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FIGHTING POVERTY THROUGH DESIGN: COMPARING DESIGN PROCESSES FOR THE BASE AND THE TOP OF THE WORLD INCOME PYRAMID

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ABSTRACT
The base (BOP) and the top (TOP) of the world income pyramid represent the poor people and the people from developed countries, respectively. About two-fifths of the world population can be categorized as poor. Poverty is a trap because children born to poor parents are likely to grow up to be poor adults. In recent years, a poverty reduction approach that combines business development with poverty alleviation has received attention. The design of products for the BOP is an important ingredient of this poverty reduction approach. While companies are beginning to address the product needs of the BOP, there is limited practical and theoretical knowledge to support them. The current understanding of the design for the BOP is limited. This study, using a protocol analysis, compared the design processes for the BOP and TOP markets. The results indicate the differences between the design processes for these markets in terms of the design strategy employed by the designers (i.e. problem driven, solution driven strategy), their requirements handling behaviour, and their information behaviour. We have discussed the implications of the findings for design practice and education.

Keywords: design for the base of the pyramid, design process, human behaviour in design, sustainability, protocol analysis

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1 INTRODUCTION

Figure 1 shows the world income pyramid (Prahalad and Hart, 2002). The top of this pyramid, called the 'Top of the Pyramid' (TOP), includes people from developed countries. The middle segment consists of the rising middle class from developing countries. The base of this pyramid, generally called the 'Base of the Pyramid' (BOP), consists of poor people. About two-fifths of the world population can be categorized as poor. Their income is less than 2 dollars per day. Many researchers prefer the poverty line of 2 dollars per day (Karnani, 2011). About a fifth of the world population is classified as extremely poor with income of less than 1.25 dollars per day.

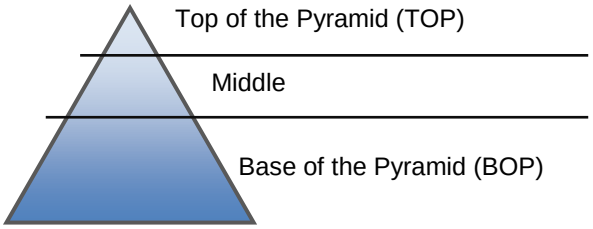

Figure 1. The world income pyramid (Prahalad and Hart, 2002)

Poverty is a trap because children born to poor parents are likely to grow up to be poor adults (Karnani, 2011). Mahatma Gandhi often said - poverty is the worst form of violence. It is important to alleviate poverty. In recent years, a poverty reduction approach that combines business development with poverty alleviation has received attention (Prahalad, 2004). Private sector firms continually search for new business opportunities. Saturated markets and a highly competitive business landscape motivate companies to search for new markets to increase profits. This has led companies (e.g. GE, Procter & Gamble, Unilever, etc.) to pay greater attention to opportunities at the BOP (Nakata, 2012). While companies are beginning to address the product needs of the BOP, there is limited practical and theoretical knowledge to support them (Nakata, 2012).

In the approach of combining business development and poverty alleviation, the poor at the BOP are considered as producers and consumers of products. Design of products is an important ingredient of this market-based approach. Furthermore, some universities have begun to offer courses and/or design projects in the area of the design for the BOP. In addition, design of products for the BOP is important in the area of social innovation and social entrepreneurship at the BOP.

The research in the BOP domain has been carried out by several authors from different disciplines (Prahalad, 2004; UNDP, 2008). While design research is important in understanding and improving design practice and education (Blessing and Chakrabarti, 2009), design researchers have given little attention to the field of the design for the BOP. Most of the design research has been carried out in the context of developed countries and relatively affluent markets (Viswanathan and Sridharan, 2012; Jagtap and Larsson, 2013). There has been little empirical examination of the design for the BOP, and this limits our ability to develop tools and methods for improving current practice and education of design for the BOP. It is therefore important to develop an understanding of design for the BOP.

