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# Cultures and Systems of Thought: a Preliminary Investigation on Implications for the Design Process and its Artifacts*

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*This paper presents our preliminary exploration of differences in design thinking patterns due to cultural differences. While our ultimate goal is to seek empirical evidence for how culture impacts on the design process and design outcomes (the artifacts), in this study we focus on the attention paid to objects versus contexts by a group of Eastern and Western designers. Our work is informed by the recent findings in social psychology regarding the covariance of persisting social differences and cognitive processes.*

**Keywords:** engineering design; cultural differences

## INTRODUCTION

PAST RESEARCH has shown differences in engineering design and product development practices in various countries. For example, Ettlie and Trygg [1] explored the differences between US and Swedish design groups and found significant differences in concurrent engineering practices: Swedish firms were about ten years behind compared to American, in adoption of design for manufacturing training. Case study comparisons also showed regional effects. For example, there was a strong influence of German engineering philosophy on Swedish and Hungarian design methods [2]. Gordon [3] argued that the products of designs can be seen as 'embodying cultures of engineering, which in their turn embody broader national cultures'. In addition, researchers have highlighted the importance of cultural studies within engineering design education. For instance, Siu [4] concluded that students were weak in problem identification in part due to the absence of cultural studies within their curriculum.

Researchers have also concentrated on the reasons for the cross-national differences in product design. For example, Cole [5] argued that the differences between Japanese and US approaches to new product development were rooted in their dissimilar quality philosophies. Others pointed out the complexity of these comparisons, and that in addition to cross-country differences the company culture impacted the design and development practices [6]. For example, in the auto industry, the practice differences could exist between Toyota and Ford, and also between Toyota and Honda; moreover, Toyota in Japan and Toyota in North America could be divergent in their design and development practices [7].

Whatever the reasons for these differences, given the contemporary need for functioning in a global environment, major challenges for multinational design and development teams have been identified as:

- members who speak different native languages;
- members with different cultural backgrounds;
- members living/working in different countries;
- members from different companies [8].

While some of these challenges can be addressed by facilitating good communication with a cultural sensitivity among team members, we assert that recent findings in social psychology regarding the covariance of persisting social differences and cognitive processes necessitate a deeper investigation of the impact of culture on design and development practices. Accordingly, we first provide our understanding of culture, and rationale for our study; we then report on our pilot experimentation and its results.

## LITERATURE REVIEW

Culture has many definitions. In 1990, Soudijn *et al.* [9] reportedly analysed 128 definitions. Instead of formulating an integrative definition of culture, Poortinga [10] suggested a more realistic

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approach: Culture is best operationalized based on the type of research questions one asks. Following this reasoning, we utilize Poortinga's definition: '[c]ulture becomes manifest in shared constraints that limit the behavior repertoire available to members of a certain socio-cultural group, in a way different from individuals belonging to some other group'.

A number of differences have been documented in the literature as a result of between-culture comparisons. For the purpose of the current study, however, we focus on comparing differences between East Asians and Americans. It should be noted that researchers in general recognize that there is a clear distinction between cultural paradigms and demographically defined regional groups or ethnocultural population [11–12]; that is, the boundaries between cultures may be much more blurred than the geographical boundaries of countries or regions. The simplification by comparing individuals from East Asian countries and the US by no means denies this distinction. As Lehman *et al.* [13] suggested, it is one approach to maximize cultural differences for research purposes because it is generally observed that the cultural distance—the extent to which cultures are similar or different [14–17]—between East Asian countries and the US tends to be fairly large.

In discussing the relativity of management theories, Hofstede [15] compared cultures around the world on four dimensions: Power Distance, Uncertainty Avoidance, Individualism and Masculinity. Power Distance describes the extent to which a society accepts the unequal power distribution in organizations and institutions. Uncertainty Avoidance indicates the extent to which a society feels threatened by ambiguous and uncertain situations and provides means to avoid these situations. Individualism refers to the belief that one is only loosely connected with others in the society and needs only to be concerned with his/her own welfare and that of his/her immediate family, whereas its opposite, collectivism, dictates people to be interdependent with other members of their in-group. Finally, Masculinity describes the extent to which the dominant values in the society are 'masculine', which is characterized by assertiveness, acquisition of money and things, not caring for quality of life or people.

