Participatory Design with Marginalized People in Developing Countries: *Challenges and Opportunities Experienced in a Field Study in Cambodia*

Sofia Hussain [1,*], Elizabeth B. -N. Sanders [2], and Martin Steinert [3]

[1] *Department for Engineering Design and Materials, the Norwegian University of Science and Technology, Trondheim, Norway*
[2] *Department of Industrial, Interior and Visual Communication Design, Ohio State University, Columbus, Ohio, USA*
[3] *The Centre for Design Research, Stanford University, Palo Alto, California, USA*

In this article we present a field study where participatory design tools and techniques were used in Cambodia to develop ideas for a device that enables children who use prosthetic legs to walk in mud. The study shows that it can be rewarding to do participatory design projects with marginalized children and prosthetists in developing countries. However, for such projects to be successful, designers and organizations in charge of product development must understand that they will be working under different circumstances than when doing participatory design in developed countries. We identify and describe examples of differentiating circumstances across four categories: human; social, cultural and religious; financial and timeframe; and organizational. The field research illustrates that an important advantage of using participatory design with marginalized people in developing countries is the opportunity to develop empowering outcomes of two types: products that meet the users' needs as well as psychological empowerment of the participants. We propose a pyramid model of empowering outcomes that is based on Zimmerman's (1995) model of psychological empowerment. Based on integrating this notion of psychological empowerment, we present an alternative framework for deploying participatory design in developing countries as it has served us in the Cambodia case.

Keywords **–** Children, Developing Countries, Generative Design Tools, Marginalized People, Participatory Design.

Relevance to Design Practice **–** The article describes experiences from a field study in Cambodia and gives suggestions that are valuable for other designers who want to design for and with marginalized people in developing countries.

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Introduction

The use of participatory design is often advocated when developing new solutions for economically or socially marginalised people in developing countries (see for example Arce, 2004; Sharma et al., 2008). It is argued that through including users in the design process designers can understand their needs better (Arce, 2004). Yet, few studies address the real-life challenges of doing participatory design projects in developing countries or how participatory design methods have to be adapted to local conditions. What possibilities and challenges do designers face when trying to organize participatory projects in developing countries? How do they have to mediate between the wish to have high levels of user participation and cultural, economic, and organizational restrictions? The various forms user inclusion takes, due to practical challenges in real projects in developing countries, are rarely discussed.

Participatory design is a design approach in which users and other stakeholders work with designers in the design process (Sanders, Brandt, & Binder, 2010). Participatory design practitioners share the view that every participant is an expert in how they live their lives and that design ideas arise in collaboration with participants from diverse backgrounds (Sanoff, 2007). The core idea is that the people who are affected by a decision or an event should have an opportunity to influence it. Democratic decision making processes are, therefore, important in participatory design projects (Schuler & Namioka, 1993). The strength of this design approach is that it cuts across traditional professional boundaries and cultures (Sanoff, 2007). However, an important challenge for success is to find appropriate ways of involving and engaging people in participatory design activities (Sanders et al., 2010).

Participatory design was pioneered in Scandinavia. It evolved as a design approach from work beginning in the early 1970s in Norway when computer professionals and union leaders strove to enable workers to have more influence on computer systems in the workplace (Winograd, 1996). Several projects in Scandinavia were aimed at finding effective ways for computer system designers to collaborate with labor organizations to develop

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***Corresponding Author:** sofia@ntnu.no

systems that most effectively promoted the quality of work life. Currently, participatory design is being used in a large variety of fields, such as product design, urban design, organizational development, geography, and information technology (Sanoff, 2007). The underlying assumptions in literature emerging from a Western perspective are usually that workspaces, or other communities, are democratic, that they have high literacy rates, and that there is a reasonable technological infrastructure present (Puri, Byrne, Nhampossa, & Quraishi, 2004). Although these assumptions can also be questioned in Western projects, Puri et al. (2004) point out that it is unrealistic to make any of these assumptions in a developing country context. What happens when participatory design approaches are transferred to cultures that have much stronger social hierarchal structures than Scandinavian societies and have greater variations in education and income level than in Western countries?

The traditional model for participatory design is described in Figure 1. Designers team up with users and some other selected stakeholders to do co-creation, i.e., participatory design. Together, often in workshops, user needs and problems with existing technology or products are identified and new solutions are developed. It is almost taken for granted that participants are available, have the skills for contributing to the design process, and will be able to work together in an egalitarian manner.

Our experience is that this model does not always reflect the situation in participatory design projects in developing countries. In this article we present a field study where we used participatory design techniques in Cambodia to develop ideas for a device that can enable children who use prosthetic legs to walk in mud. There is a need for such a product in Cambodia, especially in rural areas, where the monsoon lasts from May to October and dust roads become muddy. The aim was to involve users, in addition to prosthetists and mechanical engineer students, in the early stage of the design process as much as possible. However, we discovered that the model in Figure 1 was too simplified for the complex context in which we were working. Our scenario looked more like the model in Figure 2.

We never managed to facilitate true co-creation where designers worked with users and other stakeholders at an equal level. Instead, the designer had to take the lead in the participatory design activities. We were also not able to gather together the end-users and stakeholders. Our users lived in extreme poverty in rural areas outside of the capital Phnom Penh. The children had to help their families with household chores throughout the day. They lived in different villages. This meant that if we had

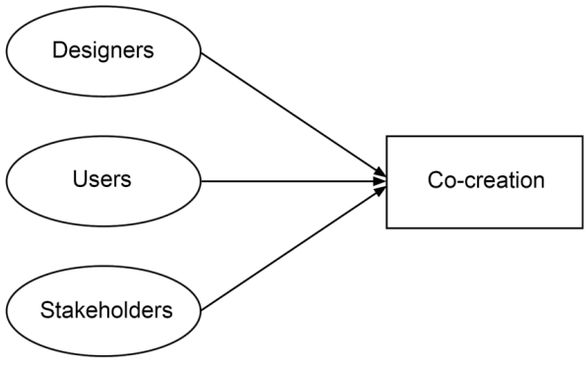

Figure 1. Traditional model for participatory design. This figure is based on a general understanding of participatory design often reflected in literature [derived from Figure 3 in (Sanders & Stappers, 2008, p. 11)].

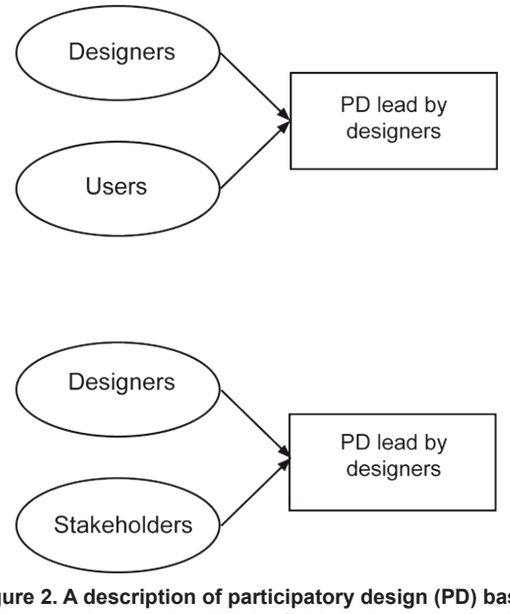

Figure 2. A description of participatory design (PD) based on the experience gained in the field study on marginalized people/children in a developing country.

Sofia Hussain, PhD, is a researcher at SINTEF (sintef.com). She has a MSc. in Industrial Design and has been working with design and research projects in developing countries since 2005. Her research focuses on finding non-positivistic frameworks for identifying and understanding tacit user needs in design projects. This article is a part of Sofia's PhD-dissertation defended at the Norwegian University of Science and Technology.

As an Associate Professor in Design at The Ohio State University (OSU), **Liz Sanders**' focus is on facilitating transdisciplinary learning experiences and co-creation practices for addressing the significant challenges we face today. She introduced many of the tools, techniques and methods being used today to inspire design from a human-centered perspective. Her research at OSU focuses on collective creativity and transdisciplinarity. Liz has a Ph.D. in Experimental Psychology with a minor in Quantitative Psychology as well as a B.A. in Psychology and a B.A. in Anthropology. Liz is also the founder of MakeTools, a company that explores new spaces in the emerging design landscapes. She has been engaged as a design research consultant in industry for over 30 years. Some of her clients have included Apple, AT&T, Coca Cola, Compaq, GE, IBM, Intel, Johnson Controls, Kodak, Microsoft, Motorola, Procter & Gamble, Roche Diagnostics, Steelcase, Thermos, 3M, and Xerox.