This study aims at exploring the differences between the design processes for the BOP and TOP markets, where designing for the TOP is a baseline. The sharp contrast between the BOP and the TOP makes the distinctions clear. The design processes are compared using the widely employed technique of verbal protocol analysis in the area of design research. In a laboratory setting, four designers individually solved a design problem for the BOP, and four other designers individually solved the same problem for the TOP. The collected data was encoded and analysed. Encoded results of the protocol analysis show the differences between the design processes for the BOP and TOP markets.

2 BACKGROUND LITERATURE

2.1 BOP markets and product design

The BOP includes poor people. About two-fifths of the world population can be categorized as poor. These people live in rural villages, urban slums, or shantytowns. In recent years, a poverty reduction approach, popularised by the late C.K. Prahalad, has received attention (Prahalad 2004). This approach proposes solutions involving business development combined with poverty alleviation. According to Prahalad and Hart (2002), the most visible and prolific writers in the area of the BOP, this business

strategy is important in, "…lifting billions of people out of poverty and desperation, averting the social decay, political chaos, terrorism, and environmental meltdown that is certain to continue if the gap between rich and poor countries continues to widen". Furthermore, saturated markets and a highly competitive business landscape motivate companies to pay greater attention to opportunities at the BOP (Nakata, 2012).

The potential purchasing power of the BOP is five trillion US dollars (IFC 2007). Furthermore, the products originally developed for the BOP can be adapted for the markets in developed countries, and this is called 'reverse innovation'.

In the market-based approach of combining business development and poverty alleviation, the poor at the BOP are considered as producers and consumers of products. Design of products is an important ingredient of this approach. Designing and developing products for the BOP require addressing constraints in the BOP. These constraints are significantly different from those in developed country markets. Jagtap and Kandachar (2011) pulled together these constraints from different studies (e.g. Kandachar and Halme, 2008; Donaldson, 2006), and found that the constraints identified in the study of the United Nations Development Program (UNDP, 2008) are comprehensive. Regardless of the location of a BOP market, the constraints in the design and development of products for the BOP are the following. (1) *Market information*: In the design of products for the BOP, businesses often lack detailed information about the BOP markets (e.g. what the poor need, their capabilities, etc.). (2) *Regulatory environment*: The regulatory frameworks are under- or un-developed in the BOP. In addition, enforcement of the existing rules is inadequate. (3) *Physical infrastructure*: The infrastructure (e.g. roads, electricity) in the BOP can be inadequate. In the BOP, the existence of a logistics infrastructure cannot be assumed. (4) *Knowledge and skills*: The poor, generally, are illiterate and do not possess knowledge and skills regarding the availability of products, usage of products, etc. (5) *Access to financial services*: The poor lack access to credits and banking services. In the design for the BOP, the designers must take into account the price-performance relationship.

Companies need to change their business assumptions, models, and practices in order to address these constraints (Viswanathan and Sridharan, 2012). While companies are beginning to address the product needs of the BOP, there is limited practical and theoretical knowledge to support them (Nakata, 2012). There has been little empirical examination of the design for the BOP, and there is an urgent need to develop an understanding of this area.

2.2 Design problem solving

There is a plethora of design process models (Pahl and Beitz, 1996). Chakrabarti et al. (2004) found that the main ingredients of the design process are: requirements (i.e. problems), solutions, information, and strategy (i.e. plan of action to progress through the design process). Some characteristics of the design process have been widely observed. It is commonly accepted that the design process is iterative in nature. In the design process, the requirements and solutions co-evolve (Suwa et al. 2000).

In design research, there has been interest in investigating design strategies used by designers. Kruger and Cross's (2006) empirical study of designers found that most designers employ either a problem driven or a solution driven design strategy, with each of these strategies being equally prevalent. In a problem driven strategy, the designer focuses closely on the problem at hand. The designer emphasises on defining the problem, and finding a solution as soon as possible. In a solution driven strategy, the designer focuses on generating solutions. The designer emphasises on generating solutions, and little time is spent on defining the problem. Christiaans and Restrepo (2001) also observed these problem driven and solution driven strategies in homogenous groups of designers.