Hofstede [15] emphasized that these dimensions described cultures at the collective level and were not characteristics of individuals. However, comparisons between the US and some East Asian countries can shed light on the distance between these cultures. Based on Hofstede's data, the US has below average power distance, is high on tolerance for uncertainty, is dominated by masculine values and is the single most individualistic country of the 40 he surveyed. In contrast, East Asian countries including China, Japan and Singapore belong to the group characterized by large power distance, weak uncertainty avoidance, collectivism and only average on masculine values. These data show that US and East Asian countries, at the national level, tend to stand at opposite ends of certain dimensions, especially the individualism–collectivism spectrum.

Some researchers have suggested that Easterners and Westerners may have some fundamentally different worldviews (e.g. [12, 18]). For example, Peng and Nisbett [19] reported that Chinese and American participants dealt with contradiction differently. Specifically, Chinese individuals used a dialectic approach including addressing issues from both sides and attempting to reconcile conflicts by compromising, whereas Americans tended to compare and choose between two opposing views through reasoning. These different approaches in understanding and perceiving their environment may have led people to engage in different decision-making behaviours ([20–22]). For example, when asked to justify their purchasing decisions, consumers in Hong Kong reported more of a preference for products that compromise among different attributes (e.g. reasonable price and medium level quality) than their US counterparts [23].

People from collective cultures also tend to be more attracted to the idea of group harmony and maintaining relationships. For example, compared to the United States, Korea tends to use advertisements that emphasize in-group benefits, harmony and family integrity to a greater extent [21]. A separate experiment that compared individuals in the US and Korea showed that US nationals found advertisements emphasizing individualistic benefits of products that are to be used with others more persuasive and those emphasizing in-group and family benefits less persuasive than their Korean counterparts. These social norms can be reflected in children's behaviour [12]. In game-playing situations involving the distribution of tokens, it was found that Chinese children chose strategies that were beneficial to the group and that resulted in equity, whereas American children chose strategies that were associated with individualism and competition [24]. Furthermore, in conflict-resolution situations, research has frequently shown that people in individualistic cultures prefer to use active, assertive and confrontational tactics for resolving conflicts, whereas people in collectivistic cultures prefer passive, collaborative and avoiding tactics [25–29]. For example, a study conducted by Ohbuchi *et al.* [30] found that Japanese and American students have different goals and use different tactics in resolving interpersonal conflict. In general, Japanese students strive to maintain good interpersonal relationships, whereas American students pursue justice. American students also chose assertion to a greater extent and avoidance to a lesser extent as compared to Japanese students. In summary, these studies provide evidence that different cultural norms have been shown to be associated with fundamental differences in the way people behave.

Given the above cultural differences and others,

Table 1. Thought patterns

| | Ancient Greeks (Western Thought) | Ancient Chinese (Eastern Thought) |
|---|---|---|
| Vantage Point (Self) | Personal agency | Collective agency |
| Vantage Point (Problem) | Discrete<br>Object and its attributes | Continuous<br>Object within the field |
| Communication | Encouragement for debate | Discouragement for debate |
| Problem Solving Approach | Analytic<br>Scientific theory and model building<br>Fundamental principles, logic<br>Abstract analysis<br>Categories and rules | Holistic<br>Genius for practicality<br>Dialectic<br>Experience-based knowledge<br>Relationships and similarities |

Table 2. Background and expertise of participants

| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Country of origin | Taiwan | Taiwan | China | USA | USA | USA | South Korea | South Korea |
| Coursework related to design/product development | 1 project<br>1 semester | 2 projects<br>2 semesters | 1 project<br>1 semester | 5 projects<br>5 semesters | 3 projects<br>3 semesters | 3 projects<br>3 semesters | 3 projects<br>3 semesters | 3 projects<br>3 semesters |
| Work experience related to design/ product development | None | LCD manufacture<br>6 years | None | None | Pharma-ceutical company<br>4 months | Computer manufacturer<br>3 months | None | Car manufacturer<br>8 years |

