbal communication alone was not an effective way to engage meaningfully with the residents, and therefore visual tools were introduced in focus-group sessions with Enkanini residents as discussed below in the section on visualization.

Focus-Group Session 2: Interaction between Researchers and Co-Researchers

In the second focus-group session, the participants were four Enkanini co-researchers and four researchers who were to be involved in making a film about the sanitation work from Phase 1 of the intervention. The drawing exercises in this session were organised based on the observation that even the co-researchers found it difficult to communicate effectively with the researchers, who often dominated group conversations. The session thus started off with a cartoon-strip drawing exercise, in which each participant was supposed to visualize a storyboard for the film. Afterwards, each participant explained their storyboard, followed by a group conversation.

From the storyboard explanations, it became clear that the co-researchers did not understand what the film was about and how it was going to be made. The group conversation was thus focused on formulating a shared understanding about the film. At the end of the session, one of the co-researchers commented that she now knew what the film was about and how it was going to be made. Analysis of the group conversation (Ambole, 2016) revealed that the researchers framed the discussion to a great extent, while the co-researchers declared the meeting to be successful only because they finally understood how the film was to be made.

Focus-Group Session 3: User Experience from Phase 1

At the beginning of Phase 2 of the intervention in 2014, it was agreed that a relaunch of the intervention was necessary. This was done so as to address the drawbacks that had emerged at the end of Phase 1 in December 2013. One of those drawbacks was the dissatisfaction of users with the pour-flush system of the toilets. To tackle this problem, a full-flush system referred to as micro-flush was proposed to replace the pour-flush toilets. Alongside this, biogas trials were to be carried out with the aim of providing users with alternative cooking energy, which would be cheaper and safer than the paraffin they currently used. The payments from the biogas supply would then be used to maintain the sanitation system, making the system more self-sustaining. The trials were ongoing at the time of submitting this paper.

Consequently, the corresponding author organised a third session to discuss with the users these changes as well as to collect their experiences from Phase 1. During the discussion, the users expressed some level of satisfaction with using the pour-flush toilets, although in earlier interactions, some users (who ended up dropping out of the intervention all together) had expressed strong dissatisfaction with the pour-flush system. The drop-out users therefore reverted to using the communal toilets provided by the municipality. Consequently, in Phase 2, more than half of the 20 users were new participants who had not been part of Phase 1. The discussion in this session was therefore also an opportunity to engage with the new users.

Lessons from the Focus-Group Sessions

In synthesis, the focus-group sessions were more informative than they were participatory. They therefore exemplified the challenges of participatory processes. Their planning was largely determined by the activities in the intervention, since the design ethnographer organised them based on what was needed at the time. In this regard, the design ethnographer had little control over the discussions and their outcomes. For instance, the second focus-group session in October 2013 that was declared a success by the participants was soon followed by a falling-out between the researchers and the co-researchers in December 2013.

Additionally, the focus-group sessions were difficult to convene. Finding the right time and venue for a large group to meet in Enkanini was one difficulty. Since the meetings were held during the day, the participants were mostly unemployed, female residents. Later, other research meetings were held in the evening, and that too was fraught with problems such as security concerns. In the end, the most rewarding engagements were not in any of these organised sessions, but in the unplanned and naturally occurring dialogue with Enkanini residents.

Working in Enkanini was thus a significant source of frustration for the SU researchers, who were trying to impose structured processes in the unpredictable and volatile context of Enkanini. Protest marches by Enkanini residents in Stellenbosch town further highlighted the volatility of the settlement. During one such march, the ward councillor's house was littered with rubbish, and one research project office in the settlement was vandalized (iShack Project, 2015).

A study by Le Roux and Costandius (2013) reveals similar challenges in an earlier art project in Enkanini, in which foreign artists intended to collaborate with residents to paint their shacks. The authors argue that the art project failed to negotiate

sustainable social change in the settlement by not seeking the express consent and active involvement of the residents. From this project, the authors conclude that there is need for a more critical consideration of the "unquestioned optimism" and often "romanticized prospects" that drive social projects for the disadvantaged. In a collaborative design project in South America, Hussain, Sanders, and Steinert (2012) also point out the challenges of designing with marginalized users. They advise that such projects should aim at producing empowering outcomes for the participants, beyond the tangible design outcomes. In this paper, a critical lens has been used to articulate the significance of design facilitation in the Enkanini case, without romanticizing it as a solution. Rather, the aim is to bring to the fore the challenges and inconsistencies in the Enkanini case so as to provide a way forward for design practice and theory in complex processes.