Martin Steinert, PhD, is an Acting Assistant Professor Mechanical Engineering at Stanford University. As Deputy Director of the Center for Design Research (CDR) and of the Hasso Plattner Design Thinking Research Program (HPDTRP) at Stanford University Martin is focusing on optimizing the intersection between engineering, new product development and the design process. He has been teaching ME397 a thesis seminar, 'Design Theory and Methodology Forum' and ME243 'Designing Emotion-Reactive car interfaces'. His research interest are 1) the fuzzy front end of new product/service development and design: optimizing the intersection of engineering design thinking and new product development, the diversion/conversion design process; 2) physiology frameworks and mobile in-situ measurement setups for divergent and convergent problem solving activities; and 3) technology and innovation management issues with special interest in disruptive technologies, their socio-economic implications, and their underlying industry dynamics such as adoption and diffusion.

gathered them in one place we would have placed an extra burden on their families who would have to manage without the help of the children (Hussain & Sanders, 2012). Moreover, the users were raised in a culture where children are not encouraged to express their own opinions but to be obedient towards adults. Also when encouraging adults to participate, we had to understand social structures and work around their hectic work schedules as they had to give priority to patients travelling long distances to the clinics. Because of this, it was not a straight forward process to gather participants and enable them to participate. We identified four main barrier categories of factors that made the traditional model for participatory design projects not applicable to our case:

- Human aspects
- Social, cultural, and religious aspects
- Financial aspects and project timeframe
- Organizational aspects

In this article we describe the challenges in each of these categories as they arose within the field study. We also highlight the opportunities that participatory design presents in developing countries if designers are aware of and prepared for dealing with the challenges. Last but not least, based on integrating the notion of psychological empowerment, we will present an alternative model for deploying participatory design in developing countries as it has served us in the Cambodia case.

Participatory Design in Developing Countries

Most of the literature on participatory design in developing countries is from the field of information system (IS) design. Elovaara, Igira, and Mörtberg (2006), for example, investigate the similarities and differences between two participatory design projects in health care in Tanzania and Sweden. In Tanzania, when developing a health management system within a hospital, designers found that they could not take for granted that health professionals would be able to participate. Due to the lack of human resources, health workers had a very hectic schedule and designers had to show flexibility and reschedule meetings when there were emergency situations at the hospital. The designers had to follow the participants during working hours and adapt to their work schedule. In the Swedish project, dealing with IS supporting the work practice of civil servants in municipalities, human resources was not a problem and setting aside time for researchers was seen as a priority. This allowed designers to organize larger workshops with participants. Another difference was that the technological skills of participants in Tanzania were much more limited than in Sweden. The authors conclude, based on the case study, that "[...] participation and how to participate has to be negotiated and adapted to the local setting" (Elovaara et al., 2006, p. 113). The same conclusion is reached by Puri et al. (2004) who examine three case studies on health information systems for communities in South Africa, India, and Mozambique. Different participatory approaches had to be used in each of the three case studies. In South Africa there is a strong tradition for community participation and collective decision making in communities, thus, it was fairly easy for researchers to gather participants from different levels of the community and together form a common vision for the project. In India, on the other hand, a bottom-up approach did not work. The authors explain that this was due to the hierarchical structure of the country with strong government involvement in community issues, a tradition that can be traced back to British colonial rule. The participatory processes, therefore, had to be initiated by the Chief Minister of the state in which they were working. In the project in Mozambique, the inclusion of national academic participants was crucial for the success of the approach. The participating university acted as a bridge between health bureaucracy on one hand, and communities and the local health workers on the other. It was a mediator and inspired local people to participate. Another important point is made by Byrne and Sahay (2007) who emphasize that participants' capacity to participate is often assumed in projects, but that there is often a need to develop this capacity. There are several studies that report that participatory design methods are used in projects in developing countries without going into how participation was organized and if the methods used for involving participants were successful or not. See, for example, Sharma et al. (2008) about the development of a wheelchair convoy system in India and Lalji and Good (2008) on designing a mobile interface for illiterate users in India.

In spite of the growing literature on participatory design in developing countries, there is still a need for more in-depth analyses of case studies exploring both challenges and opportunities for conducting participatory design projects for marginalized people in developing countries, especially of studies that do not focus exclusively on development of IS systems.

The Field Study

The field study described in this paper is part of a larger longitudinal project conducted for the International Committee of the Red Cross (ICRC) from 2008 to 2011. The first author has visited Cambodia five times with an accrued time of around 10 months in the country. That author used participatory research methods in a project with children that identified the need for developing devices that enable prosthesis users to walk in mud (Hussain, 2010, 2011). That need arose from the fact that the cultivation of rice is an essential part of economic life in rural areas and that rice is cultivated in irrigated paddy fields. Children assist in the work in rice paddies. They are expected to contribute to the family household by helping out with farming, taking care of animals, looking after siblings, getting water from the well, etc. (Hussain & Sanders, 2012). Such activities become difficult for prosthesis users during the rainy season since most areas in rural Cambodia are unpaved and prosthetic legs get easily stuck in mud. If children cannot take part in helping their family at an equal level as their siblings, it might have a negative impact on their self-esteem and social status within the family. Both adult and child prosthesis users face these problems. However, adults usually develop walking techniques that prevent their prosthesis from getting stuck. Such walking techniques require a lot of energy and are consequently more difficult for children to use. For this reason, we decided to focus on children in this project.

We also chose to focus on the special needs of children because children with disabilities are often left with downscaled versions of adult assistive devices. We therefore wanted to work the other way around by designing a product for children that – if successful – could possibly be used by adults. The field study does not deal with a complete product development process, but describes an early phase participatory design project where ideas for possible products were generated.

Participants

As noted by White (1996), it is essential to make conscious decisions about who should actually participate in participatory projects. In the field study, we chose to include prosthetists, mechanical engineer students, and children using prosthetic legs. The prosthetists were trained by nongovernmental organizations and work for these organizations by fitting patients with prostheses and other assistive devices. These people meet the intended users on a daily base and are highly aware of user needs, local technical recourses, and economic restrictions. Yet, they do not usually have the organizational power to suggest new products but only to offer input on alteration of existing products offered by their organizations. We wanted to bring forth their abilities by letting them take part in a design project and teach them design skills that could enable them to design new products for people with disabilities in the future.

Two mechanical engineer students were hired through the larger research project to do their internship, as part of their bachelor's degree, at the prosthetic component factory in Phnom Penh supported by the ICRC. These students also took part in the case study. In Cambodia the educational system is still poorly developed after it was totally destroyed, along with all other governmental institutions, by the Khmer Rouge regime from 1975 to 1979 (Ledgerwood, 2002). There are currently no government supported educational institutions offering design education. In a country with as many economic challenges as in Cambodia, it can be a useful starting point for local capacity building in design to teach prosthetists and mechanical engineers basic design principles that can enable them to develop new solutions for people with disabilities living in their own country. By including prosthetists and engineer students in the two workshops described in next section, we wanted to teach them about idea generation.

The larger research project, of which this field study is a part, had a strong focus on bringing forth the voices of children using prosthetic legs (Hussain, 2010; Hussain & Sanders, 2012). Designers should not rely solely on information provided by adult carers but communicate with children directly (Ansell, 2005; Druin, 2002). Earlier research showed the vulnerable social position of children using prosthetic legs in Khmer culture (Hussain, 2011). Three children have taken part in the project as key informants, or "expert-users", since its start in 2008: an 11-year-old girl (Siya), a 13-year-old boy (Socheat), and a 16-year-old boy (Vannak). They have, through their participation, built trust with the first author and become comfortable taking part in participatory research methods (Hussain, 2010; Hussain & Sanders, 2012). We hence chose to also include them in the field study. Ideally, we would have liked to work with a larger number of children. However, travelling to the children's home in rural areas on the outskirts of Phnom Penh required a lot of time since they all lived in different villages. It also took a lot more time and effort to build report with the children than anticipated (Hussain & Sanders, 2012). Because of this, we chose to prioritize the quality of the relationship with participants and visit each child several times over the three years instead of having a larger number of participants.

Figure 3. A 6-year old girl demonstrated how she has to stand outside of the mud while her older brother collects morning glory. They have to collect morning glory each day to raise money to pay for tuition. However, she does not dare to go into the mud because she is afraid that the prosthesis might fall off or water will get into it and make it uncomfortable to wear.

Methods and Procedure

The research for this article was conducted in February-March, 2010 and July-August, 2010 in the Cambodian capital, Phnom Penh, and surrounding provinces. The first author, who is an industrial designer, carried out the fieldwork in Cambodia.

Two workshops with eight prosthetists, three women and five men, and two mechanical engineers students, both males, were organized in Phnom Penh during the first visit to Cambodia. All participants were Khmer. The prosthetists worked for two different nongovernmental organizations providing prosthetic legs and rehabilitation services in Cambodia: Veterans International and the Cambodian School for Prosthetics and Orthotics. The students belonged to the Cambodian Institute of Technology. In the first workshop, the ten participants were paired choosing their own partner. The exception to this was the two engineer students and two prosthetists who were married to each other. These participants were asked not to work together to allow for more diversity in the groups. This was seen as important for facilitating equal participation. The workshop started with a short presentation of findings in the research project that showed the need for a product that could enable prosthesis users to work in mud. This was done to motivate the participants and give them the context for the design challenge. The pairs were then given a set of inspirational pictures (Figure 4). The picture set was developed as a collaborative effort between the first and second author. The first author had experience from previous field trips to Cambodia and knew what materials were easily accessible, while the second author has many years of experience with developing generative tool kits for co-designing. The participants were asked to place the pictures they found most relevant for the design task (i.e., a solution to help children walk in mud) inside the square in the middle of the diagram shown in Figure 5. Whereas, the pictures they considered as irrelevant should be placed outside the square. The participants could also write down names of materials or products on post-it notes and include them in the diagram, if they felt something was missing in the provided set of pictures. The teams used about 30 minutes for organizing the pictures and afterwards presented and explained their diagrams to the others in a plenum session. After the presentations, participants were asked to decide as one group which pictures should be put inside the square. Before ending the workshop, participants agreed on who should bring what of all the selected materials or products in the pictures that they had finally decided to include for the next meeting. They could also choose to bring additional materials or products that could be helpful when developing prototypes.