Nisbett *et al.* [31] advocate the covariance of persisting social differences and cognitive processes. They explain this by the malleability of the cognitive processes with training, and the fact that the society one lives in provides an inherent learning environment. That is, persisting cultural norms impacting on how we think. They explain this thesis by providing examples from scientific accomplishments of ancient Greeks and Chinese and observing a set of differences in their systems of thought [31–32]. Table 1 summarizes these differences.

Based on the differences presented in Table 1, we hypothesize that thought processes used during design also differ and that they culminate in differences in the design artifacts, and design processes.

## EXPERIMENTAL DESIGN AND RESULTS

In the pilot experiment presented in this paper, we sought empirical evidence for how culture impacts on the design process and the design outcomes—the artifacts. In order to test our hypothesis, we conducted an experiment using the following design problem:

> With the increasing energy related problems in the world, an increase in usage of bicycles is observed. However, in many cases bicycle accessories are not available to respond to current needs of riders (safety in traffic, carrying laptops, usage of cell phones during the ride etc.). As a designer your task is two-fold: find the most important need of bicycle riders that is not met, which can increase/improve the usage of bicycles in your location, then design an accessory that will respond to that need, and that will work with most bicycles.

Eight participants, from four different countries (three from the USA, two from South Korea, two from Taiwan and one from China) were asked to solve this design problem individually. The participants have different backgrounds and expertise in product design (see Table 2).

The experiment was conducted simultaneously by the eight participants, under the same conditions. It lasted approximately three hours. The participants had access to laptops with Internet connection. No communication was allowed among them. Before the experiment started, participants were presented with a sample design problem and a concept generated to solve this design problem (see Fig. 1). The approach to this concept was not explained, and participants were free to approach the design problem the way they wanted.

At the end of the experiment, the participants were asked to turn in the following documents:

- a completed background survey;
- a reflection on their design thinking;
- a detailed sketch (similar to the one shown in Fig. 1) to describe their final design.

They were asked to write any information in the language they were most familiar with. The background survey was used to determine their cultural background, as well as their level of expertise in engineering product design. The reflection on their design thinking was aimed at capturing their way of thinking during the design process. To do so,