Discussion: *Methodological Concerns in Designing for an Informal Settlement Context*

From the lessons of the focus-group sessions, we propose design ethnography as a method that was best suited to the informal and complex nature of the Enkanini case. Professional designers may not have the time for long-term engagements with underserved users and so a design ethnographer can bridge that gap by engaging in long-term research processes such as doctoral research, as has been done by the corresponding author.

The Role of the Design Ethnographer

Design ethnography is a hybrid role that combines the analytical strengths of research with the generative skills of design (Kjærsgaard & Otto, 2012). By acquiring such hybrid roles, professional designers are already focusing greater attention on social and cultural problems such as homelessness, insecurity, poor health and aging (Steen, 2011), as well as sanitation in unserviced areas (Hurn, 2014). Design ethnographers are thus broadening the social agenda of design, in which end-user participation is paramount, and this has led to the development of a variety of participatory methods including various human-centred design approaches (Björgvinsson, Ehn, & Hillgren, 2012; Nilsson, Peterson, Holden, & Eckert, 2011). In these methods, emphasis is laid on the need for design to be more socially, culturally and environmentally responsive (Cipolla & Bartholo, 2014).

Further, the emerging field of design anthropology and ethnography proposes that a designer can become a provocateur who questions the intersections between context, user and design (Barab et al., 2004). As design ethnographers, designers can explore inherent design narratives in working with underserved users, in long-term design processes of innovation that aim for social change (Gunn & Donovan, 2012). In other words, ethnography offers the tools for long-term engagement and deep contextual understanding, while design offers the generative and creative techniques that can facilitate innovative results.

As a trained designer, the corresponding author was generally interested in the technological aspects of the sanitation intervention from the beginning. This interest led to close collaboration with the Maluti GSM civil engineer who was in charge of installations in the Enkanini case. Unfortunately, the corresponding author was not as involved in the actual technical design of the system as she had hoped to be. This was because the design process was controlled to a large extent by the engineer, whose mandate was to prototype the pour-flush and micro-flush toilets specifically. The corresponding author therefore found more opportunity in what the engineer referred to as "non-technical processes."

Upon reflection, these non-technical processes were articulated as the expanding social role of design that transcends technological product design. Nonetheless, the corresponding author still accorded great significance to the technology as demonstrated in the in-depth analysis of the sanitation technology (Ambole, 2016). The less active role in the actual prototyping of the technology was thus supplemented by a thorough understanding of the technology, in an effort to gain an integrated and holistic view of the design process in the Enkanini intervention.

In other words, the focus of the corresponding author as a design ethnographer was not just on the design object (sanitation technology), but also on the design team (engineer and SU researchers), the design users (Enkanini residents) and the design context (Enkanini informal settlement). These were regarded as the components of the design process, and the interplay between them required facilitation. Design facilitation thus became one of the contributions of the design ethnographer, who had to engage with each of the components through long-term participation. This made it possible to further articulate the core design competencies as the generative skills that were employed in the case.

Why Design: *Core Design Competencies*

Design facilitation is premised on the idea that designers already possess the skills needed to support co-design activities with non-designers. These skills are the analytic and creative methods of traditional design, which are: visualising, experimenting, prototyping, gathering feedback, and redesigning (Razzouk & Shute, 2012). Such design skills can be applied through collaborative exercises to augment other professional competencies. In this section, three core competencies of design are selected and used to frame activities that occurred in the Enkanini case. These are: *iteration*, *prototypying* and *visualisation*.

In Phase 1 of the intervention, the technical design consisted of pour-flush toilets, simplified piping and an anaerobic digester. In Phase 2 of the intervention, the pour-flush toilets were to be replaced by micro-flush toilets, which will be discussed under the topics of *iteration* and *prototyping*. In the focus-group sessions, user-generated images were used to enhance dialogue. These images will be discussed under the topic of *visualization*.

