

**DesignEd Asia Conference 2010**  
**Asian Culture: Preserve the Past, Create the Future**

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# Cultural Relevance in Sustainable Product Design and Development

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## ABSTRACT:

This paper details a culture-centric approach to shift design thinking and practices away from the ongoing unsustainable production of goods and services, that are unfit for the human conditions in poor countries and the use of resources that are harmful to the environment, towards a more sustainable framework of production and consumption whereby cultural relevance and other human factors, natural resources and technology are analyzed to inform the design of a human powered transportation system – the Greencycle. It uses a trans-disciplinary research and design approach to capture and transform the collective knowledge and

experiences of a society by consulting all stakeholders; including farmers, artisans, industrial designers, engineers and manufacturers to provide insights that has enabled this research study to produce a cohesive socio-technical system – in Indonesia – which satisfies societal needs and wants and the use of indigenous people skills and renewable materials to produce greencycles and accessories that are more environmentally sustainable, meaningful and beneficial to the way of life of the local people.

**Keywords: Culture, Sustainability, Greencycle.**

## 1. INTRODUCTION

The notion that Cultural Relevance as a key driver for sustainable product design and development for Developing and Third World Countries was put to bear in this Master of Philosophy research project to analyse, design and evaluate a human powered transportation system – the Greencycle - for rural Indonesia.

The bicycle provides more than a basic transportation to go from A to B. Poor countries need and depend on this mode of transportation for a wide range of uses. Expanding its functions and uses would be of great benefit to the society. We have created a series of Greencycles and accessories to extend the artifact's functionality, with the core parts made by local artisans from sustainable materials such as the mighty ubiquitous bamboo that is available abundantly in many Third World Countries.

For this project it would have been a simple process for the designer to come up with a concept that was based on a personal view of what would be a suitable solution for the target users. Instead however, we used human-centered research methods to capture knowledge and feedback from the target group participants to

shape and develop the design process and to ensure the design will not only be acceptable, but also culturally meaningful and desirable for the users to use, manufacture and trade. Due to the scope of this conference paper, only a précis of the project is presented here. Diagrams and images are used in many places to show our design thinking and to minimize the use of texts.

## 2. CULTURE AS CORE CRITERIA IN DESIGN

“Culture” is a highly complex and often misunderstood and misused term and concept. Culture refers to the “way of life” that defines a particular group of people that may include, but not limited to their forms of expressions such as their language, art and science, thoughts and thinking, social activities and interactions – (www.roshan-institute.org. 2010) that are knowable and designable as embodiments in an artifact. We believe that true sustainable design should embrace and express the system of knowledge, rituals and custom shared by a relatively large group of people. Culture is a very powerful collective programming of the mind that distinguishes the members of one group of people from another. Understanding this learned behavior of a group of people therefore will ensure relevance and value to the design, development and evaluation of the Greencycle. People don’t merely own or use a product for their own sake, but rather for the emotional cultural story, explicit and implicit emotional relevance and meaningful cultural experiences that are embodied and conveyed by the product.

We maintain that cultural understanding is a core design criteria. Studying cultural differences among user groups call for unbiased interpretation and judicious translation of the research designer, as there is no scientific benchmark for deciding the intrinsic superiority or inferiority of the way of life of a group or society. More often than not, the way of life within a group in the Third World, or a

professional group even within our own society, will be different to our own. Insights about the nature of this cultural difference and their consequences preceded our design process.

To understand and prepare us for the Greencycle project, we have adopted a participatory design approach that has included four expert interviews, eleven case studies of target users, prototype testing and field experiments with sustainable resources, in order to propose, design and evaluate two Greencycles and a series of transportation accessories. This collaborative approach to the design problem has revealed many opportunities that would otherwise be hidden by less co-creation methodologies.

