INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED'09
24 - 27 AUGUST 2009, STANFORD UNIVERSITY, STANFORD, CA, USA

FOUR DOMAIN MODEL: A NEW POSSIBLE INNOVATION MODEL FOR DESIGN FOR BASE OF THE PYRAMID (DFBOP)

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ABSTRACT
The World Bank (2005) estimates that there are 4 billion people living on an income of less than US$3 per day and 1 billion living less than even US$1 per day. This part of the population is often identified as "Base-of-the-Pyramid" (BoP). Recently, some design projects have been carried out at Faculty of Industrial Design Engineering, Delft University of Technology (IDE/DUT), The Netherlands. These projects are aimed at serving the unmet needs of the BoP consumers. This paper is the result of the analysis of such projects and based on empirical research, proposing an innovation model for BoP design cases: four domain model. This paper also includes testing of this model on selected design projects.

Keywords: Design for Base of the Pyramid (DfBoP), four domain model, innovation process, product design, the faculty of Industrial Design Engineering, Delft University of Technology (IDE/DUT)

1 INTRODUCTION
World Bank (2005) estimates that, there are 4 billion people living on an income less than US$3 per day and 1 billion living less than even US$1 per day. This part of the population is often called "Base-of-the-Pyramid" (BoP). Most of BoP live in developing countries including Africa, India, China and Brazil, and so on.

Currently, most of the entrepreneurs, professional designers and design institutes are targeting the end-users in advanced markets as this group has a higher purchasing power averaging more than US$10,000 per year. C.K Prahalad and Stuart Hart's (2002 and 2005) work in this area suggests that there is a fortune to be made for entrepreneurs in BoP initiatives, while at the same time offering great opportunities for the world's poor to escape from poverty. Prahalad's book 'The Fortune at the Bottom of the Pyramid' (2002) proposes a framework for the active engagement of the private sector and suggests a basis for a profitable win-win engagement. He argues that all that is stopping business from designing products and services to meet the needs of the world's poor, and then efficiently manufacturing and distributing them is human ingenuity - innovation. This topic has unleashed an extensive and generally enthusiastic response from academics, businesses, NGOs and governments.

BoP is therefore also a strategy with a dual objective: alleviating poverty as well as profit motivation of entrepreneurs.

As a special user (and consumer) target group, BoP has a number of special characteristics, which are a result of local context. Through execution of several BoP design cases, we found that current product design innovation models such as Pahl and Betiz (1980), Roozenburg and Eekels (1998), Muller (2001), Hekkert and van Dijk (2006) or Tassoul (2006) are not complete enough to guide a BoP design case from academic side. In the other words, academically trained designer students from Industrial Design Engineering in Delft University of Technology (IDE/TUD), when involved in BoP design projects, are confronted with several design questions: "What rxactly are my design objectives and tasks?", "How to configure user and product requirements?" "What's the contribution of my past design experience and how I can apply it here?" How exactly my past design experience relevant at BoP? With the increasing design opportunities for BoP in developing countries recently, these questions are also faced by supervisor of such projects.

2 DEFINITION

2.1 Design for Base of the Pyramid (DfBoP)

Similar to other innovative design research projects, DfBoP research is an outcome of design cases. Several DfBoP projects have been carried out at IDE/TUD such as “Lifestraw” or “Woodstove” (Kandachar, 2006). :

Kandachar and Halme (2007) found that many cases revolved around the needs of the users as a starting point for BoP product and innovations. Kandachar (2006) has observed that several developments are taking place in different domains influencing product design and development, that need to be considered for an effective approach to serve the unmet needs of the BoP-community. These developments include: on the user side ethnographic tools, cultural probes,rtc.,; on the business side, business innovations such as hybrid business models, corporate responsibility, etc., ; on the technology side, technological innovations like disruptive innovations, open source designs, etc. Entrepreneurs are also coming up with innovations such as microfinance, social entrepreneurship, etc..