The pour-flush toilet bowl and p-trap shown in Figure 2 were initially developed by David Still and partners to flush on 1 litre of water. The current prototype is manufactured from fibreglass

and is flushed by the user pouring a jug of water into the toilet bowl. The design is similar to the pour-flush toilets found in Asia but has incorporated a pedestal design to enable people to use the toilet in a sitting position, as opposed to squatting. Maluti GSM Consulting Engineers redesigned the P-trap (Maluti GSM Consulting Engineers, 2014). The five pour-flush toilets installed in Enkanini are connected to a *BiogasPro-6* anaerobic digester by Agama (Biogaspro Agama, 2014).

Figure 2. The pour-flush toilet bowl and p-trap
(source: Maluti GSM Consulting Engineers, 2014).

Iteration

The pour-flush toilet was installed in Phase 1 of the Enkanini intervention in April 2013. By April 2014, users had expressed dissatisfaction with the pour-flush toilet. This dissatisfaction was attributed to: i) the need to pour water into the toilet bowl by hand, and ii) the need to store greywater for flushing the toilet, a practice that was against Xhosa cultural beliefs. This dissatisfaction was reported by one of the researchers to the engineer, as shown in the following email excerpt:

> We've had some feedback from users re the pour flush being a bit of a pain. Users are finding that they need to dispose of their grey water at different times to when they need to use it to flush. Cultural reasons prevent them from storing grey water for any length of time, they want to discard it immediately, as its generated. Users want flush toilets, they want the automated experience, the convenience of not having to ensure you've got your flush water with you (eg someone had to use toilet urgently as she had diarrhoea and was unable to flush as there was no water… (Tavener-Smith, personal communication, September 17, 2013)

The engineer responded to this feedback by pointing out that the pour-flush toilet bowl, which was developed by Still and Louton (2012), would be developed further into a micro-flush version by Maluti GSM engineers:

> Our work to date has been to demonstrate the design developed by others, but we are now gearing up to develop our own design (the Micro flush toilet) which will utilise the effective pour flush pedestal design with the convenience of a flush… (Harris, personal communication, September 17, 2013)

The corresponding author was to be involved in the design of the micro-flush toilet by facilitating a co-design process with the users. This role was implied in the communications between the engineer and the researchers: "Lorraine and myself will be working on the Micro flush design over the coming year…" (Harris, personal communication, May 31, 2013).

The corresponding author therefore got involved in the initial design process of the micro-flush toilet and discussed the micro-flush design with users in Focus Group 3, which will be described later. At the time of submitting this paper, the micro-flush toilet was still in the design phase. The design phase of the micro-flush toilet illustrates an iterative process that was informed by user needs. Iteration was also demonstrated in the downscaling of the proposed design due to budgetary constraints (Figures 3 & 4).

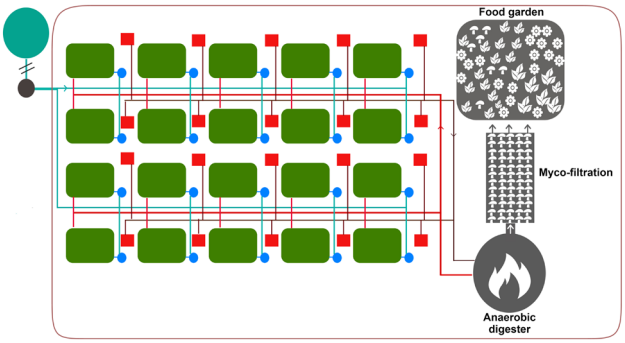

Figure 3. Proposed technical design for the Enkanini intervention (source: research presentation, Sustainability Institute, Stellenbosch University, 2012).

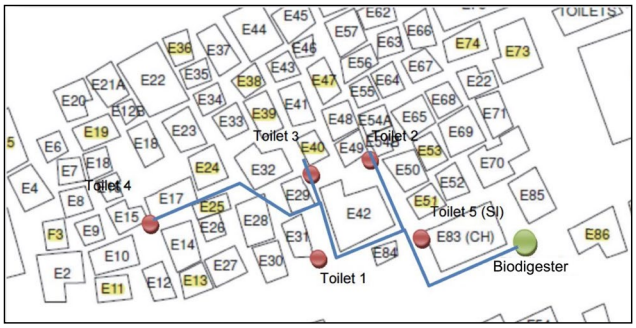

Figure 4. Plan implemented in Phase 1 of the Enkanini sanitation intervention
(source: Maluti GSM Consulting Engineers, 2014).