In the field of design research, several authors note that design is an information-intensive activity. Several studies, carried out in laboratory settings with experienced designers or students, note the importance of information in the design process (e.g. Kuffner and Ullman, 1991).

3 THE PROTOCOL STUDY

3.1 Experimental design

We carried out the protocol studies using the think-aloud method to address the aim of exploring how the design process for the BOP differs from that for the TOP. A design activity can be influenced by several factors, and no experimental arrangement for comparative analysis allows to having just one of

the factors as variable, while the others are kept fixed (López-Mesa et al., 2009). In our study, the experimental arrangement was as follows. In total, eight designers participated in the experiments. These designers were divided into two groups, namely BOP and TOP groups/sessions. Each designer worked on one design problem individually. While the eight designers solved the same design problem, the designers in the BOP sessions solved it for the BOP and the designers in the TOP sessions solved it for the TOP. Although the sample size in our study is small (i.e. four protocols in each of the BOP and TOP sessions), the experiments provided sufficient data for our empirical exploratory study. This sample size is adequate for a think aloud protocol study, and is in accordance with other studies, for example studies of Kruger and Cross (2006) and Rahimian and Ibrahim (2011).

3.2 Participants

In our study there are two types of markets (i.e. BOP and TOP). It is therefore necessary that the participants in the BOP sessions (i.e. BOP designers) and the participants in the TOP sessions (i.e. TOP designers) are required to have good understanding of the general characteristics of the BOP and TOP markets, respectively. In our experiments, this criterion was fulfilled by ensuring that the designers in the BOP sessions had experience of working on university-based design projects for the BOP, and that the designers in the TOP sessions had experience of working on university-based design projects for the TOP. Before the experiments, discussions were carried out with the four BOP designers to ensure that their understanding about the BOP markets was good for involving them as participants in the experiments. All these eight designers were Masters students in 'Industrial Design' or 'Product Design'. Each designer from the BOP and TOP sessions was provided two movie tickets as compensation for their time.

3.3 Procedure

In our experiments, the following steps were followed with each of the eight designers: (1) explanation of the experimental procedure (15 minutes), (2) warm-up task to train the subject in speaking his/her thoughts (30 minutes), and (3) solving the design problem (maximum 90 minutes). The designers, on average, finished the third step within 60 minutes. As an information source, a researcher was present during the entire experiment. The designers were allowed to ask questions to the researcher. The experiments were audio and video recorded.

3.4 Design problem

In our experiments, to formulate the design problem, we considered different criteria. The design problem must be suitable for the above-mentioned Masters students. The problem also needs to be applicable for the BOP and TOP markets. This is an important consideration because some problems may be applicable for the BOP, but may not be applicable for the TOP. Based on these considerations, we created the design problem as shown in Figure 2. In this figure, in the case of the BOP sessions, (---) was replaced by 'a cluster of BOP communities in a developing country' and (xxx) by 'the cluster of BOP communities'. In the TOP sessions, (---) was replaced by 'a city in a developed country' and (xxx) by 'the city in the developed country'. The BOP and TOP designers were asked to consider general characteristics of the BOP and a developed country, respectively. After the experiments, all the designers expressed that the problem was interesting and new to them.

A highly contagious and deadly disease called 'anthrax-d5' is spreading across (---). This disease is transmitted only through contaminated food and water. A person infected with this disease needs to be hospitalized in order to save his/her life. The spread of this disease is such that the existing healthcare infrastructure (i.e. available number of hospitals) is inadequate to hospitalize and treat the large number of infected people. There is an urgent need to erect a number of temporary shelters that can be used as hospitals. For (xxx), where the 'anthrax-d5' is spreading at an enormous rate, design such a temporary shelter that can be used to hospitalize 5 infected people (per shelter). Each shelter also needs to accommodate basic healthcare facilities and healthcare staff consisting of 1 nurse. The time to install this shelter must be less than 2 hours. The shelter also needs to withstand different types of weather conditions.