Diehl (2008) looked at DfBoP within the framework of sustainability: “DfBoP means Integral Product Development for the BoP which includes four characteristics: (a) Acceptability- sustainability user, profit and planet, (b) Awareness- User Context Research, (c) Availability- New technologies and innovations, (d) Affordability- Business development. ”

Jiang (2009), proposes that “DfBoP is one kind of consumer-oriented innovation. The four components of DfBoP are: user-community-product and service-environment. DfBoP innovation process focusses on exploring relationships among each component and with the context in which these components are relevant.”

Illinois Institute of Technology's Institute of Design (Rich, 2006) explores DfBoP as "human-centered design strategies and concepts for new products, services and businesses capable of generating sustainable economic improvement in the lives of people living in the vast base of the global economic pyramid", which was also definition from “design for sustainability”.

In this article, the definition of DfBoP of Jiang, who is also the first author of this paper, is focused upon.

2.2 Local context: User-Community-Product-Environment

Based on the observation on a limited number of DfBoP cases, Jiang (2009) has proposed that DfBoP is one kind of “user-oriented” innovation process and the process is non-linear. The initial motivation of a DfBoP project is from basic societal needs, such as drinking water, energy, communication or healthcare. The most often noticed feature of DfBoP is that “providing local solutions in local context”. The knowledge about local context is therefore necessary during design. There are four elements in local context:

- User - As directly benefited target groups, users are considered as the first information providers. The requirements of users are concentrated firstly in a DfBoP case.
- Community – Once users are targeted, user data are collected before (engineering) design. However, according to DfBoP practice the community such as a village is often looked as a user group as a whole and the product is designed for the community rather than one person alone. This phenomenon is noted often, in issues that need both instrument (product) and service design such as healthcare solutions.
- Product – The third element of local context is product, which refers solutions including instruments and services. The acceptance of new solution is often based on the comparison with existing solutions for BoP population, which has low purchasing power.
- Environment – The last element is the environment, which refers to all contexts from stakeholders like investment companies, government, or Non-Government Organization (NGO). Because the design motivation of DfBoP is beginning from social problems, the output of the design should be judged through social benefits (or social impact). For instance, when a drinking-water filter is designed and implemented, and when the disease rate caused by drinking-water is decreased after a period, it is considered social benefits. The social benefits are measurable and stimulated by environment context such as government funding or company investment.

Above four elements are major context elements in DfBoP, and they affect each other at the same time as a complex system. As a result, the starting step of DfBoP product design innovation might be setting up Social-Technical System (STS) of local contexts once the design topic is confirmed.

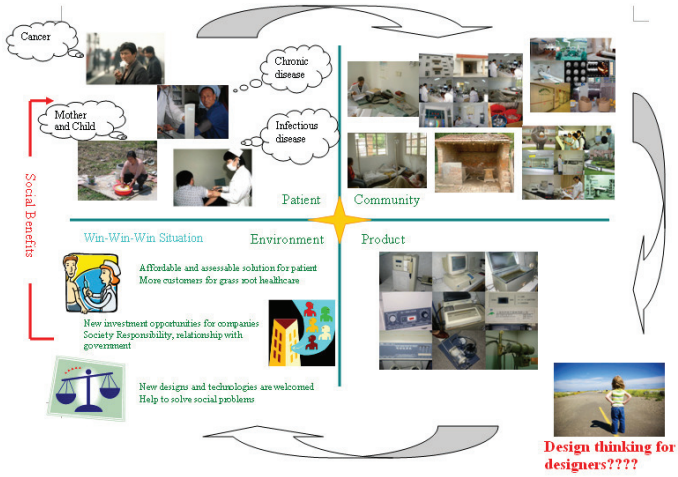


Figure 1: The Social-Technical System (STS) of the general topic "provide healthcare solutions for rural China"

The design topic at the start could be specific (like woodstove for rural Bangalore in India (2006)) or general (like strategy healthcare product design for rural India (2006)). Figure 1 is the STS example of a general topic "provide healthcare solutions for rural China". Here the user is replaced by the patient, while the contexts of the patient includes medical requirements such as chronic diseases, diseases about "Mother" and "Child" and so on. The contexts of the community are including contents resulting in patient's medical requirements like living condition or medical condition. The product includes instruments in different tier hospitals and the environment includes government, company and hospital and so on.