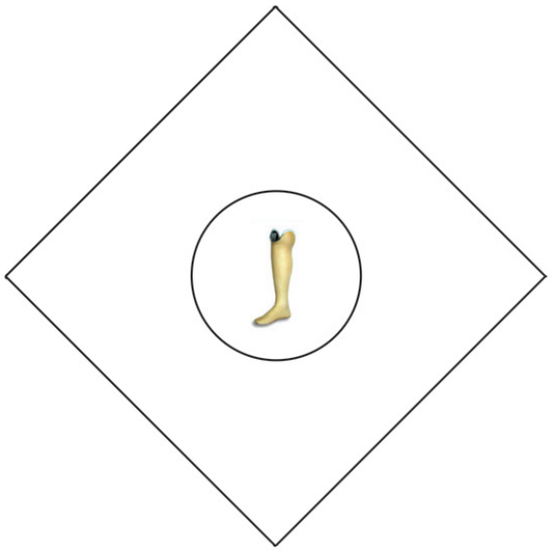

Figure 5. Blank diagram.

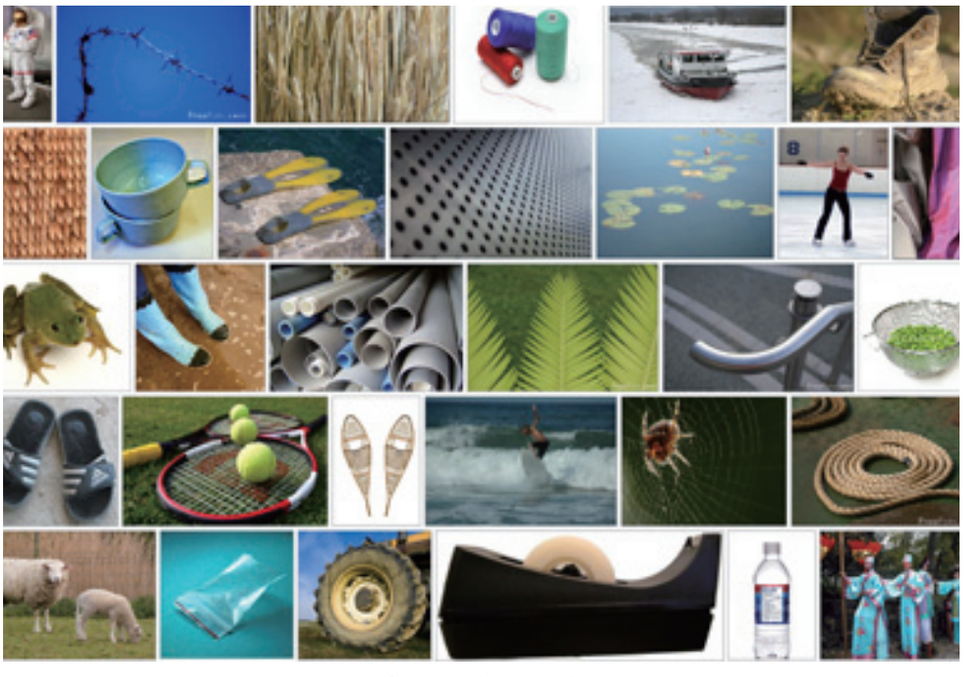

Figure 4. Inspirational pictures.

The second workshop was organized one week later in an orthopaedic clinic. All participants from the first workshop took part except for one man who had to visit his mother in another province. His teammate joined another group which meant we had three groups with two members and one group with three participants. The participants were told that they were free to form new groups, but all of them chose to work in the same teams as in the first workshop. All materials that the participants had brought were put on a table (Figure 6). The teams worked for about one hour in the prosthetic workshop and developed prototypes that communicated their ideas. They worked independently without any interference or guidance from the designer. The participants used the materials shown in Figure 5 and simple cutting and shaping tools available in the clinic. They were told not to be too critical of their design ideas since we were still in the early phase of ideation. Afterwards the teams presented their prototypes and tested them in a bucket filled with mud.

After these two workshops, the designer went back to Norway and used the participants' ideas as input for developing concepts. Three prototypes were developed. These still represented ideas at a very early stage, and not completed concepts. By presenting rough prototypes, we wanted to make it easier for participants to be critical and suggest alternatives. During the next visit to Cambodia, the three product ideas were shown to eight prosthetists in order to get their input. The prosthetists, four females and four males, were interviewed individually. Four of them had participated in the workshops conducted in the earlier visit, whereas four of them were new to the project.

To include the views of children, the one girl and two boys who had been a part of the research project since 2008 were visited by the designer in their individual homes where they were interviewed about their opinions about the prototypes. The results of the two workshops and the feedback given by the prosthetists and the children on the designer's prototypes are presented in appendices A, B, and C.

The data were analyzed by reviewing audio and video recordings, field notes and photographs and tracking challenges in organizing and performing participatory design practises. Discussion among the authors was also a useful tool in the analysis phase. The work was documented and handed to the International Red Cross Committee in the form of a PhD-thesis.

Figure 6. Materials brought by the participants and the designer for the second workshop.

Challenges Experienced

Through the two workshops and feedback on prototypes, we were able to get more insights into user needs, which was the ultimate goal. Nevertheless, we experienced several challenges with facilitating user participation and it has been necessary throughout the process to be flexible and make compromises. In this section, we will describe the challenges we encountered.

Human Aspects

The Designer's Relationship to the Participants

Puri et al. (2004) describe how they had to take different approaches to foster participation in South Africa, India, and Mozambique. Their projects involved the development of IS systems for communities and consequently they focused on community participation. In our field study, we did not work with development of solutions targeted at whole communities such as villages or districts. Nevertheless, we had to find ways of motivating the selected participants to take part. The key to convincing users and other stakeholders to participate was to build trust with them over time.

Visiting the users several times in their homes and showing interest in their lives and concerns helped the designer win the trust of the children and their families. The first time she visited, she brought a community worker along who knew the families. This was important for getting access to the users' private homes before trust was established.

The prosthetists who took part in the project also knew the designer from previous visits and this probably influenced their willingness to take part as they were motivated to help her. Moreover, understanding the social hierarchy was important for organizing the two workshops with the adults. Khmer society is well known to be very hierarchal and social relationships are structured vertically in terms of power, status, and patronage (Hinton, 1998; Ledgerwood, 1990). It is a part of good etiquette and moral order to show obedience towards one's social superior. Children must obey their parents, employees their boss, a wife her husband, and students their teachers (Hinton, 1998). Age is important for social status and Cambodians are taught that they should respect the ones who are older than themselves (Ovesen, Trankell, & Öjendal, 1996; Smith-Hefner, 1999). The designer consulted the prosthetist she knew best to get advice on how to motivate people to participate. She was advised to get one of the oldest and most respected prosthetists on board since if he supported the project, others would attend the workshops. Additionally, she had to understand that social obligations towards family members are very important in Khmer culture (Smith-Hefner, 1999). For this reason, she could not expect participants to want to set aside many hours in the evening or during the weekend for work. Keeping the workshops short and being flexible with scheduling was essential for recruiting participants.

Puri et al. (2004) found that the participating university in their project in Mozambique took an active role and functioned as a bridge between different stakeholders. In our study, the university was very passive. The students were allowed to work with the designer as part of their internship at the ICRC component factory but aside from this, the university did not take part in the project. The students regarded the designer as their boss and teacher and participated in the workshops simply because she asked them to.

Access to Users and other Stakeholders

Even though the relationship to the participants proved to be essential for their willingness to take part in the project, this was not the only factor that influenced the conditions for participation. Access to participants, in terms of both physical distance and time, was also important for how and how much we could work with users and health workers.

We believe it could have been really rewarding, both for us and the children, to gather the three children and let them work together on designing simple prototypes. This would have increased their level of participation. However, we did not find an appropriate method for facilitating this. Parents had in earlier interviews expressed concerns about the time required to take children to Phnom Penh for getting new prosthetic legs. They had to leave their work and other children behind in the village and lost their income that day. All the children lived in three different villages, so we could not organize for them to meet in a place that would be close to all three's homes. We would also have liked the children to take part in the workshops with adult prosthetists. The feedback given from children on the prototypes (see Appendix C) does show that they did have the ability to contribute meaningfully to such workshops if they were given the opportunity. However, based on previous experiences we knew that this would not be appropriate. The designer had earlier in the project asked children to show her where they would normally play and spend time away from their home. None of the children had responded to this activity. They explained that those places were far away and that they could not show them to the research team. One boy agreed to walk us to his school so we could understand why he struggled with getting to school. The school was less than a 10 minute walk away from his house. Before leaving, we had asked the boy's mother for permission to walk with him to school. However, she came running after us after a short while and said she was worried because the school was so far away. When discussing this with Khmer adults who had been working with children through nongovernmental organizations, they explained to us that in rural areas child abuse is a big problem and children, especially girls, are taught to be careful of going far away from their homes. Newspapers in Cambodia also report daily about children who are sexually exploited in villages. Because of this, we chose never to take children away from their parents and to do all interviews at a place where parents could not interfere but see us at all times. In Cambodia, children have to help out their families with household chores. Hence, we had to be careful about not taking up too much of the children's time, since this would be a burden for their families. Instead of gathering them in workshops, we had to go to their homes and make sure that their voices were heard in the product development process through us.