Prototyping

The concept design of the micro-flush toilet was inspired by the vortex shape of the arum lily, as explained by the engineer. According to the design, the micro-flush system is expected to offer the same convenience as a full-flush cistern toilet, but with a significant water saving. This is due to the spiral flush of water that should clear the pan (Figure 5). Currently, the micro-flush system is being designed by the engineering consultancy Isidima Design and Development. The engineer responsible for the design moved from Maluti GSM to Isidima, and was able to continue working on the micro-flush system. The funding for this work is provided by the WRC and the system is expected to take two years to develop and prototype, starting from 2014.

As an interim measure, the pour-flush toilets in Enkanini were to be fitted with greywater filters in late 2014 (Figure 6). The users would therefore not have to store their greywater in their homes as they would pour it into the filters attached to each toilet bowl.

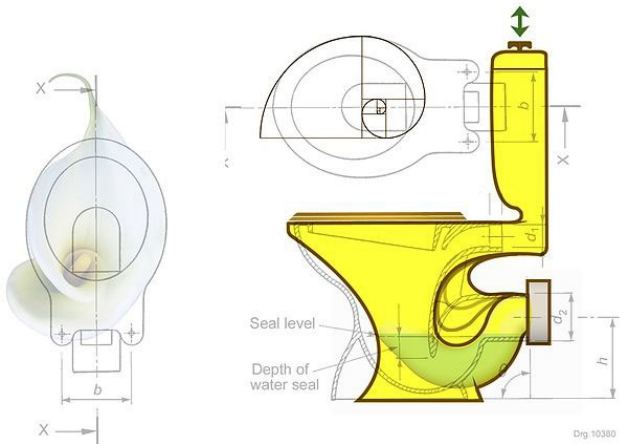

Figure 5. Concept design for the micro-flush toilet inspired by the arum lily flower (source: Isidima, 2016).

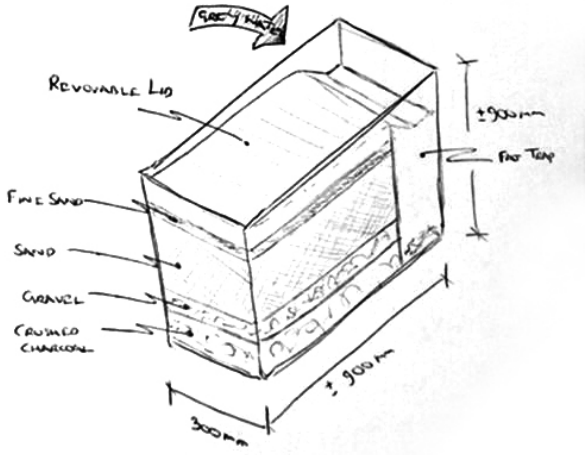

Figure 6. Greywater filter for the pour-flush toilet (source: Harris, personal communication, Jul 12, 2014).

Visualization

As revealed in the focus-group sessions, there were challenges in collaborating effectively with the Enkanini residents. Literature shows that users do not always have the capacity to engage meaningfully in collaborative design processes. Accordingly, participatory design processes should not only seek to involve users in design but also to empower them (Anderson, Curtis, & Wittig 2014). In the Enkanini case, there was a need to enhance user participation as a path towards empowerment.

In research on participation, verbal communication, which is often expressed in the form of rational arguments, limits the participation of stakeholders. More specifically, "text" is a specific barrier to effective participation of vulnerable communities and so "beyond text" tools are advocated for as a way to democratise knowledge by enhancing participation (Beebeejaun, Durose, Rees, Richardson, & Richardson, 2014; Cumming & Norwood, 2012).