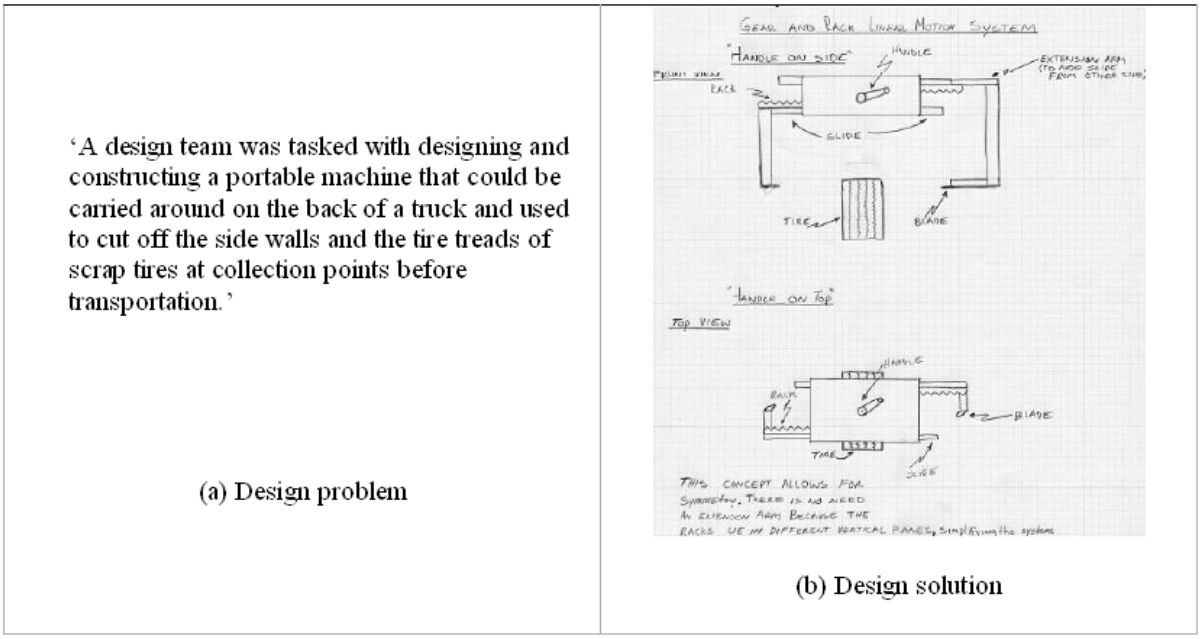


Fig. 1. Tyre Cutter Design Problem (a) and Solution Presented (b).

they were asked to write down what they were thinking of every 15 minutes. A review of participants' reflections revealed fundamental differences in their approaches to tackling the design problem (see Appendix A). The sketches drawn by participants are presented in Appendix B.

## DISCUSSION

Because we were interested in individual thinking patterns, we used self-recording of thought as a way of data collection in this pilot experiment. In order to limit the potential distraction making this recording act might cause, the prompts for recording were separated 15 minutes apart.

When the results (provided in the appendices) were analysed, we saw that the American designers were more concerned about the properties of the objects (e.g., participant 4 focusing on the properties of the tyres) while the Eastern designers were more concerned about the design in a more holistic way. For example, Eastern designers thought how things relate to different riding experiences one can have (e.g. participant 7), or how the designed piece could fit to other parts of the bicycle (e.g. cellphone holder fitting on the handle bar). These results are in line with Nisbett *et al.*'s findings (2001). We consider our observations to be preliminary evidence that Eastern and Western designers use different patterns of design thinking.

We arrived at this preliminary conclusion after a thorough review of the data (recorded design thinking prompts, follow-up essays explaining the thought process, design sketches) from each participant by each of the authors. After the review, a debriefing was held during which reviewers (authors) exchanged the findings of their review. For the preliminary experiment, the backgrounds of these reviewers (two engineering design researchers, a psychologist focusing on cross-cultural differences and a psychologist focusing on assessment) were deemed appropriate.

We acknowledge, however, several limitations in our work. First of all, our sample is too small to generalize the results to a broader population—5 Eastern and 3 American designers participated in our study. Accordingly, in a follow up study we plan to increase the sample size. Second, we would like to analyse the thinking records in a more quantitative way; thus we are currently researching methods for enabling this. In addition, the qualitative analysis implemented will be improved by conducting structured interviews and/or focus groups to verify our observations. Overall, our future effort will focus on complementing the work presented in this paper by designing experiments by which we can gather data to arrive at more generalizable results.