Figure 2. Design problem used in the experiments

3.5 Analysis

The audio recordings were transcribed. The transcripts were parsed into segments using the previous guidelines of Ericsson and Simon's (1993) verbal protocol analysis. The transcripts were divided into segments, with each segment corresponding to a single thought, expression, or idea.

The structured analysis of protocols involves the application of a coding scheme. Our coding scheme consisted of four major categories, borrowed from the coding schemes successfully implemented and developed by Chakrabarti et al (2004), Kruger and Cross (2006), and our own sub-categories based on various design cognition models and theories. The four major categories are: 'requirement', 'solution', 'information', and 'strategy' (see Table 1). The coding scheme was considered to be appropriate for our empirical exploratory study.

As shown in Table 1, for the segments that were classified under the major categories - 'requirement', 'solution', and 'information' - we interpreted the applicable activities. We measured the reliability of the coding process by calculating the percentage agreement between two coders. Due to resource limitations, two out of the eight protocols (i.e. two transcripts) were coded by the researcher and one coder. The average inter-coder reliability was above 85%.

Table 1. Coding scheme

Category	Description (example)
Requirement	
Identify	Designer identifies or modifies a requirement for the first time in the protocol ("That needs to include…")
Evaluate	Designer evaluates or analyses a requirement ("That is the most important requirement…")
Repeat	Designer repeats or remembers a requirement (The designer repeated the following requirement, "Time to install must be…")
Interpret	Designer expresses a requirement in a different form ("This means that it has to be…")
Ask	Designer asks about a requirement to the researcher ("Does the shelter…?")
Select/reject	Designer selects or rejects a requirement ("I am not considering this…")
Assume	Designer assumes a requirement ("I am assuming this should be…")
Solution	
Generate	Designer generates, modifies or details a solution ("Let's put cloth on inside…")
Evaluate	Designer evaluates or analyses a solution ("So, this is efficient to…")
Repeat	Designer repeats a solution or parts of a solution generated earlier (The designer repeated the part of a solution, "This is made from…")
Select/reject	Designer selects or rejects a solution ("I am not going with this…")
Information	
Access	Designer accesses/collects information ("Developed countries have…")
Ask	Designer asks the researcher for information ("Does anthrax spread from…?")
Evaluate	Designer evaluates or analyses information ("This is actually not accurate information of…")
Repeat	Designer repeats or remembers information (The designer remembered the information, "The disease is transmitted through…")
Assume	Designer assumes information ("Let me assume that…")
Interpret	Designer expresses information in a different from ("So, this also means the disease is…")
Strategy	A plan of action for proceeding through the design process ("I will start by just taking…")

4 RESULTS

As the sample size in our study is small (four designers in each of the BOP and TOP sessions), we have explored the structures of designers' behaviour using descriptive statistics and visually through graphs. This is in line with the studies of Fricke (1999), Günther and Ehrlenspiel (1999), and Kruger and Cross (2006).

4.1 Overview

Table 2 shows the number of segments, total time, and time per segment in the case of BOP and TOP sessions. The average number of segments is slightly higher in the BOP sessions as compared to that in the TOP sessions (227 and 218). However, the standard deviation of the total number of segments is higher in the BOP sessions as compared to that in the TOP sessions (103 and 55). This suggests that the distribution of the total number of segments is widespread from the mean value in the BOP

sessions. Average total time (62 and 61 minutes) and time per segment (17.8 and 16.9 seconds) have approximately the same values in the BOP and TOP sessions.