2.3 Product innovation model

As a kind of "market-oriented" design activity, DfBoP project is also follow the structure of common product life cycle such as SDLC phases and process control such as Design for Six Sigma (DFSS) (Jiang, 2009). The typical SDLC phases include planning (strategy formulation), analysis (idea finding), design (strict development), implementation (realisation), and support (market). Roozenburg and Buijs complex model has been chosen in this article as the basic model as Figure 2, which is developed from common spiral model showing that products using an iterative approach rather than a linear approach (Lessard, 2002).

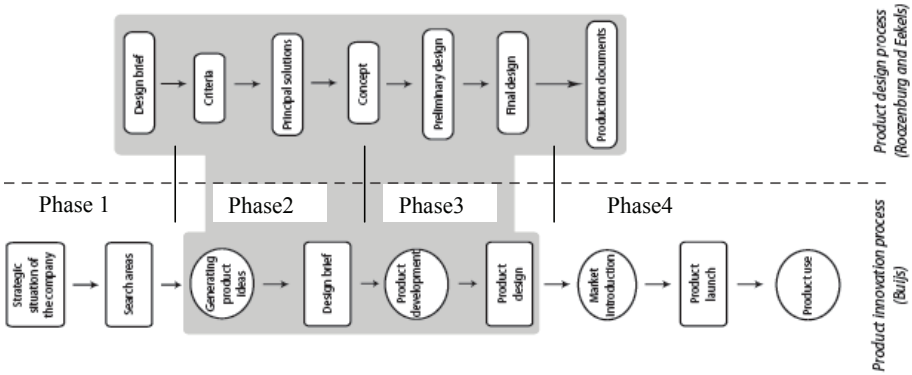


Figure2. Roozenburg and Buijs complex model (Hoog etc, 2008)

The structure of the innovation process a presented in Figure 2 is a four stage innovation model based on the assumption that the product innovation process is similar to a (experiential) learning process. The four-stage product innovation model consists of:
(1) Strategy formulation (i.e. policy and strategy formulation).
(2) Design brief formulation (i.e. idea finding).
(3) Product development (i.e. strict development).
(4) Product launch and use (i.e. realisation).

However, while implementing this model, some knowledge gaps were identified such as "how to seek product ideas that fit with needs of BoP or how to reason from function to form before a decision".

The aim of this paper is to generalize a suitable innovation model for DfBoP to bridge such knowledge gaps. As the number of IDE/TUD design cases are limited, this has however an empirical character.

3 PROBLEM STATEMENT

There are three knowledge gaps identified through an analysis of some DfBoP cases carried out at IDE/TUD.

1. How can designers translate social problems into concrete user and product requirements? Visits to BoP regions revealed many social problems; they are also easy to identify through observation or literatures. However, translating these problems to requirements is an unknown territory.
2. What kinds of specialization are needed in "strict development process" and what technical properties should be focused in DfBoP?
3. How can the DfBoP case be evaluated? There are hardly any previous product experience.

Q1 and Q3 will be discussed in the new model, while the research about Q2 is still ongoing.

4 FOUR DOMAIN MODEL: A NEW POSSIBLE INNOVATION MODEL FOR DESIGN FOR BASE OF THE PYRAMID (DFBOP)

In term of case observation of 24 DfBoP cases within IDE/TUD (Jiang, 2009), a new possible innovation model named "four domain model" has been proposed, Figure 3.