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## APPENDIX A

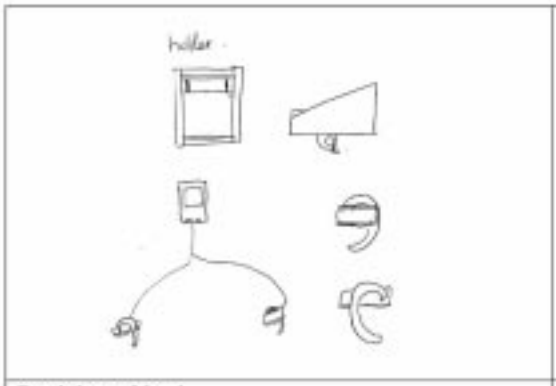
*Design thinking*

| | |
|---|---|
| **Participant No. 1** | |
| **12:45** | What kind of product is most necessary to be designed for bike riders. I am thinking about products related to communication and safety. |
| **1:00** | I'm thinking about how to design a certain product using Blue-Tooth Technology combined with the safety helmet to work as hand-free with cell phone. |
| **1:15** | I'm now confused with selecting Blue-Tooth Helmet or just blue-Tooth headset but particularly designed for bike ride. Convenience is my major consideration. |
| **1:30** | I want to design a set of product, which includes safety helmet Blue-tooth headset and a cell phone holder mounted on the handlebar of the bike. Bluetooth headset can be clipped on the helmet. |
| **1:45** | The bluetooth headset in my design includes a tiny recevier which can clipped on the helmet, it extends with the headsets which can hang on ears, but only cover a part of ears. This set of bluetooth headsets can let riders use cell phone and also listen to music but still can safely hear from the traffic. |
| **2:00** | The bluetooth headset cab dismantle the clip so that they can be also used in regular life. The safety helmet now is not my consideration since the bluetooth headset is designed for clipped on the band of the safety helmet. |
| **2:15** | I'm now thinking about the cell phone holder that can be mounted on the handlebar of the bike. The holder can be locked firmly and it can absorb the shock during bicycling and protect your cell phone. The holder can adjust with two sides to fit the size of all the cell phones. |
| **2:30** | I'm now thinking about the headsets. The pair of headsets can be comfortably clipped on the ears with no pain, and they only cover the upper side of the ears so the sounds from the environment still can be heard clearly. The shape of the headsets noe has been considered. |
| **2:45** | The receiver of the bluetooth headsets have two kinds of clips that can be changed easily by the user. Once is specially designed for biking, and the other one is designed for using in regular life. |
| **3:00** | Brifely draw the concept prototype. |
| **Participant No. 2** | |
| **12:45** | The features of the new product: light and portable, comfortable, safety, shake enduring and environmental concern. |
| **1:00** | Search and survey in the Internet the current products in the market. |
| **1:15** | Choose target as an electronic device from: (1) Map framce (2) Helmet (3) Electronic device. |
| **1:30** | Decide the detail spec of the electronic device: (1) Clock (2) Mileage counter (3) Time counter (4) Emergnecy signal sender |
| **1:45** | Additional requirements: (1) Small (2) Rechargeable battery (3) Waterproof (4) Temperature detector. |
| **2:00** | Key components list (1) LCD panel (2) Flexible printing circuit (ASIC) (3) Membrane switch and nameplate (4) GPS modules (RFID) (5) Battery (6) Sensor. |
| **2:15** | Start the appearance design. |
| **2:30** | Outsourcing the key components worlwide (1) Function (2) Price (3) Size (4) Supply ability (distance, credit, plant size). |
| **2:45** | Search the related knowledge and expert of electronic components. |
| **3:00** | Try to make the first prototype (order parts, materials, equipments). |
| **Participant No. 3** | |
| **12:45** | What are the possible problems bicycle riders face? Why do people not want to ride bikes? |
| **1:00** | Defined initial need - possibly 1 - somehting that can be used to carry weight but not weigh down the rider. |
| **1:15** | Considering other new possibilities. Weight-carrying accessories seem to have been around for a long time. |
| **1:30** | Develop a new idea -> A "tent" for a bike -> Loving it! Trying to decide its features. |
| **1:45** | Decided that this would only need to be as large as a large umbrella. Trying to figure out how to deal with turns. |
| **2:00** | Trying to figure out how to draw! I forgot all about technical drawing. |
| **2:15** | Changed umbrella to a shield in front of the rider. Not much need to cover the back, but maybe the side. |
| **2:30** | Trying to decide how should the "sides" of the shield should extend. |
| **2:45** | Well I'm slowing down. Losing interest gradually. Not being able to draw certainly doesn't help. |