Designers have traditionally used visualization as a communicative method: in IDEO's Design Kit, card sorting and collage are recommended as visualization methods (see Design Kit website, www.designkit.org). These methods have proven effective with literate participants who are familiar with analytical thinking and the logic models that underpin such visualization methods. Logic models were considered inappropriate for Enkanini participants who have limited formal education and appeared to prefer a more narrative style of communication. Du Preez, Cilliers, Chueng-Nainby, and Miettinen (2015) used a narrative style in which participants created three-dimensional structures as "story strings." The resulting structures were presented as museum-style abstract installations, which would also not suit an Enkanini audience. Cartoon-strip drawing was therefore chosen as a humorous and metaphorical storytelling tool, well suited to discussing a sensitive topic such as sanitation (Costandius, 2012). Figure 7 shows some of the cartoon strips drawn by participants in the first focus-group session on greywater use.

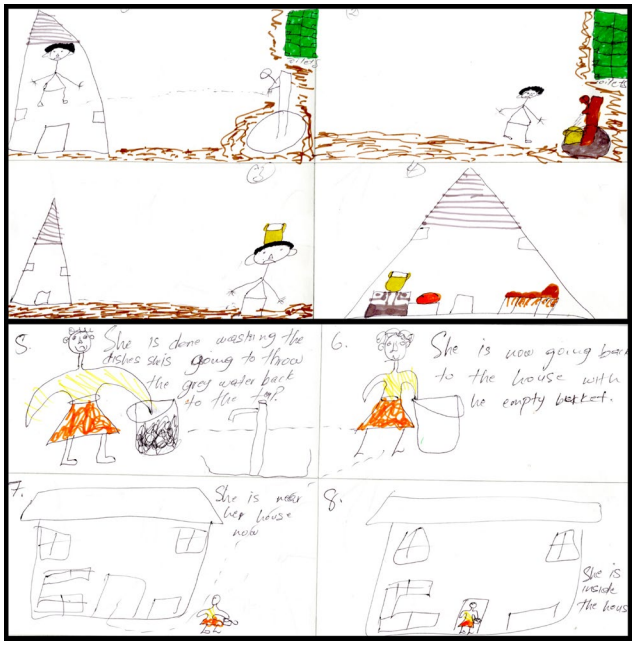

Figure 7. Cartoon-strip drawings by participants in Enkanini (source: focus-group participants).

The imagery generated by the users became conversation pieces that spurred dialogue on issues such as: difficulty in accessing water for daily use; the communal role of shared facilities; the gendered perspective of water access; belief systems governing water disposal; and the health and environmental consequences of poor water disposal. After the discussion, individual drawings from participants were compiled into one cartoon strip to display a shared understanding on the topic (Figure 8).

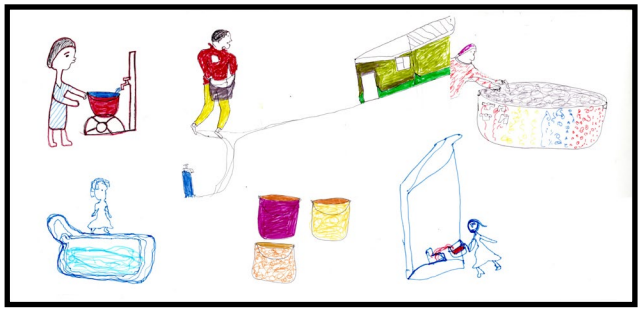

Figure 8. Compiled drawings from individual participants to tell the agreed-upon greywater story (source: focus-group participants).

Despite their immediate effectiveness, the drawing sessions were time-consuming and more involving for the participants. It was therefore not possible to have a consistent group that could participate in a quasi-experiment. The quasi-experiment would have been an opportunity to test the causal impact of the drawing sessions on a specific target group. Nonetheless, the first drawing session, which yielded the cartoon strips discussed above, was considered a success insofar as it enabled dialogue and revealed nuanced user experiences.