### 3. RETHINKING HUMAN POWERED TRANSPORTATION

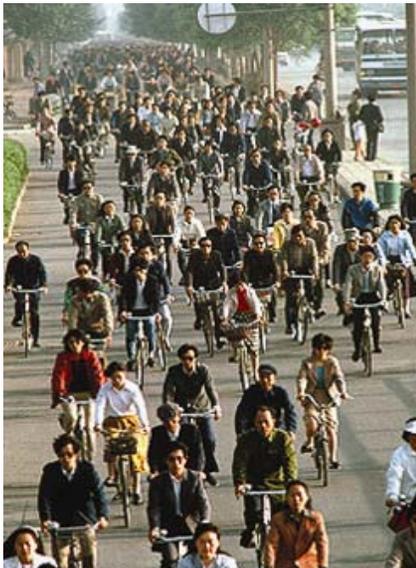


Fig 01. A Common road scene in

The research applies system design thinking, informed by cultural insights, to improve on this form of human powered transportation, taking into account the behavior, belief and value relevance, functionality, the needs and wants of the users, and the use of appropriate technologies and environmental considerations. The focus of cultural-centric design is to improve the usability of a

product or service so that it becomes more personally related and meaningful to the user's way of life.

A participatory design approach ensures that researchers, practitioners and stakeholders co-operate to explore complex human-machine-environmental issues. (Nicolescu, 2007), (Peterson, et al., 2000) These issues include exploring new cleaner/greener local materials and processes, socio-cultural issues in relation to economics, new business and labor models to ensure the lasting sustainability.

Pre-design information gathered from observation and interviews of target users and bicycle manufacturers in Indonesia provided a good understanding of bicycle use in relation to the user's needs and wants in their natural environment. This information provided insights on how low income users modify their bicycles to maximize their use and accommodate their needs.

This knowledge was later used to produce a series of new bicycle concepts and bicycle accessories to increase the bicycle's load capability aimed at improving the user's way of life. A series of scale models were constructed to explore different types of load and weight options as well as customization possibilities to suit the different needs of users.

From these studies, two full-size Trailer prototypes were built, tested and evaluated by target Indonesian users. This field test was to see if the target users were willing to accept and try new ideas, and to evaluate whether the design criteria have been met from previous findings as well as to find out what the user would do to these prototypes when they adapt them to suit their daily activities.

Two full-size Greencycle prototypes together with a series of cycle accessories to enhance the usability, functionality, desirability and sustainability of the humble bicycle have now been built as a possible local business venture.

## 4. RESEARCH DESIGN AND DESIGN METHODS

Trans-disciplinary research and design approaches involving human-machine-environmental interactions have been applied to analyze, design and evaluate the Greencycle and the socio-cultural and environmental systems in which the Greencycle exists.

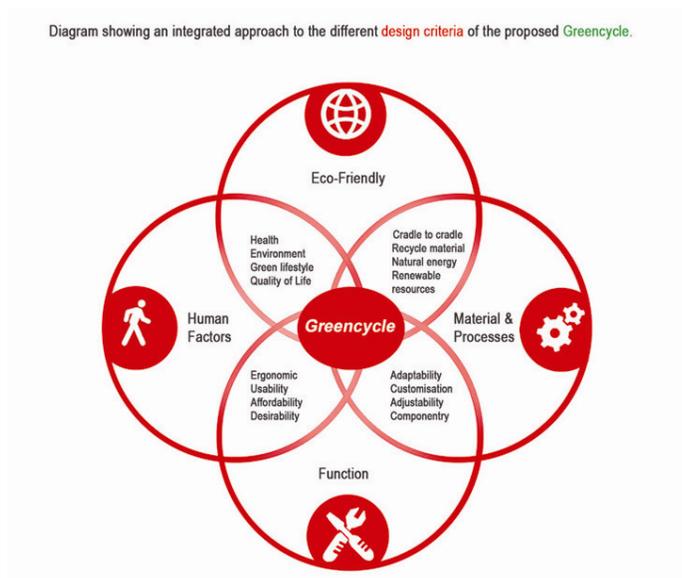


Fig 02. Diagram showing an integral approach to the different criteria of the proposed Greencycle. (Maringka 2009)