Table 2. Number of segments and duration of segments

		Total number of segments	Total time in minutes	Time per segment in seconds
Average (Std. dev.)	BOP	227 (103)	62 (17)	17.8 (4.8)
	TOP	218 (55)	61 (21)	16.9 (5.5)

4.2 Design strategies

Figure 3 shows the average percentage of segments under the major categories - requirement, solution, information, and strategy - in the case of BOP and TOP sessions. This figure shows that the average percentage of segments under the category 'strategy' is about the same in the BOP and TOP sessions (9.4% and 8.4%). This indicates that the BOP and TOP designers have spent approximately the same amount of time in planning activities. The higher average percentage of segments under the category 'information' in the case of the BOP sessions as compared to the TOP sessions (13.5% and 7.8%) suggests that the BOP designers spent more time in dealing with information as compared to the TOP designers.

As shown in Figure 3, the average percentage of segments under the category 'requirement' is considerably higher in the BOP sessions as compared to the TOP sessions (38.3% and 30.4%). In contrast, the average percentage of segments under the category 'solution' is substantially greater in the TOP sessions as compared to the BOP sessions (55.9% and 39.2%). This suggests that the designers in the BOP sessions have spent more time with requirements as compared to the designers in the TOP sessions, and that the designers in the TOP sessions have spent more time in dealing with solutions as compared to the BOP designers. This indicates that the designers in the BOP sessions have used a problem driven strategy, whereas the designers in the TOP sessions have used a solution driven strategy.

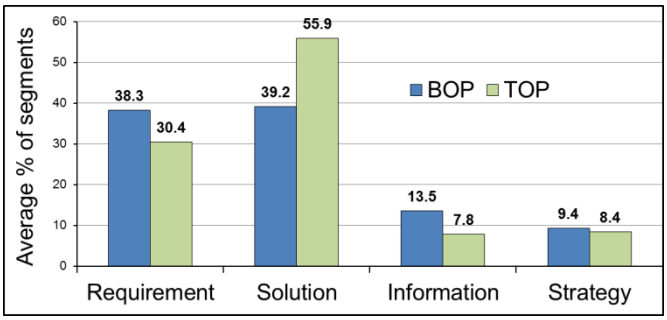

Figure 3. Average percentage of segments for major categories

We created scatterplots of major categories (i.e. requirement, solution, information, and strategy) for each of the designers in the BOP and TOP sessions (see Figure 4). In Figure 4, the vertical axis of each scatterplot represents the percentage of the total number of segments, and the horizontal axis represents the major categories (1 - Requirement, 2 - Solution, 3 - Information, 4 - strategy). For all designers in the BOP and TOP sessions, the most frequent activities are associated mainly with the categories 'requirement' and 'solution'. We can note a pattern of activities in these two categories in the case of BOP and TOP sessions by drawing ellipses as shown in Figure 4. In the case of BOP sessions: (1) the upward slope of these ellipses is small in the case of the designers BOP-1 and BOP-3, (2) the ellipse is flat as can be seen in the case of the designer BOP-4, and (3) the ellipse is downward sloping as seen in the case of the designer BOP-2. In contrary, in the TOP sessions, the upward slopes of the ellipses are sharp in the case of the designers TOP-2, TOP-3, and TOP-4. In the case of the designer TOP-1, the upward slope of the ellipse is small. These findings support the abovementioned interpretation that the designers in the BOP sessions have exhibited a problem driven strategy and the designers in the TOP sessions have exhibited a solution driven strategy.

These problem driven and solution driven strategies in the BOP and TOP sessions can also be verified by computing the solution to problem (S-R) ratio (i.e. the ratio of average percentage of segments under the 'solution' category to the average percentage of segments under the 'requirement' category). For the designers in the BOP sessions, these ratios are 1.4 (BOP-1), 0.8 (BOP-2), 1.3 (BOP-3), and 1

(BOP-4). In contrast to these small S-R ratios, the S-R ratios in the case of the TOP designers are relatively higher: 1.3 (TOP-1), 3 (TOP-2), 1.9 (TOP-3), 1.7 (TOP-4). The average S-R ratio in the TOP sessions is 1.84, which is higher than the average S-R ratio of 1.02 in the BOP sessions.