In a second session with users, the deliberations from the discussion were compiled by the corresponding author with the help of an Enkanini co-researcher. The compilation was presented as a generative workbook that was to be used in groups to elicit further deliberations and suggestions for the planning of Phase 1 of the intervention. Apart from care and cleaning, the generative workbook also addressed issues of: membership, pilot operator, payments, defaulting, group meetings, and security. It ended with a motto which had been generated during a focus-group session: "Please let us take good care of the toilets because they will improve our health and our lives. Working hand in hand, we can go far." The participants were expected to work on the generative workbooks within these groups. In this regard, the generative workbooks failed to elicit the kind of extended participation that was hoped for. The failure was due to the fact that the participants did not make much effort to meet outside of the organised focus-group sessions, so that the workbooks were never used. Nevertheless, the workbooks still served the purpose of articulating the deliberations from the focus group; hence they were less generative but were informative.

The articulation of these three core design competencies was done in retrospect by appropriating certain actions by participants in the case and framing them as design activities. In this way, design as a practice is not a preserve of the designer since the designer in this case has taken on the broader role of a design ethnographer, and is therefore more concerned with the methodological underpinnings of design.

Infrastructuring: *Conceptual Model for Design Facilitation in Informal Contexts*

The design process in the Enkanini case faced challenges and exhibited inconsistencies between intention and outcome: the SU researchers and the engineer had an explicit but narrow aim to improve sanitation and were driven by academic and professional obligations, while the Enkanini residents had a more nuanced and in-depth understanding of the challenges in the settlement. In retrospect, infrastructuring is one possible way of framing the convoluted design process of the intervention in Enkanini, so as to provide theoretically significant lessons from the case, its challenges notwithstanding.

Using the approach of infrastructuring, the intervention can be reconceptualised as an open-ended network that allowed participants to imagine and visualize social and technological arrangements that were improved collaboratively over time. For such infrastructuring to work, it has to be supported by a community of collaborators who are not necessarily defined by geographic proximity, although the physical environment of Enkanini served as a node for forming a community of practice. A more productive community of practice in the Enkanini informal settlement should thus be an inclusive, outward-looking group that seeks to work with the challenges of informality while taking advantage of formal processes such as academic research and professional expertise.

Communities of practice also need to be dynamic enough for members to join and exit freely, yet have the capacity to contribute meaningfully. In this way, members can attend to other obligations. Members should thus have an exit strategy when they join such a community. An exit strategy guarantees that individual agency is held within the institutional memory of the collective, and not in any one individual. In synthesis, infrastructuring is a reconceptualisation of design as a fluid collaborative process that is complex but yields tangible solutions when there are points of congruence.

Through infrastructuring, design research can bring about radical innovation if it can address the fundamental questions of new meanings and interpretations in technology. In the Enkanini case, the sanitation technology served as a boundary object for a multidisciplinary process in which design was a contributing discipline. It was therefore a point of congruence within a broader agenda for realizing transformative change.

In infrastructuring, it is important to acknowledge that achieving transformative change in underserved contexts may happen at a much slower pace than hoped for. This means that infrastructuring has to be visionary in the search for radical change, but also practical by building on incremental processes (Ernstson, Lawhon, & Duminy, 2014) The design ethnographer should therefore be prepared to deal with challenges such as poor user participation, conflicts amongst members of the collaboration, vested interests and failed innovations.

Conclusion

In this paper, we have conceptualised the expanding social role of design by examining the collaborative process in the Enkanini sanitation intervention as experienced by the design ethnographer. In the intervention, the aim of the collaborative team (made up of a civil engineer, university researchers and Enkanini community members) was to achieve both technological and social innovation by improving the dire sanitation situation in the settlement. The collaboration turned out to be a challenging, long-term, open-ended process. By immersing herself in this process, the design ethnographer was able to analyse activities and interactions in the collaboration and use them to enhance the methodological understanding of design within a complex, informal context.

The findings from the Enkanini case may be limited in scope but they are theoretically significant in that they have been used to articulate infrastructuring as a methodological approach that is open-ended and long-term, and is therefore better suited to informal, complex cases such as Enkanini, which rarely conform

to the more commonly used design-centred participatory processes that make use of logic models. Ultimately, this paper provides an alternative design narrative, in which the designer participates in a multidisciplinary process and therefore has to take on other roles (as a design ethnographer); has to be flexible and agile in order to contribute to the technological and social innovation objectives of complex collaborative undertakings; and has to cede control over the design process. Other complex problems facing the world today could benefit from such an open-ended, flexible design approach.

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