Ideally, we would have liked the prosthesists to take part in the entire product development process. However, simply to organize the two workshops and get feedback from prosthetists was challenging since all of the participants had full time jobs. Participation had to take place in the evening or on the weekend. Even though the prosthesists were willing to spend time helping the designer because they cared about the users, one could not expect them to participate for longer times since this in reality meant having two jobs. Several of the participants were taking part in English and sign language courses in evenings and weekends through the nongovernmental organizations they were working for. It was therefore not easy for them to devote time to our project. As noted by White (1996) and Michener (1998), participants become tired of being volunteers and taking part in activities in the name of participation. Participation requires time and energy and participants might want to use this on other productive or recreational activities (Michener, 1998). A full product development process takes a long time, and the only way to resolve this issue was for the designer to develop prototypes on her own and then ask for participants' feedback. Even getting feedback from prosthetists was difficult, because this had to be done in between their busy work schedules and the designer could not interfere with their normal work responsibilities. This is in accordance with the experiences of Elovaara et al. (2006) who also had to adapt to the work schedule of busy health workers in their project in Tanzania.

Participants' Capacity to Participate

Like Byrne and Sahay (2007), we recognize the need for developing participants' capacity to participate. Not all of the ideas developed in the creative workshops were realistic and some of them had clear problems in terms of usability. It should be noted that the participants were told that they should not be too critical since this would interfere with creativity. However, in the second workshop, they did tend to take thoughts from the first workshop too literally and did not do much to further develop initial thoughts. This shows that they may benefit from learning more about the design process and product development. All people are creative, but they need to have the opportunity to immerse themselves in thinking about the problem, to learn about the creative process, and be given the tools with which to express ideas (Sanders, 2006). It could have been beneficial to organize a short session to teach participants about the various stages in a design process before undertaking workshop 2. Some exercises about creative ways of thinking may also have been beneficial.

In participatory design projects, co-creation and democratic decision making processes are seen as the ultimate aim (Schuler & Namioka, 1993). The designer should step back and act as a facilitator and let the participants take the lead (Arce, 2004). However, it is our experience that it can be challenging to do this

in the early phases of a project. It takes time for participants to learn how to take part in design projects and creative processes. We believe that often participatory design projects in developing countries are led by the external designer as opposed to being user-led or led by the local product developers in the early phases of a project. This can be a necessary step towards teaching participants how to participate. The adult participants reported that they had never taken part in these types of creative workshops before and that they felt that they had learned a lot about design activities through their participation. If they are given some more training in designing products and services, they should, in future projects, be able to take a more active role in co-creating solutions. The same can be said about the child participants. Through meeting the designer several times and taking part in many open-ended exercises (Hussain, 2010; Hussain & Sanders, 2012), the three child participants showed more confidence and at this point they will probably be comfortable with participating in workshops.

Language Barriers

It is not only the capacity and skills of the participants that impact participation; the designer did not speak Khmer and this was clearly a challenge when working with children and parents as they did not understand English. Communication consequently had to go through an interpreter. During this field study, we were able to find a skilled interpreter but throughout the larger project that this study is a part of, there have been instances where incorrect translation has made it difficult to communicate with the children. Interpreters sometimes try to be helpful by "clarifying" or adding to the interviewer's questions. This makes it difficult to know to what questions children are responding. This problem is also reported by Winschiers-Theophilus, Chivuno-Kuria, Kapuire, Bidwell, and Blake (2010) from their participatory design project in South Africa.

The prosthetists and engineer students were proficient English speakers. Language barriers were, therefore, not a problem during the two workshops with adults.

Appropriate Ways of Rewarding Participants

Designers cannot assume that people who are living in extreme poverty and working hard for survival will prioritize their time to participate in design projects. Since participants were not paid salaries, it was important to reward them in other ways for their contribution. This was done by thanking them in person, both the children and the adults, and showing appreciation for their willingness to help. The children were given a small sum of money (5 USD) and some school materials (pencils, pens, books, etc.) to compensate them and their families for the time we had taken up. Tangible gifts were given in addition to money to make sure that the children also received something, since parents were most likely to keep the money.

The adult participants were not given any monetary compensation, but after each workshop they were taken out for dinner. This was important both for socializing and rewarding them for their time. Appropriate ways of reimbursing participants depend on local culture and customs. The designer consulted some health workers prior to the field study to understand what participants would be expecting from her and followed their advice.

Social, Cultural, and Religious Aspects

Social and Cultural Structures that can Make it Difficult for Participants to Collaborate at an Equal Level

Social structures influence group dynamics in participatory activities. Social hierarchy in Cambodia is linked to a number of factors, including: age, sex, familial background, birth order, occupation, political position, influence, education, and financial situation (Hinton, 1998). Natural inequality of members of society is morally legitimized since Buddhism teaches, through the concept of karma, that a person's situation in this life is determined by deeds in previous lives (Kirsch, 1981). When the oldest and most respected prosthetist spoke, the other participants always listened carefully and no one objected with his views. However, he also showed great respect for the other participants' ideas and let them talk freely. All prosthetists previously knew each other, and many of them had studied together; they seemed comfortable with sharing opinions and collaborating. The two engineer students were both new to the group. They were quieter than the other participants and took on a subordinate role in the beginning of the first workshop, but gradually they became more active in communicating ideas. Some of the women were also quite silent, but if the designer addressed them directly and asked them for their opinion, they always responded with insightful answers. The prosthetists that participated are known to be among the best qualified prosthetists in Cambodia and they all had high recognition within their NGO's. Two of them were managers but still their positions in the NGOSs were fairly at an equal level. This probably made it easier for them to collaborate without restricting power imbalances.

Customs and Religious Beliefs that can Impact Participants' Willingness to Share Opinions

Understanding the local culture was essential for knowing how to approach participants and treat them with respect in accordance with their culture and beliefs. In the beginning it was frustrating when children would not give any answers to open-ended questions (Hussain & Sanders, 2012). Through learning more about the cultural and social implications of having a physical disability in Cambodia, we developed a better sense of why we were getting so little information from the children. People with disabilities are often discriminated against since in Buddhism it is believed that one's situation in this life is the result of one's merits in previous lives (Hussain, 2011). Socheat, for example, noted that he did not want to use prototype 2 (see Appendix C) since it did not have natural looking toes and people claimed he had been a soldier in his previous life when they saw that he used a prosthetic leg. Being poor is also seen as a reflection of deeds

in former lives (Hinton, 2004). Additionally, social hierarchy is closely related to age; older people should be respected. Children are not encouraged to express their own views but to do as they are told by adults (Hinton, 2004; Miles & Thomas, 2007). The children we worked with, therefore, faced discrimination because of their physical condition, age, and financial situation. They were socially marginalized and not used to the fact that their views matted to others. They needed time for getting accustomed to reflecting upon and expressing their own opinions. Additionally, according to Buddhist beliefs, one should never show ingratitude. Consequently, we had to rephrase some questions so that the children would not be worried about criticising. Instead of asking the children what they did not like about the prototypes, for example, we asked them what they really liked about them and what they liked a little less.

The adults on the contrary, were not afraid of sharing ideas and opinions. However, they were very careful about criticising each other and not to give negative feedback on prototypes. This can be linked with the concept of "face" in Khmer culture. Hinton (1998) defines face "[...] as a sociocentric self-image that is based on the evaluations of others and shifts along an axis of honour and shame" (p.101). From a very early age, children are taught that they must consider their social standing and not bring shame on themselves and their families. Not to lose face and honour in front of others is given strong cultural emphasis and Cambodians often do hide negative feeling to avoid losing face or making someone else lose face. If you protect the face of others, they will protect yours (Hinton, 1998). It was difficult to create a climate where participants could give honest feedback on each other's ideas as any negative evaluation could make the owner of the idea lose his or her face. A possible solution around this could perhaps have been to ask participants to give feedback anonymously in writing.

To our surprise, the designer did not experience problems with getting honest feedback during evaluation of her prototypes. Prosthetists were not reluctant about telling her about possible problems with the product ideas. This could have been due to the fact that interviews with prothetists were done individually without anyone else being present. The health workers therefore did not have to worry about ridiculing her in front of others. The designer also encouraged them to be honest by making it clear that she needed their advice. She emphasised that she knew that the prototypes were not perfect and that any input would be of great value to her.

Financial Aspects and Timeframe

Available funding and time obviously impact how and which participatory activities can be organized. A possible way of resolving the challenge of motivating adult participants to take part in the workshops could have been to pay them for working on the project in the evenings. But in a small project like this, we did not have the means for paying salaries and we were also worried about attracting participants who only took part because of an economic reward. By not offering salaries, we found that participants took the time to contribute to the project, because they wanted to support it.

The number of workshops that can be organized and times that children in remote areas can be visited also depend on economic resources and time available. In spite of practical constraints to implementing high levels of participation, we were able to include prosthetists and child amputees in the product development process. However, we recognise that if we have had more time and funding, we could have given participants more training in design methods and encouraged them to have a more active role in the product development process.

Organizational Aspects

The designer had the permission and the support of ICRC to carry out the field study, but the participatory design project was done quite independently of the organization. It was planned as a pilot study to see how well participatory design would work in this particular context and if this approach was something that could be recommended to ICRC. In future work it will be important to integrate user participation more into the product development process of the organization.