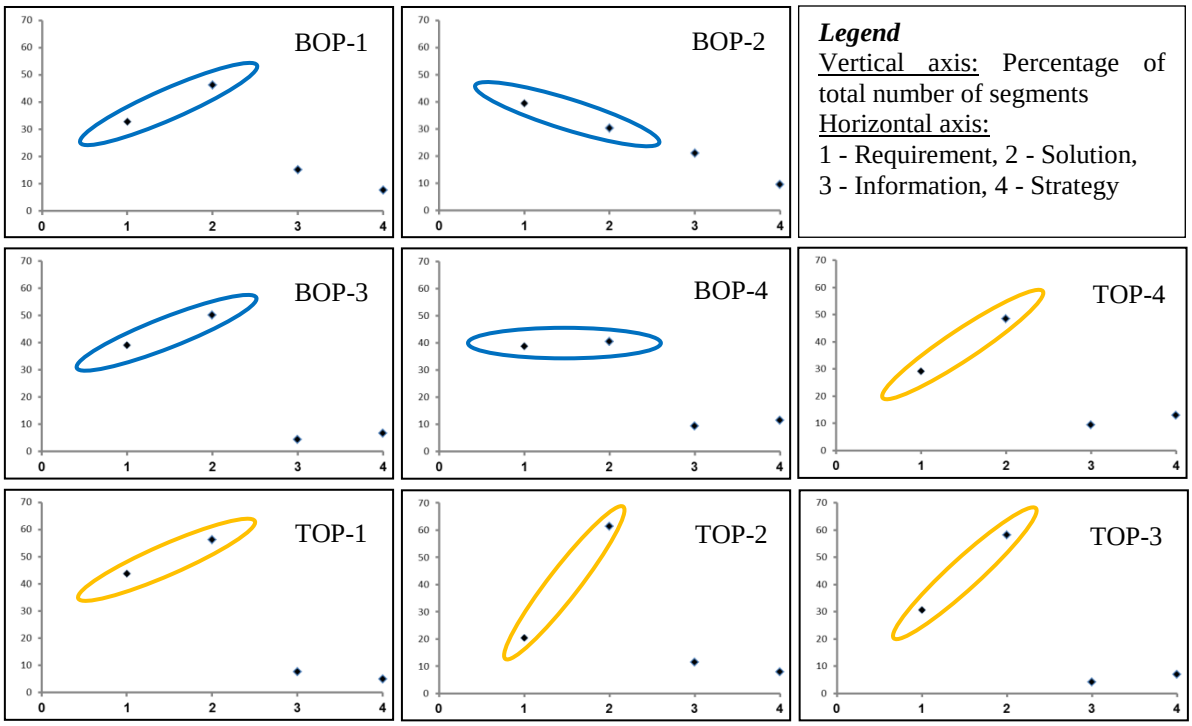

Figure 4. Scatterplots of major categories (i.e. requirement, solution, information, and strategy) for the BOP and TOP designers

4.3 Activities associated with requirements

The designers in the BOP sessions have spent more time in activities associated with requirements as compared to the designers in the TOP sessions (see Figure 3). The BOP designers exhibited the problem driven strategy, whereas the TOP designers used the solution driven strategy. Figure 5 shows the average number of segments and average percentage of segments for different activities under the category 'requirement' in the BOP and TOP sessions. This average percentage is based on the total number of segments classified into the 'requirement' category. In this figure, the coloured bars under the column 'Average %' are drawn by using the conditional formatting facility of the Microsoft Excel. The horizontal length of these bars represents the value of the average percentage of segments.

