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DESIGN FOR THE BOP AND TOP MARKETS: STRATEGIES USED BY THE DESIGN STUDENTS

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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 aims at exploring the differences between the design strategies used by the industrial design students in designing products for the BOP and TOP markets. The results indicate the differences between their design strategies (i.e. problem driven strategy, solution driven strategy) in designing products for the BOP and TOP markets. We have discussed the implications of the findings for design practice and education. In particular, we have discussed how university-based design projects for the BOP can help in developing students' different design skills.

Keywords: Base of the Pyramid (BOP), poverty, design strategies, design education, protocol analysis

1 INTRODUCTION
Figure 1 shows the world income pyramid [1]. 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 [2].

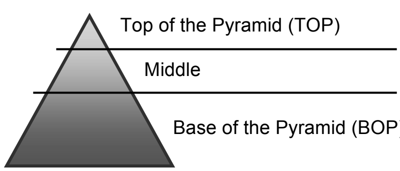

Figure 1. The world income pyramid [1]

1.1 Design for BOP markets
Poverty is a trap because children born to poor parents are likely to grow up to be poor adults [2]. It is important to alleviate poverty. In recent years, a poverty reduction approach that combines business development with poverty alleviation has received attention [3]. Saturated markets and a highly competitive business landscape motivate companies to search for new markets to increase profits. This has led companies to pay greater attention to opportunities at the BOP [4]. While companies are beginning to address the product needs of the BOP, there is limited practical and theoretical knowledge to support them [4].

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. Some examples of these universities are as follows: (1) Centre for Product Design and Manufacturing, Indian Institute of Science, Bangalore, India, (2) Department of Design Sciences, Lund University, Sweden, (3) Design for Extreme Affordability course at the Stanford University, USA, and (4) Faculty of Industrial Design Engineering, Delft University of Technology, The Netherlands.

The research in the BOP domain has been carried out by several authors from different disciplines [3]. While design research is important in understanding and improving design practice and education [5], 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 [6]. 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 strategies used by the industrial design students in designing products for the BOP and TOP markets. The sharp contrast between the BOP and the TOP makes the distinctions clear. The design strategies are empirically explored by using the widely employed technique of verbal protocol analysis. Encoded results of the protocol analysis show the differences between the design strategies used by the BOP and TOP students (i.e. problem driven strategy, solution driven strategy). We have discussed the implications of the findings for design practice and education. In particular, we have discussed how university-based design projects for the BOP can help in developing students' different design skills.

1.2 Design problem solving

Chakrabarti et al. [7] 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.

In design research, there has been interest in investigating design strategies used by designers. Kruger and Cross's [8] 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 [9] also observed these problem driven and solution driven strategies in their empirical study of designers.

2 THE PROTOCOL STUDY

2.1 Experimental design

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 [10]. In our study, the experimental arrangement was as follows. In total, eight Masters students in 'Industrial Design' individually participated in the study. These students were divided into two groups, namely BOP and TOP groups/sessions. In a laboratory setting, four students (BOP students) solved a design problem for the BOP, and four other students (TOP students) solved the same problem for the TOP. Before this protocol study, we ensured that the BOP and TOP students had prior experience of working on university-based design projects for the BOP and the TOP, respectively. Although the sample size in our study is small, the experiments provided sufficient data for our empirical exploratory study.

The following steps were followed with each of the eight students: (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 students, on average, finished the third step within 60 minutes. As an information source, a researcher was present during the entire experiment. The students were allowed to ask questions to the researcher. The experiments were audio and video recorded.

2.2 Design problem

The formulated design problem needs to be applicable for the BOP and TOP markets. 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 students were asked to consider general characteristics of the BOP and a developed country, respectively. After the experiments, all the students 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

2.3 Analysis

The audio recordings were transcribed. The transcripts were parsed into segments using the previous guidelines of Ericsson and Simon’s [11] 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 scheme successfully implemented and developed by Chakrabarti et al. [7]. 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. We measured the reliability of the coding process. 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	Student deals (e.g. identify, evaluate, ask, select/reject, assume, etc.) with a requirement (“That needs to include…”, “I am assuming this should be…”)
Solution	Student deals (e.g. generate, modify, evaluate, select/reject, etc.) with a solution. (“Let’s put cloth on inside…”, “So, this is efficient to…”)
Information	Student deals (e.g. access, ask, evaluate, assume, etc.) with information. (“Developed countries have…”, “This is actually not accurate information of…”)
Strategy	A plan of action for proceeding through the design process (“I will start by just taking…”)

3 RESULTS

As the sample size in our study is small (four students in each of the BOP and TOP sessions), we have explored the structures of students’ behaviour using descriptive statistics and visually through graphs. This is in line with the studies of Fricke [12] and Kruger and Cross [8].