For participatory design projects to be successful, they must be embedded into the product development strategy of the organization producing or providing products. The organization must recognise the value of user participation and that better knowledge of user needs can be derived from such approaches. Support of participatory design at high levels of the organization is necessary for ensuring that adequate resources for participatory design activities are set aside. Transferring decision-making power in product development from high ranking employees to participants does not happen overnight. The ease of the process will depend on how hierarchical the organization is and whether it has a tradition for collective decision-making processes or not.

ICRC focuses on creating local ownership of their projects to make sure the work continues irrespective of the presence of NGOs and development agencies in the future. The goal is to transfer the responsibility of providing physical rehabilitation services gradually to the Ministry of Social Affairs, Veterans and Youth Rehabilitation (MoSYV). The component factory is already formally owned and run by MoSVY, although ICRC provides most of the funding for operational and material costs. Shortly, all orthopaedic clinics now run by NGOs will be handed over to the ministry. This is hence a crucial time for establishing good practises for product development. ICRC has already created a climate where the head of the factory uses the advice of skilled prosthetists to make product improvements. There are, therefore, some existing structures of active participation of prosthetists that should be built upon to become more coordinated co-design processes.

ICRC has created subcommittees across NGOs working with physical rehabilitation. There are subcommittees for prosthetics and orthotics, physiotherapy, and wheelchairs. The committees meet once a month at the component factory. We recommend that the subcommittees for prosthetics and orthotics and wheelchairs should be merged into one committee and given training in product development and participatory design processes. The designer observed that ideas for changes were

quickly implemented by the factory without adequate user testing and evaluation of other options. The creation of a product development team of engineers and prosthetists who are taught about product development processes is therefore important for ensuring quality.

Health workers and engineers are already used to cooperating with product improvement at ICRC. Creating acceptance for involvement of end users, however, will be much more difficult and require more time since there is no tradition for involvement of this group. Prosthetists report back patients' feedback but this is not enough. Working with the children gave a much deeper understanding for their lives and needs than only talking with adult health workers (Hussain, 2010; Hussain & Sanders, 2012). For including end users in the design process, a top-down decision probably will have to be made within ICRC in Cambodia since listening to the voices of children, with disabilities, from poor families is not grounded in Khmer culture and tradition.

Opportunities Discovered

The field study showed opportunities both in terms of product development (see Appendix D) and especially through the empowerment of participants. The wish to bring forth and further develop the abilities and skills of local people leads to a new way of thinking about design processes.

Insights for Participatory Design - Creating Sustainable Results through Participation and Empowerment

When designers undertake participatory projects in developing countries, the aim should not be only to provide a product or service that can "fix" a current problem but also to build local human capacity so that future design projects can be carried out without being dependent on foreign designers. The goal of participatory design projects should not be to just develop tangible solutions but also to yield intangible results such as psychological empowerment of participants. According to Zimmerman (1995), psychological empowerment comprises intrapersonal, interactional, and behavioural components. The intra-personal aspect refers to how people think about themselves. The interactional component relates to people's critical awareness of what is needed for achieving their goals such as options, influencing factors, and norms and values in a particular context. The behavioural component includes actions that address needs in a specific context. Figure 7 shows how this can be transferred to design projects.

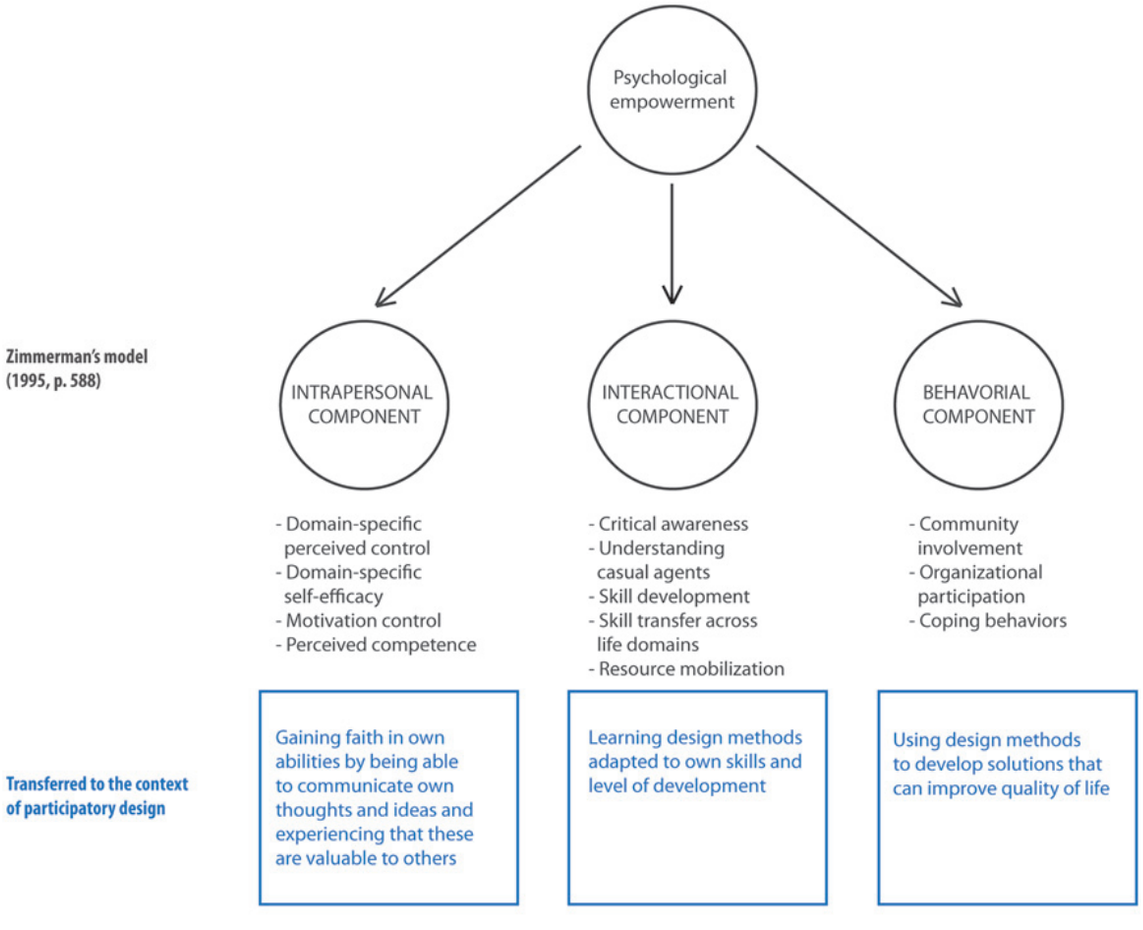

Figure 7. Psychological empowerment in design projects (Hussain, 2010, p.107).

It is useful to distinguish between empowering processes and empowered outcomes (Zimmerman, 1995). The first refers to how people, organizations, or communities get empowered, whereas the second refers to the consequences of those processes. Participatory design can be an empowering process that results in empowering outcomes. Such outcomes can be that participants gain more confidence in their own abilities by taking part in developing solutions that can help both themselves and others. The solutions developed can also be viewed as empowering outcomes, since they can contribute to giving participants better lives. A prosthetic leg, for example, can enable an amputated child to have a more independent lifestyle and to walk as much and as fast as other children.

The Zimmerman model transferred to the context of participatory design advocates for an approach where the product is not seen as the only aim of the design process. Instead, designers should strive for psychological empowerment of users and other stakeholders. By empowering participants, designers contribute to building local human capacity and enable people in developing countries to undertake their own design projects in the future.

The pyramid model visualizes the various layers a designer has to explore when striving to develop solutions that are socially and culturally acceptable for people. Based on our experience of how important it is to build human capacity, the original model (Hussain & Sanders, 2012) has been expanded. In the expanded model shown in Figure 8, we have put empowering outcomes at the top of the pyramid instead of only the product. The left side of the pyramid shows a typical design process, whereas the right side reflects actions needed for empowering participants. Designers need to work with both sides of the pyramid in parallel but do not have to work with only one layer at a time or in a specific order.

A typical approach for designing products for people using prosthetic legs in Cambodia, would usually start with scanning literature about the culture and demographics of the country and getting an overview of production facilities and technical production constraints. A designer would then typically ask prosthetists what they believe is most essential for users and what properties of the current product should be changed. Interviewing some users would also usually be a part of the process to investigate user needs. This was how the first author started her design process when wanting to improve prosthetic legs for children in Cambodia (Hussain, 2010), but she soon discovered that it was impossible to understand the many challenges users face through brief interviews and observations. Instead, she had to revisit the children several times. She had to find ways of communicating with the children that raised their ability to express their own needs