	BOP		TOP	
Activity	Ave. Seg.	Average %	Ave. Seg.	Average %
Identify	44.0	50.6	45.8	69.1
Evaluate	20.0	23.0	7.8	11.7
Repeat	22.0	25.3	13.0	19.6
Interpret	1.8	2.0	3.0	4.5
Ask	0.5	0.6	0.0	0.0
Select/reject	1.0	1.1	0.8	1.1
Assume	3.8	4.3	4.5	6.8

Figure 5. Activities associated with requirements

The occurrence percentages of segments in the activities, namely 'interpret', 'ask', 'select/reject', and 'assume' are small in both BOP and TOP sessions (see Figure 5). The average percentage of segments under the activity 'identify' is substantially higher in the TOP sessions as compared to the BOP sessions (69.1% and 50.6%). This indicates that the percentage of the total time associated with requirements is higher in 'identify' activity in the TOP sessions than the BOP session. However, the average number of segments under this 'identify' activity is approximately the same for the BOP and TOP sessions (44 and 45.8) (Figure 5). This suggests that the number of requirements identified in the BOP and TOP sessions is about the same. The average percentage of segments under the activity 'evaluate' is considerably higher in the BOP sessions as compared to the TOP sessions (23% and

11.7%). This finding indicates that the designers in the BOP sessions were engaged more in the evaluation of requirements than the designers in the TOP sessions. The occurrence percentage of segments in the activity 'repeat' is higher in the BOP sessions than the TOP sessions (25.3% and 19.6%). This implies that the designers in the BOP sessions frequently remembered the requirements as compared to the designers in the TOP sessions.

4.4 Activities associated with solutions

Figure 6 shows the average number of segments and average percentage of segments that are classified into the activities associated with solutions in the BOP and TOP sessions. This average percentage is based on the total number of segments under the 'solution' category. The occurrence percentages of segments in the activities 'generate' (56.7% and 53.1%) and 'select/reject' (1.6 and 0.8%) is slightly higher in the TOP sessions. The BOP designers dealt slightly more with the 'evaluate' (33.4% and 30.4%) and 'repeat' (16.3% and 15.4%) activities. Overall, the average percentage of segments for a given activity associated with solutions is about the same in both BOP and TOP sessions.

	BOP		TOP	
Activity	Ave. Seg.	Average %	Ave. Seg.	Average %
Generate	47.3	53.1	69.0	56.7
Evaluate	29.8	33.4	37.0	30.4
Repeat	14.5	16.3	18.8	15.4
Select/reject	0.8	0.8	2.0	1.6

Figure 6. Activities associated with solutions

4.5 Activities associated with information

The BOP sessions were more information intensive than the TOP sessions (see Figure 3). Figure 7 shows the average number of segments and average percentage of segments for different activities associated with information in the BOP and TOP sessions. In this figure, the average percentage is based on the total number of segments under the 'information' category. The occurrence percentages of segments in the activities 'access' (38.2% and 23.5%), 'ask' (29.3% and 17.6%), and 'repeat' (13% and 5.9%) are considerably higher in the BOP sessions than the TOP sessions. On the other hand, the designers in the TOP sessions assumed substantially more information than the designers in the BOP sessions (36.8% and 9.8%). The TOP designers evaluated slightly more information than the BOP designers (16.2% and 13.8%).

	BOP		TOP	
Activity	Ave. Seg.	Average %	Ave. Seg.	Average %
Access	11.8	38.2	4.0	23.5
Ask	9.0	29.3	3.0	17.6
Evaluate	4.3	13.8	2.8	16.2
Repeat	4.0	13.0	1.0	5.9
Assume	3.0	9.8	6.3	36.8
Interpret	0.0	0.0	0.8	4.4

Figure 7. Activities associated with information

The BOP designers assumed less information and asked for more information (9.8% and 29.3%). This implies that, in the BOP sessions, asking for information was preferred over assuming the information. This also suggests that the BOP designers were not confident in assuming the information. On the other hand, in the TOP sessions, assuming information was preferred over asking for information (36.8% and 17.6%). This finding suggests that the TOP designers were confident in assuming the information.