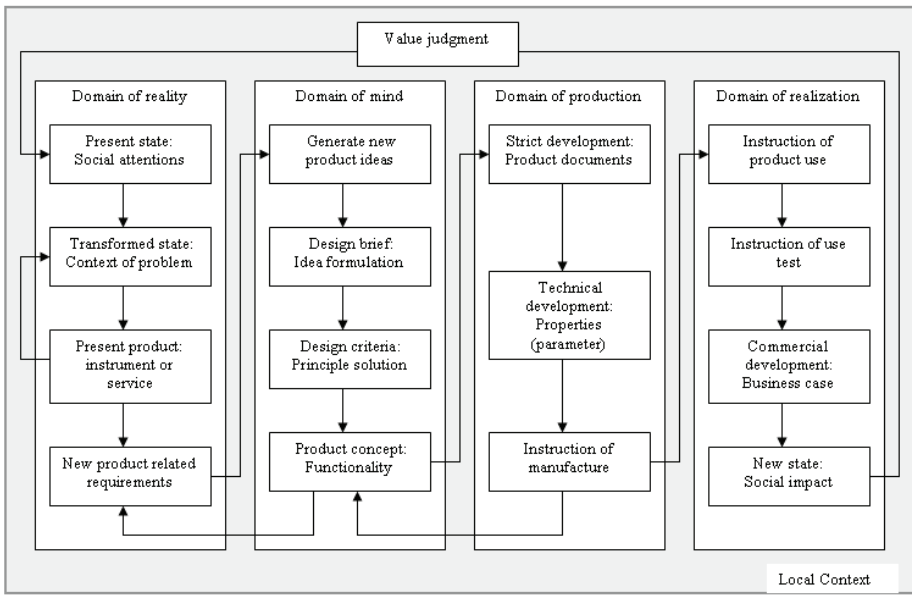


Figure 3: Proposed innovation process framework for DfBoP

In this framework, all innovation process happens in local context, which means that design platform about interest issues should be set up before starting the topic. Local experience or knowledge is necessary. In some cases within IDE/TUD, local experience was provided by local partners such as local academic, local NGO or local companies; while in other cases, designers have to live in villages with local residents to get experience from users directly.

There are four phases in the proposed framework:

- *Domain of reality*: this phase starts from present state, and then some transformed state about problems will be found about context, once information about current instruments or services are collected and analyzed, new requirements will be inducted.
- *Domain of mind*: after the requirement analysis, new product ideas will be set up and these ideas will be formulated, detailed and forming concepts. This phase is created by designers subjectively.
- *Domain of production:* embodiment design of the product will be completed in this phase, product properties also will be defined such as shape, material, color and so on.
- *Domain of realization*: last phase of innovation process is about interaction among user-product-environment. Innovations on user test are commonly needed and social impact will be produced through business case. (Business case might be profited by company or non-profited by funding from government or NGO.)

The value judgment is processed between social impact and social attentions, which is always measurable through variables.(E,g. the change about death rate of indoor pollution after using new woodstove is measurable in a certain area) However, it will take a long term to achieve the social impact (and therefore to measure) and it will happen step by step.

Compared with Roozenburg and Buijs complex model, several features have been added in the new model:

1. Local context is the innovation platform: In this framework, the dependence of local context will happen in every step. It means outputs of each component itself are related with local context and resulted in the interaction of local context factors. E,g. a very common phenomenon in DfBoP is that “Face to face using illustration is necessary in local village besides using guide booklet”. Most of time, these activities are difficult to be generalized and even they cannot be planed beforehand. The opinion of “Design for local in local” is consolidated in DfBoP.

2. There is a process of state transforming: In "Domain of reality", the social attentions will be extended into local context model such as "*User-Community-Product-Environment"*. Actually, the transforming process is a complex circular system. A possible detail protocol for this circular system has also been achieved in IDE/TUD called "Qualitative-Quantitative Filter"(QQF), but it is beyond the scope of this paper.
3. The projects examined have an experimental character. During the three phases "Domain of reality, mind and production", some projects are discontinued. In other words, few projects have been carried out which have gone through all the four phases. The reasons could be several, like the try out character, funding restrictions, concerns about investment risks, etc..

The value judgment is visible: The final evaluation of DfBoP is measurable in this model and it is related with local context as well. The value judgment could be progressively developed and the social benefits might include benefits for users, NGOs, governments, companies or design institutes.

5 CASE OF FOUR DOMAIN MODEL: "ADOPTABLE WOODSTOVE IN RURAL INDIA"

Four domain model has been tested on a few DfBoP cases at IDE/TUD, one typical case is "Adoptable woodstove for rural India" by cooperation of IDE/TU and Domestic Appliances of Philips (DAP) in 2006.

The description of design motivation in project report (Master graduation thesis): "At the Base of the Pyramid (BoP) in India, cooking is one of the most time-consuming activities during the day. People at the BoP usually cook with solid fuels on simple, inefficient stoves that fill their houses with smoke. ……this idea towards a product proposal and an implementation strategy to increase the adoption chance of this product by the rural BoP in India."