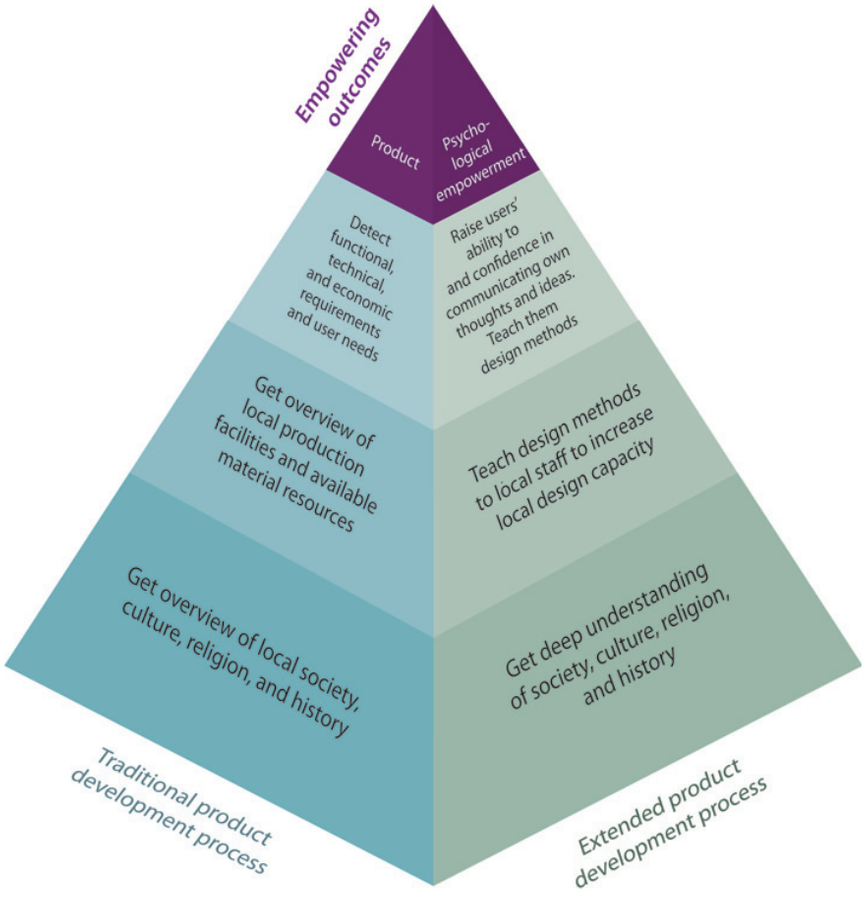

Figure 8. New pyramid model. The pyramid represents an empowering design process with empowering outcomes.

and desires and become more confident (Hussain, 2010; Hussain & Sanders, 2012). Moreover, to really understand the social and cultural needs, it was necessary to understand what it meant to be disabled in rural areas of Cambodia through in depth interviews with children and their parents as well as Buddhist monks, traditional medicine men, adults who had been using prosthetic legs since childhood, and children without disabilities (Hussain, 2011). Through this process, we learned about the deeper needs of children. It was already known that the current prosthetic foot was too heavy and stiff, the cosmetic cover of the prosthetic leg got worn out too quickly, and the prosthetic components were too big and bulky for the smallest children. The prostehtists had noted that users tended to be really concerned about the appearance of their prostheses. However, it was not before doing more participatory research with children that it was understood how aesthetical concerns were linked to Buddhist beliefs about disabilities and should, therefore, not be treated as mere user preferences but as actual user needs. Initially, since the larger research project that this case study is a part of is carried out for the ICRC, the first task was defined as improving prosthetic legs for children in Cambodia, and later narrowed down to improving the prosthetic foot. It was through doing participatory activities with the users that the importance of providing support products that could enable them to walk in mud was discovered in this project.

Any design project should be based on a strong understanding of the history, culture, and society of where the product will be used. This is, therefore, the foundation of the pyramid model. Additionally, along with acquiring an overview of available production facilities and material resources, designers should investigate needs for improving the technical skills of local producers to increase production capacity. In some developing countries, there is no formal design education. Local producers, in our case factory staff and prosthetists, therefore function as local product developers. By teaching local product developers about design methods, we can help build local design capacity for future projects. In parallel with investigating user needs, designers should look for ways for including users in the design process and empowering them to express their own needs by giving them confidence in their own abilities. The pyramid model represents an empowering process that leads to empowering outcomes in the form of both a product and psychological empowerment of participants.

Zimmerman (1995) rejects the idea that a global, universal measurement of psychological empowerment can be developed since empowerment is context-dependent. Psychological empowerment is an open-ended, dynamic construct and not a static trait. This implies that every individual has the potential of becoming more or less empowered at any given time. It has not been our goal to measure or track the empowerment of the participants in the field study. However, in all participatory design projects it can be useful for designers and design researchers to reflect on how the participants have been influenced by their participation. In this field study, we have so far not worked closely enough with the adult participants for them to be truly empowered. They have only taken part in two workshops. Still, even at this early stage, they reported that they felt they had learned idea generation techniques that could help them in the future when trying to come up with new solutions for people with disabilities. The children, who had been participating in the project since 2008, seemed to be much more self-confident when talking about their own opinions. They did not need as much reassurance as earlier when answering questions. Table 2 in Appendix C shows that the children's comments on the prototypes were as detailed and valuable as the adults'. Vannak said that before he had been very shy when talking with other people, but now he felt much more confident since he had been able to communicate with the designer: "*For example, before I didn't dare to talk with other people, but now I dare to speak to them […] Because when she [the designer]came, I spoke to her; then I started to dare to talk with other people.*" Since the designer had previously asked him about his hopes for the future (Hussain, 2010), he had become aware of his dream to have a chicken farm and felt motivated to start raising chickens. Unfortunately, all his birds had died because of a disease. Nevertheless, he had felt empowered to take active steps towards fulfilling his dream and shown confidence in his own abilities. Siya explained that she had liked giving feedback on the prototypes because she felt she took part in developing something that could help other children. Socheat told that the villagers admired him for having visitors from abroad coming to ask for his opinions – in spite of his disability. He now felt he had "good honor" in the local community. He also said that because he had to think about his responses, his way of reflecting had improved: "*Because you ask me new questions and I also try to think and respond to your questions. […] My thinking is making progress.*" Socheat explained that he liked being asked questions about living with a disability because his responses to such questions "*[…] reflect the view of my heart*." All three children said that it was important for designers to not only consult prosthetists, but also to talk with children who use prosthetic legs since they know more about their needs. This is a huge step from the beginning of the project (Hussain & Sanders, 2012) where the children showed little confidence in their own opinions.

The children's feedback indicates increased psychological empowerment on mainly the interpersonal level in Zimmerman's (1995) model (Figure 7). Even though the children have learned about design methods through taking part in some design activities, more participation is needed to increase their empowerment on the interactional and behavioural levels.

Implications of the Experienced Challenges and Opportunities

The field study shows that it can be rewarding to do participatory design activities with marginalized people. We argue that for participatory design projects to be successful, designers and organizations in charge of product development must have realistic expectations and understand that they will be working under very different circumstances than when doing participatory design in developed countries. They must be aware of the possible challenges and be prepared to deal with them.

Designers should recognize that it takes a long time to build a relationship with participants and that before this relationship is built, participatory design activities are not likely to give

deep insight into user needs and product requirements. Having profound knowledge of the local culture and society is essential to motivate people to participate and to organize design activities in a culturally appropriate way. Designers should, therefore, set aside enough time to understand the local culture and use this understanding when engaging with participants. The best way to get cultural insight is to spend time with different stakeholders, and not only the intended end users. In our field study, for example, Buddhist monks, medicine men, children without disabilities, government officials, and prosthetists were also consulted.

The organizations or companies that are producing and distributing products would benefit from acknowledging the value of including users and other stakeholders in the product development process. Participatory design projects should be supported at high levels within the organization to make sure that the necessary resources, both time and money, are allocated for co-design activities. Additionally, organizations have to restructure themselves so that decisions about products are no longer made from the top down but in collaboration with participants. If participants experience that their input is ignored repeatedly, they cannot be expected to be willing to keep participating and being engaged in the project.

The most important implication of the findings in the field study, for both designers as well as producers, is to recognize that it a takes long time to establish a participatory design project. The lead time needed for understanding local culture and training participants turned out to be much greater than anticipated. Project plans and funding should reflect this. Instead of the model presented in Figure 1, we experienced a participatory design situation and evolution as described in Figure 9.

In the initial phase of the design project, described in this paper, the designer had to design and lead the participatory design activities with children and adults. Through this work, the participants learned about design methods and became more confident in their own abilities. We therefore believe that if we continue to work with the participants, they can in the next phase take the lead to a larger extent. One future goal can also be that users and other stakeholders design together. However, before gathering adult and child users in Cambodia it is necessary to train them to work with each other. Power structures and customs for interaction with children and concepts about their place in society can make it difficult for both children and adults to cooperate as equal design partners. To put them together in a workshop without preparing them is not ethical. This is something designers should be aware of not only when working with poor children with disabilities, but any child or adult user group which is socially marginalized, such as illiterate women. Designers should evaluate the benefits and drawbacks of having joint workshops with users and other stakeholders in each specific case. It is important that users' voices are heard and that users are included in the design process but it should not uncritically be assumed that gathering all types of participants in one workshop or design activity is always the ultimate goal. Being flexible and adapting participatory design methods to the local situation and cultural context is necessary.

Conclusions and Further Research

In this field study, we attempted to transfer the participatory design approach into a developing country, marginalized people situation. We found that specific obstacles prevented us from deploying a traditional participatory design approach. Based on our concrete field experience, we derived four main barrier categories and described various factors in each category (see Table 1).