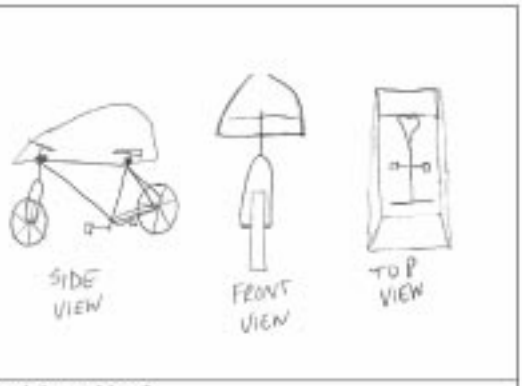
| | |
|---|---|
| **Participant No. 4** | |
| **12:45** | What does each customer desire entail? |
| **1:00** | What components attribute to a vehicle's road safety? What environments will the bike operate in? |
| **1:15** | How do tires affect the bicycle's performance? |
| **1:30** | Reviewing tire designs from major companies. |
| **1:45** | Tire designs and their applications. |
| **2:00** | How do you combine the stability? Aggressive tread patterns of an offroad tire, w/ the speed and comfort of a road tire? |
| **2:15** | Dertmining compatibility of accessories. |
| **2:30** | Are there any specific forms of rubber that work the best? |
| **2:45** | How fo all of the attributes fir together? |
| **3:00** | Will this work? |
| **Participant No. 5** | |
| **12:45** | Trying to decide what most common need is, is my personal experience common? |
| **1:00** | What to do next? Narrow needs or design different accessories and decide later? |
| **1:15** | I am distracted by thinking of cool names for the design I haven't made yet. |
| **1:30** | Researching types of bicycles so that I can design my accessory to fit w/ most. |
| **1:45** | Listing specifications, incorporate these into original idea. |
| **2:00** | Still stuck on spec but am starting to want this accessory for myself. |
| **2:15** | Working on drawings, two roadblocks. |
| **2:30** | Lots of setbacks, easier to get distracted. Want to make sure people want to buy this. |
| **Participant No. 6** | |
| **12:45** | Chatting/Getting oriented. Start analyzing factors/problems with bicycles. |
| **1:00** | Brainstorming consumer needs. Challenging norms of bike. Making comparisons. Generating ideas. |
| **1:15** | Considering marketing, target market, social changes, impacts. Developing idea of new product. |
| **1:30** | Comparing consumer needs to final design. |
| **1:45** | Generating list of attributes for new product before drawing preliminary sketch. |
| **2:00** | Generating list of attributes. |
| **2:15** | Finished list of desired attributes. Attempting to draw initial sketch. |
| **2:30** | Drew very rough initial sketch. |
| **2:45** | Considering problems to be addressed. |
| **Participant No. 7** | |
| **12:45** | First thing that should be ensured in bicycle usage is safety. |
| **1:00** | Need to develop accessories that improve safety of bicycle rides. |
| **1:15** | Searching websites to find out what kind of safety accessories for bicycles riders exist. |
| **1:30** | Conclusion from the search: the most lacking part in bicycle safety accessories are those to prevent from falling down. |
| **1:45** | Analyzing the "falling" problem": inside effect (rider), and outside effect (obstacles). |
| **2:00** | Think about designing a device which can prevent a bicycle rider from falling down even though he.she loses balance or a device which can hwlp a bicycle rider not to lose balance. |
| **2:15** | Analyzing how a bicycle and rider falls down |
| **2:30** | I decied to invent a bicycle accessory which is similar to power steering in automobile. |
| **2:45** | Thinking of the elements of the design. |
| **3:00** | I came up with the final design: three parts; the sensor on the front wheel to measure the speed, the air compressor part, and steering pressing part. |
| **Participant No. 8** | |
| **12:45** | What kind of products do you need during driving by bicycles? |
| **1:00** | Considering factors for designing a power supplier. |
| **1:15** | Desining a power supply (position, mounting methods). |
| **1:30** | Thinking of a mounting device. |
| **1:45** | Desining a power supplyer - more detail. |
| **2:00** | Designing a case for products. |
| **2:15** | Mounting devices or methods for different size electronic products. |
| **2:30** | Desgning a mounting device for a product in a case in detail. |
| **2:45** | Review the proposed design and considering pros and cons. |