5 DISCUSSION, CONCLUSIONS AND LIMITATIONS

This research, using a protocol analysis, presents empirical results of how the design process for the BOP differs from that for the TOP. The intent of the study was not to determine the differences between the outcomes of these design processes; rather, it was to empirically explore the differences between these design processes. In order to study these differences, we compared the designers who solved a design problem for the BOP with the designers who solved the same problem for the TOP. The findings of the analysis revealed differences between the BOP and TOP sessions in the design processes.

The designers in the BOP sessions used the problem driven strategy, whereas those in the TOP sessions used the solution driven strategy. This interpretation is based on the result that the BOP designers spent more time in dealing with requirements as compared to the TOP designers who spent more time in dealing with solutions. These strategies in the BOP and TOP sessions are further supported by the values of S-R ratios in these sessions. The average S-R ratio in the TOP session is higher than that in the BOP session.

Compared to the TOP designers, the BOP designers were engaged more with the evaluation of requirements. Furthermore, the BOP designers frequently repeated requirements than the TOP designers. These findings plus the finding that the BOP designers spent more time in dealing with requirements than the TOP designers indicate that the unfamiliarity with the design task was higher in the BOP sessions than in the TOP sessions. This interpretation is further supported by the findings of Jin and Chusilp's (2006) protocol analysis that the unfamiliarity with a design problem requires more time in problem understanding. In both BOP and TOP sessions, excepting the type of the market, the design problem was the same. This suggests that the major source of the unfamiliarity in the BOP sessions was the context of the market (i.e. BOP market).

The higher average percentage of segments under the 'information' category in the BOP sessions indicates that the BOP designers spent more time in handling information than the TOP designers, and that the BOP sessions were more information intensive than the TOP sessions. The BOP designers assumed less information and asked for more information. This suggests that, in the BOP sessions, asking for information was preferred over assuming the information, and that the BOP designers were not confident in assuming the information. In contrary, in the TOP sessions, assuming information was preferred over asking for information. This finding suggests that the TOP designers were confident in assuming the information. Furthermore, the BOP designers repeated more information than the TOP designers. Our abovementioned interpretation that the unfamiliarity with the design task was higher in the BOP sessions than in the TOP sessions is further reinforced by the above findings of the information behaviour of the BOP designers and Hertzum et al.'s (2000) finding that when faced with unfamiliar issues designers prefer to ask for information.

The findings of this research can be useful in design practice and education. A variety of problems with varying task environments is useful in developing different design skills (Atman et al, 2005). The differences in the design processes in the BOP and TOP sessions suggest that solving design problems for the BOP can help students to practice and improve a different set of skills. This implies that students should be given opportunities to work on BOP design projects. Working on BOP design projects can be useful in developing skills required to design products for unfamiliar contexts.

The findings of this research can also help design teachers involved in the supervision of students' BOP design projects. The findings of this research showed that the BOP designers spent more time in dealing with requirements, and that the unfamiliarity with the design task was higher in the BOP sessions despite the fact that the designers in the BOP sessions had prior experience of working on university-based BOP design projects. In general, a design student from a developed or a developing country, without any prior experience of working on a BOP design project, is likely to be unfamiliar with the BOP as it is probable that he/she will not have experienced the BOP context in his/her life. This implies that the BOP design projects may take longer in dealing with requirements than the design projects for familiar contexts, and this aspect needs to be taken into account in the supervision of students' BOP design projects. This also can apply to 'real life' BOP design projects that are carried out by companies.

There are some limitations to this research. These are the following: (1) the results are based on the design task that is not a genuine 'real life' design task, (2) the designers were on-camera and knew that they were being recorded, and (3) the designers worked individually in contrast to genuine design projects that are, in general, carried out by a team. We believe that it is important to validate the results of this research in studies of real design projects using ethnographic methodologies. We also believe that more extensive design research in the field of the BOP is warranted.

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