This is not an exhaustive list that shows all possible obstacles in participatory design projects in developing countries, but a first collection based on the main challenges that we encountered. We argue that these categories, though specifically derived from our field study, point to the existence of general barriers for participatory design in developing countries with users

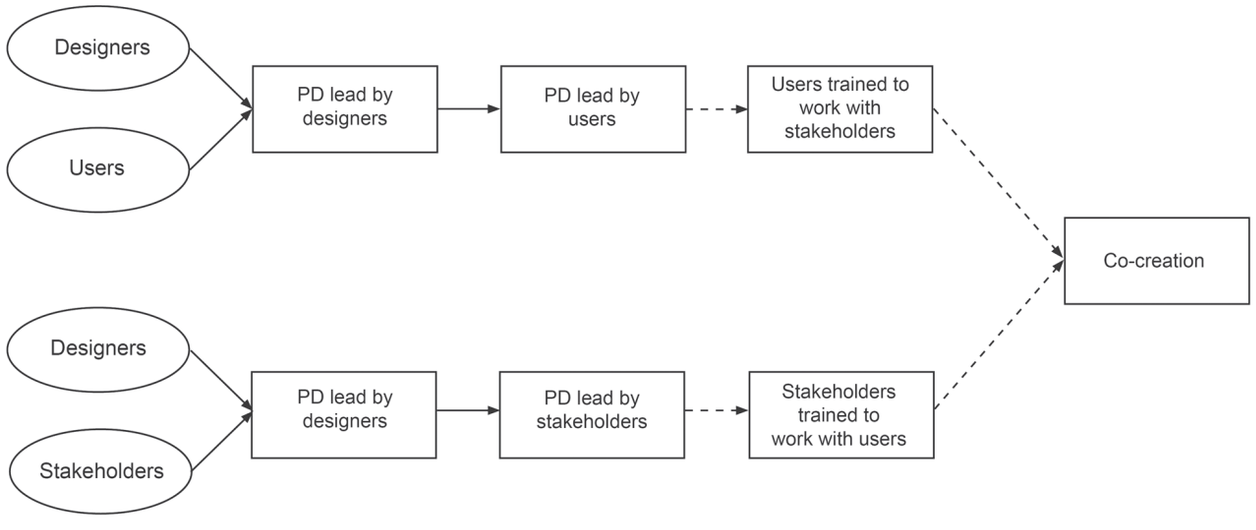

Figure 9. Evolution of participatory design projects for marginalized people (children in this case). The dashed lines symbolize steps that might not be appropriate for all projects.

Table 1. Factors that can lead to challenges in participatory design projects.

Category	Factors
Human aspects	• Designer's relationship to participants • Access to users and other stakeholders • Participant's capacity to participate • Language barriers • Appropriate ways of rewarding participants
Social, cultural, and religious aspects	• Social and cultural structures that can make it difficult for participants to collaborate at an equal level • Customs and religious beliefs that can impact participants' willingness to share opinions
Financial aspects and timeframe	• Financial resources available for transport, rent of workshop premises, hiring translators, training participants, etc. • Time available for training participants and gaining their trust
Organizational aspects	• The recognition for the importance of user participation in the organization • The willingness to allocate recourses for participatory design processes • The hierarchy within the organization that produces or provides the product • The tradition for using participatory design processes in the organization

who are marginalized by society. In line with other literature, we suggest that participatory design approaches used in the Western, developed world cannot be transferred directly to developing countries. The preconditions for participatory design -free and unhampered exchange of thoughts, democratic decision building, unbiased integration of people and opinions, and the necessary financial and organizational strength - cannot always be taken for granted, especially not in such countries. The main indictor of this initial breakdown of the participatory design principle was reflected in the problem of physically and procedurally/ motivationally getting users and stakeholders to co-create, both with the designer and with each other.

Based on the notion of psychological empowerment, we successfully (but slowly!) engaged into this process in the following sequence:

- Gaining deep understanding of the society, religion, and history.
- Teaching design methods to increase local capacity.
- Raising user ability and confidence to communicate their own ideas and to engage in design processes.

As a result of the psychological empowerment of participants, we were able to address some of the inhibiting challenges. We argue that this empowerment process enabled us to deploy an adapted version of participatory design, which may ultimately lead to the desired product innovation.

We are aware that this research is just a first step in understanding the barriers to undertaking participatory design projects in a developing country and marginalized people context. It is an even smaller step in identifying, developing, and ameliorating methods to overcome these barriers. We also acknowledge that there might be different challenges in different developing coutnries. To this end, we propose to conduct more field studies under comparable circumstances. Instead of focusing on recording and analysing only early design stages, as done here and in other literature so far, we would like to suggest broadening the research and project horizon to also include later design stages as well.

Two other opportunities for future research emerged in this study: Firstly the systematic tracking and analysis of the empowerment (or disempowerment) of participants – this will require the development of new methods, frameworks, and tools – and secondly the closer scrutiny of the value system of the stakeholders and its impact on their motivation for participating in design projects.

Acknowledgments

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Appendix

Appendix A: Results of Workshop 1

During workshop 1, the participants chose the 18 pictures in Figure 10 as their inspiration for developing prototypes of products that could help prosthesis users to walk in mud.

The participants selected the picture of willies (gumboots) and explained that it represented a protective sleeve like a plastic bag that could protect the prosthetic leg from mud and water. The image of cotton threads was selected because of the bright colours of the threads. The participants explained that when developing solutions for children, it is always important to think about aesthetical appeal.

Many of the photos were chosen in reference to the materials shown in them to be lightweight, such as silk, straws, and the strainer (which was interpreted as a foam material), and plastic pipes. They explained that prosthetic legs should always be as light as possible since amputees have reduced muscle strength. The product developed should, therefore, not add too much weight when it is worn on the foot. The image of the skater was selected because it represented being able to walk in a new way. It could be necessary to teach prosthesis users new techniques for walking in mud even if they are provided with a product that makes this easier. The participants agreed that they wanted to include the pictures of the surfboard, boat, and water lilies as one group since they all had shapes that could help the product float. The peg leg and the tip of the water bottle had shapes that would be easy to drag out of mud. Whereas, the frog has skin that would not allow mud to stick to it easily. The frog also represented a spring that could store and release energy helping a prosthesis user to bring his or her prosthesis out of mud. The snowshoe was selected both because of its lightweight materials and because a similar solution might also work in mud. The tractor tire was chosen because the participants believed its shape would allows mud to spread to each side. The participants were not sure whether the rope should be included or not. They agreed to put it on the black line of the square as a “maybe” selection. They thought it would be good to have a rope for making prototypes but noted that the rope in the picture seemed heavy. They would rather have liked to have a strong but light rope made of nylon threads. They also explained that the sheep symbolized two different interchangeable feet, one which could be useful when walking in mud and one which was made for normal use. One of the sheep in the picture had wool whereas the other one had been shaved; they thereby represented a bigger and a smaller foot adapted for different weather conditions.

From this session these requirements were identified: the product must be light weight, have aesthetical appeal to children, a shape that is easy to pull out of mud, and surface properties that makes it difficult for mud to stick to it.

Appendix B: Results of Workshop 2

In the second workshop, the participants developed prototypes that built further on the ideas and issues they had raised during workhop 1. Figures 11-14 give a brief presentation of the developed prototypes.

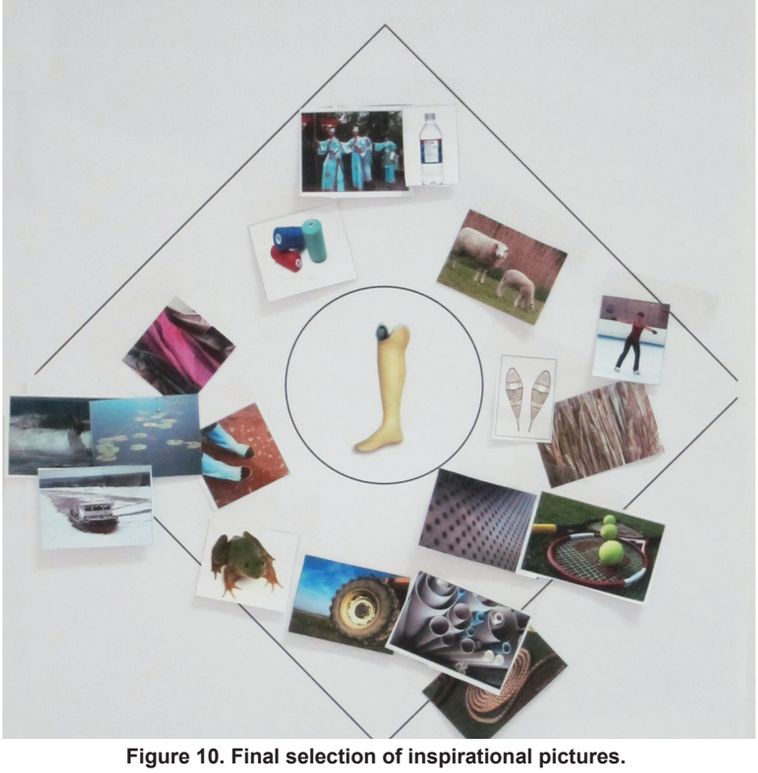

Figure 10. Final selection of inspirational pictures.

Figure 11. Group 1's prototypes (piece of a PVC pipe to the left): The first prototype (in the middle), made with wire netting, was in real life meant to be produced with carbon fiber due to this material's strength and energy storing properties. The second prototype (on the right) consisted of light weight foam covered with PVC on the top to protect against water and a sole of rubber from a car tire on the bottom to promote friction. The group advocated the use of PVC since this is a light weight, inexpensive, and water resistant material.