3.1 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)

3.2 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 students 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 students spent more time in dealing with information as compared to the TOP students.

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 students in the BOP sessions have spent more time with requirements as compared to the students in the TOP sessions, and that the students in the TOP sessions have spent more time in dealing with solutions as compared to the BOP students. This indicates that the students in the BOP sessions have used a problem driven strategy, and that the students in the TOP sessions have used a solution driven strategy.

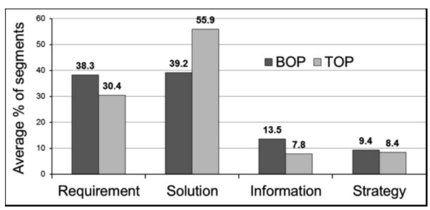

Figure 3. Average percentage of segments for major categories

These problem driven and solution driven strategies in the BOP and TOP sessions can also be verified by computing the solution to requirement (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 students 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 students 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.

3.3 Transitions

We counted the number of transitions between major categories for each of the students in the BOP and TOP sessions. Figure 4 shows the average number and average percentage of transitions in the BOP and TOP sessions. In this figure, the coloured bars under the column 'Ave. %' 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. A transition occurs when a protocol segment of one major category is immediately followed by a segment of another major category. For example, a transition from the category 'requirement' to the category 'solution' was made 18.9% of the time in the BOP sessions, and 21.3% of the time in the TOP sessions (see Figure 4). The average number of transitions (i.e. total number of transitions per student) is slightly higher in the BOP sessions than in the TOP sessions (91.3 and 84.5).

As shown in Figure 4, the average percentage of strategy-to-requirement transitions is higher in the BOP sessions than in the TOP sessions (9.6% and 5.9%). This indicates that, as compared to the TOP students, the BOP students planned to deal more with requirements. On the other hand, the occurrence percentage of strategy-to-solution transitions is higher in the TOP sessions as compared to the BOP sessions (4.4% and 9.8%). This suggests that the TOP students planned to deal more with solutions than the BOP students.

In both BOP and TOP sessions, the predominant transitions are requirement-to-solution (18.9% and 21.3%) and solution-to-requirement (16.4% and 21%). The average percentage of transitions between requirements and solutions is higher in the TOP sessions (21.3% + 21% = 42.3%) than in the BOP sessions (18.9% + 16.4% = 35.3%). This indicates that the degree of co-evolution of requirements and solutions is higher in the TOP sessions.

Transition	BOP		TOP	
	Ave. number	Ave. %	Ave. number	Ave. %
Req to Sol	17.3	18.9	18.0	21.3
Req to Info	8.8	9.6	6.8	8.0
Req to Str	7.8	8.5	4.8	5.6
Sol to Req	15.0	16.4	17.8	21.0
Sol to Info	4.5	4.9	3.5	4.1
Sol to Str	6.3	6.8	8.5	10.1
Info to Req	9.5	10.4	6.3	7.4
Info to Sol	4.5	4.9	4.0	4.7
Info to Str	2.0	2.2	1.0	1.2
Str to Req	8.8	9.6	5.0	5.9
Str to Sol	4.0	4.4	8.3	9.8
Str to Info	3.0	3.3	0.8	0.9

Figure 4. Average number and average percentage of transitions (Req - requirement, Sol - solution, Info - information, Str - strategy)

4 DISCUSSION, CONCLUSIONS AND LIMITATIONS

This research, using a protocol analysis, presents empirical results of the differences between the design strategies used by the industrial design students in designing products for the BOP and TOP markets. In order to study these differences, we compared the students who solved a design problem for the BOP with the students who solved the same problem for the TOP.

The students 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 students spent more time in dealing with requirements as compared to the TOP students 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 sessions is higher than that in the BOP sessions. The transition behaviour of the BOP and TOP students showed that the BOP students planned more to deal with requirements, whereas the TOP students planned more to deal with solutions. This result of the transition behaviour also suggests the problem driven and solution driven strategies used in the BOP and TOP sessions, respectively.

The finding that the BOP students spent more time in dealing with requirements than the TOP students indicates 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 [13] 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 students spent more time in handling information than the TOP students, and that the BOP sessions were more information intensive than the TOP sessions. This finding further reinforces our abovementioned interpretation that the unfamiliarity with the design task was higher in the BOP sessions than in the TOP sessions.

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 [14]. The differences in the design strategies used by the BOP and TOP students 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 students 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 students 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 students were on-camera and knew that they were being recorded, and (3) the students 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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