## APPENDIX B

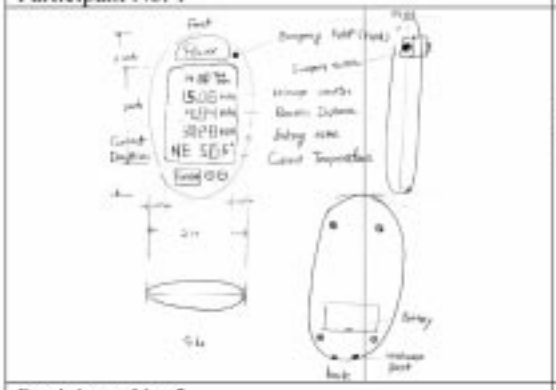
*Final sketches*



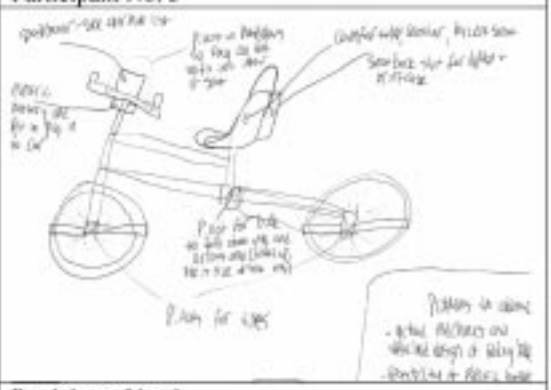

Participant No. 1



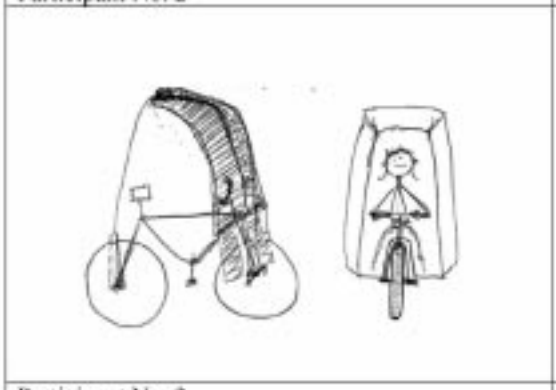

Participant No. 5



Participant No. 2



Participant No. 6



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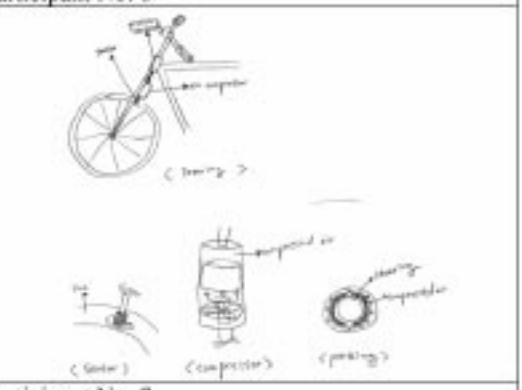

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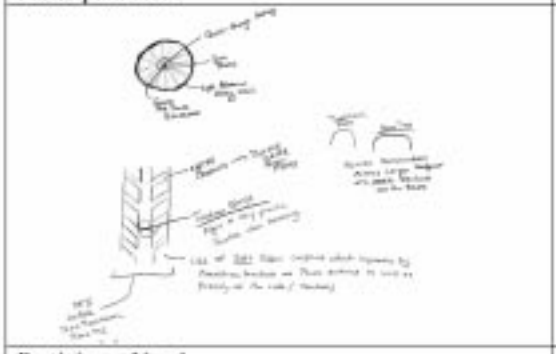

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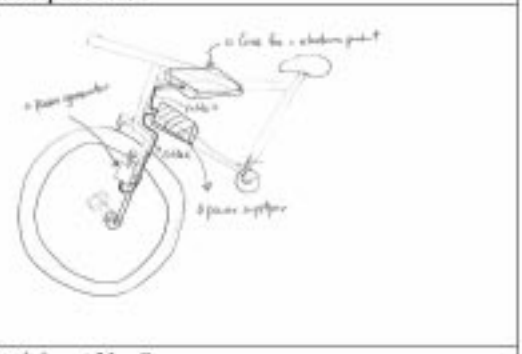

Participant No. 8

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