The design innovation process of this case can be analysed as shown in table 1:

Phase	Key step	Design aim	Content 1	Content 2	Content 3	Result
Reality	*Current state*	*Indoor smoke is not perceived as a health problem for rural India, although they think it is not good for the health of the children.*	*For people indoor smoke gives the following short time problems:* *1.Headache;* *2.irritation in the eyes;* *3.ashes on the floor;* *4.blackening of ceiling, walls and vessels* 	*Related to well-being: it cost women often much time and effort to collect and transport wood and/or cow dung* 	*X*	*X*
Reality	*State transform*	*Locate the barriers of current situation*	*Home Environment:* *1. Low efficiency of the traditional woodstove.* *2. No satisfying smokeless woodstove available.* *3.Limited ventilation*	*Awareness & Knowledge:* *1. Smoke is irritating, but not considered a long term health problem* *2. Indoor pollution considered as a nuisance, not a health issue* *3. Link between smoke and efficiency is unknown*	*Functionability of smokeless solution:* *1. Doesn't give the "right " taste.* *2. Chulah gives warmth and light* *3.Strong resistance at changing cooking habits.*	*X*
Reality	*Present products*	*Propose the current solutions*	*Woodstove outside*	*Biogas used for warming up small quantities of water or food. Biogas is quicker*	*Use of kerosene or LPG stove. Less headache, less cuffing, faster cooking.*	*New design still using indoor woodstove with low*

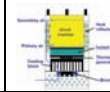
					*But high investments and high operational cost* 	*pollution (requirements)*
Mind	*Idea generate, formulate and criteria*	*Identify the function of design based on concept*	*Thermoelectric control 1.Air control 2.Cooling block 3. Water control…*	*Decreasing pollution 1. Air filter 2. Dust filter…*	*Shape and form And so on…*	*Function:* 
Production	*Strict product development, technical development and manufacturing*	*Achieve and prototype the design*	*Weight, size…*	*Material…*	*Color, light…*	*Prototype:* 
Realization	*User test and using guide*	*Popular the product*	*Visual Interface* 	*Using booklet* 	*Face to face promotion…* 	*X*
Realization	*Commercial development*	*Achieve the product for sale and set up business case*	*Pilot* 	*Sale and service network* 	*X*	*Product for sale:* 

Table 1: The design case "Adoptable Woodstove"

In the table 1, some details about mind and production phase have been ignored because the difference between four domain model and other model such as Roozenburg model is slight, and the social impact of this project is still under monitoring. The statistically relevant results about the effect of this design intervention on indoor pollution and subsequent the effects on healthcare will be take a long time to manifest.

6 CONCLUSION

The four domain model proposed seem to work sufficiently in DfBoP projects carried out at IDE/TUD. But knowledge gaps identified in problem statement cannot be addressed completely yet. The major reason is that current framework is general and concrete protocols and algorithms are needed in practical cases. Even though some efforts have been done by researchers in IDE/TUD, it is still a long distance to understand all rules of DfBoP.

On the other hand, it is still under debate that do we need to develop new theories and methodologies for BoP specifically? Perhaps the 4 billion potential users have their own solutions; the research on DfBoP is not only about "Design for sustainability" but also about "Design for future generations".

7 ACKNOWLEDGEMENT

It was great fun and an interesting research experience to collect cases for exploring an unknown field: BoP design. We would like to thank master students: Del Caro Secomandi, Boom, Groot de, Bottema, Bijtelaar, Boekhoven, Velden van der, Hendrikse, Stranders, Rodriguez, Ideler, Nguyen, Glasbergen, Huuis in't Veld, Mink, Thompson, Caluwe de, Chang, Hoikee and Broeders. Our research is based on their work.

We also would like to thank the following people, who support their students in their projects, alphabetically: Petra Badeke-Schaub, Annemiek van Boeijen, Casper Boks, Han Brezet, Jan Buijs, Henri Chritiaans, Richard Goossens, Erik Jan Hultink, Remco van der Lugt, Heimrich Kanis, Henk Kuipers, Kaj Morel, Ingo Oldenkamp, Joost Prins, Drik Snelders.

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