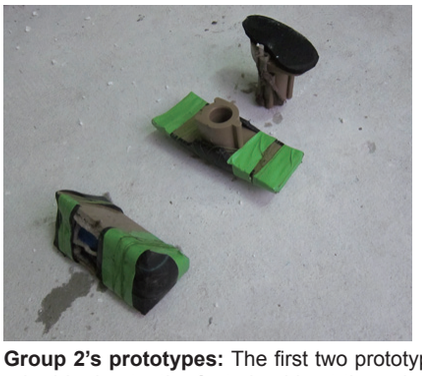

Figure 12. Group 2's prototypes: The first two prototypes to the left were inspired by boats; the foot should cut through water just like the hull of a boat. The third prototype was intended to function as a stilt when attached to the bottom of the prosthetic foot. The group believed that the narrow shape would prevent it from getting stuck in mud but emphasized that this solution would only be useful when walking in shallow mud.

Figure 13. Group 3's suggestions: The third team developed a solution where the prosthetic foot could be detached from the prosthesis when walking in mud. The distal end of the prosthetic leg was shaped like the tip of a water bottle. The participants argued that this shape would make it easier for users to get their prosthetic leg out of mud. When walking in a normal terrain, a "foot" (the object in the middle) could be attached to the "bottle". The second prototype had a foam core covered with a thin plastic material that would give protection against water and provide a smooth surface that would not attract dirt.

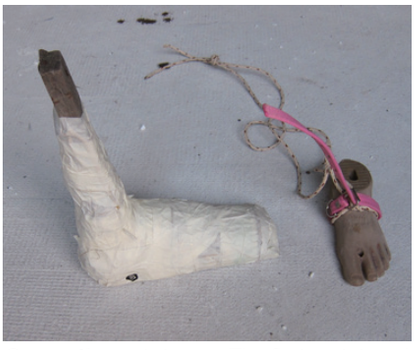

Figure 14. Group 4's prototypes: The first prototype had a hinge mechanism, allowing it to be straightened out to mimic real ankle movement when freeing the leg from mud. The ankle mechanism would have a spring that could be released by pulling out a pin with a cable controlled by the hands. The second solution was a simplified version of the first idea. It consisted of a string attached to the foot. If the prosthetic foot got stuck, the user could pull the string with his or her hands and help the leg to get loose.

Appendix C: Feedback on the Designer's Prototypes

The designer used the main contributions from the participant's ideas to develop rough concepts. Three suggestions for products were derived by building on the participant's input with the designer's own product development experience. The concepts were made with inexpensive materials in the ICRC factory in Phnom Penh. The first idea was inspired by a snowshoe. Participants had selected a picture of a show shoe during the first workshop and said that a similar product might be useful for walking in mud. By distributing the weight of the user on a larger surface area, it could become easier not to sink into the mud. The suggested solution consisted of a frame with some sort of textile functioning as filler that would prevent mud from passing through.

The second idea was to switch the prosthetic foot that was normally used, with a shorter foot when working in rice fields. Some participants had told that farmers sometimes actually cut off the front of the prosthetic foot to make it easier for them to walk in mud. A shorter foot would be easier to pull out of mud and could be a solution if the mud is not too deep and the user does not have to worry about sinking into it.

The third suggestion was to cover the entire prosthetic leg with a waterproof stocking/sleeve and tie it around the waist. This would prevent water from getting into the socket and if the user would get stuck in mud, he or she would not have to worry about the prosthesis falling off when trying to pull it out. The prototype was made of a non-elastic plastic material and the designer used rubber bands around the foot to explain that the real stocking would follow the shape of the prosthetic leg.

The designer asked eight prosthetists for feedback on these ideas. Since four of the participants had not taken part in the earlier workshop, a brief presentation of problems children had reported on walking in mud in earlier phases of the project was first given. Also the three children using prosthetic legs were asked for advice about the prototypes. As noted by Durin (2002), it is important to give some introductory design tasks for children to become used to taking part in design processes. The designer first asked the children to find a product in their home that they

would like to improve and how the product should be made to be considered as "perfect". This was done to help the children get used to evaluating products and imagining new solutions. The designer also asked children about their experience of walking in mud. All three children said that they found it difficult to walk in mud because the prosthetic foot often got stuck. The boys told that they experienced this problem when they had to take cows out to graze. The oldest boy, Vannak, also told that he stuggled with water entering into the socket. The girl reported that she had problems with catching fish in the pond close to her home. Her family drained the pond to make the water lower, but she still struggled with walking in the shallow water due to the mud in the bottom of the pond. Vannak, explained that both thick and thin mud was difficult to walk in, but that walking became particularly challenging in deep mud.

In earlier work, we have found that in Cambodia it can be difficult to get participants to talk about things they dislike, since it in Buddhist tradition is important to always show gratitude and not be negative (Hussain & Sanders, 2012). Before presenting the prototypes, the designer therefore emphasised that these were not completed products but just ideas – and that all ideas have some problems linked to them. She asked for help with finding both the benefits and the possible problems with each prototype since there were many things she could not know not being neither a prosthesis user nor a prosthetist.

Table 2. Feedback on prototypes. The statements are not quotations but summarize the comments given by adults and children. It can be seen that the children's comments and insights are equally broad and as knowledgeable as the adults'.

Prototype	Feedback given by adults	Feedback given by children
	• The frame should not be too wide since this will force the user to keep legs wide apart when walking.	• It will be easier to walk if the frame is not as wide as in the prototype.
	• The strap and textile should not absorb water that will add to the weight of the product.	• It is important that the weight of the product is low.
	• The frame and textile must be strong. • It will be easier to walk if the frame is flexible.	• The textile or strings that the straps are attached to are the weakest parts of the product and have to be made stronger.
	• Must be aware of the risk of stones and grass getting trapped in the frame. • Should have one additional strap around the heel for preventing the foot from slipping out.	• Should have two sharp blades on each side which will cut through rushes and thorns in the mud. • Should have one additional strap around the heel for preventing the foot from slipping out.
	• If the frame gives high friction, it will be easier to walk in slippery mud. • The frame should be as thin as possible to keep the length of the prosthetic and sound leg equal.	• The brim of the frame should be flat and not round in the prototype so that the whole oval rests on the ground. This will give better stability.
	• May function well but still not be accepted by users due to aesthetical concerns.	• Important that the foot looks natural and has toes.
	• Can be difficult for children to change feet by themselves.	• Can be difficult to change feet.
	• The nut and bolt that attaches the foot to the rest of the prosthetic leg can get worn out if they are lighted and unscrewed several times. • Users may not have access to a screw driver.	• Should cut away even more of the front part to give the product the shape of a cylinder.
	• Should use a rubber plug to cover the hole underneath the heel, where the nut and bolt for attaching the foot are located, to prevent rust.	• Should use a rubber plug to cover the hole underneath the heel, where the nut and bolt for attaching the foot are located, to prevent rust.
	• Must be produced with a strong and durable plastic material. • Would be better to find an elastic waterproof material that does not restrict movement.	• The plastic garment should not be too big or loose, otherwise it will irritate when wading in water. • Need to learn how to put on the plastic garment. • The belt will be uncomfortable to tie around the waist; should rather be tied on the upper thigh. • It will be easy to fold the garment and bring it to the rice fields.

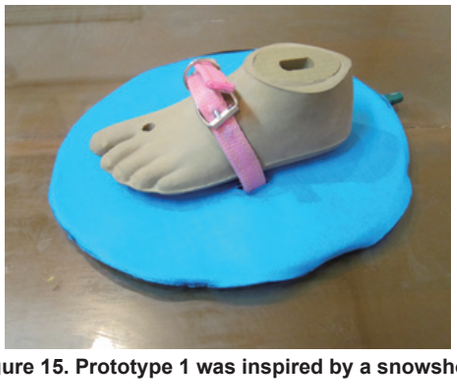

Figure 15. Prototype 1 was inspired by a snowshoe.

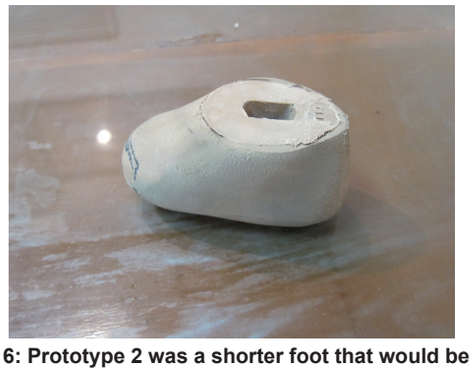

Figure 16: Prototype 2 was a shorter foot that would be easier to pull out of the mud.

Figure 17: Prototype 3 covered the entire prosthetic leg with a waterproof stocking/sleeve and was tied around the waist.

Appendix D: Product Design Opportunities

Through listening to both children and adults, we learned that a product that enables child prosthesis users to walk in mud should:

- be durable
- provide friction in slippery mud
- not be heavy
- not add much to the length of the prosthetic leg
- be aesthetically acceptable for the users
- have toes that look natural if the designed solution resembles a foot

This list evolved during the project through communicating with participants. It was not given to adult participants as a set of requirements before the workshops.

The efforts put into listening to children and understanding their lives (Hussain, 2010) showed the need for a product that allowed prosthesis users to walk in mud. The two workshops with adult participants gave further insight into product requirements and the ideas generated during the workshops helped the designer with developing concepts. Through feedback from both from children and adults, the designer could confirm if she had understood user needs and product requirements correctly and if there were any other issues that she should be aware of. The field study shows that even though designers cannot always succeed in involving participants as much as desired, any effort to include users and give them a voice is rewarding for the design process.