### 4.1. HUMAN CENTRED DESIGN APPROACH

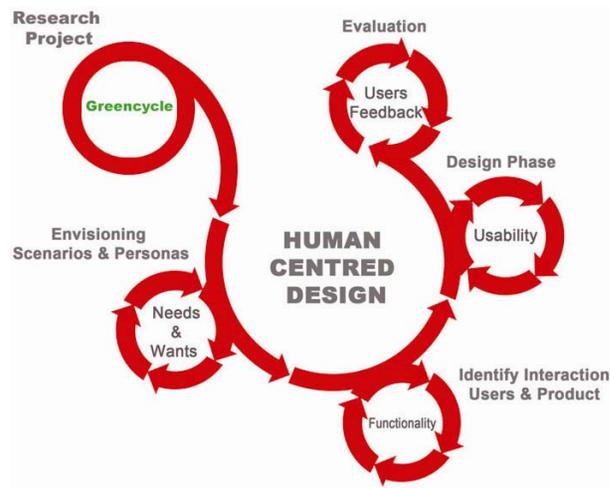


Fig 03. Diagram showing human centred design in the context of the proposed project. (Maringka, 2009)

While we believe that cultural relevance is a key enabler for sustainable product design and development, it would be naïve of us to suggest that the application of cultural factors per se could ensure lasting sustainable design. From the start of the research, our position has been that the anthropological, emotional, experiential and spiritual aspects of culture should be complemented with other equally important and more tangible human factors such as the user's physical capabilities and limitations, technology, business viability and so on. This project has applied these, as an integrated system approach, whereby the behavioral and physical characteristics of the human user are taken into account – albeit with local cultural factors as an important frame of reference.

The Human Centred Design method used in this project consists of the following four approaches to:

#### **4.1.1. Understanding the User's Needs**

This research project began with the aim to improve product functionality, based on the needs and wants of the users.

#### **4.1.2. Identify Interaction between Users and Product**

We summarized and synthesized the information from the literature context reviews, personas and scenario building which then fed into users' needs to establish product functionality. This information was then used to guide the design process, especially to check if the needs of the user were being achieved

**4.1.3. Human Centered Design**

Using data and information gathered from expert interviews, the design ideas were generated, developed and improved with a focus on culture, human dimension, ergonomics, materials and processes. The functionality and usability of the Greencycle and accessories were also explored based on product use and needs.

**4.1.4. Evaluation by stockholders**

Drawings, mockups and prototypes were used in the design process to validate and evaluate whether the needs of users had been met and to establish any changes or modifications that needed to be implemented to improve the final idea.

4.2. RESEARCH METHODS

As shown on the following diagram, this research project has used mainly qualitative research with some quasi-experimental research to generate empirical information to inform and evaluate the design outcome (which also includes interpretative and heuristic-generative methods). This mixed method provided a "triangulation" to produce more rigorous and reliable design outcomes.

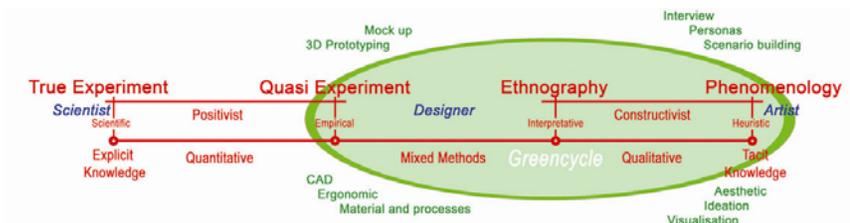


Fig 04. Diagram showing the research methodology of the proposed research design project. (Adopted from Yap, 2009)

### 4.3. RESEARCH & DESIGN PROCESSES

The research process consisted of the following six methods:

1. Direct observation
2. Literature context review (including internet ethnography and visual analysis)
3. Scenario building
4. Personas
5. Expert interview
6. Design evaluation

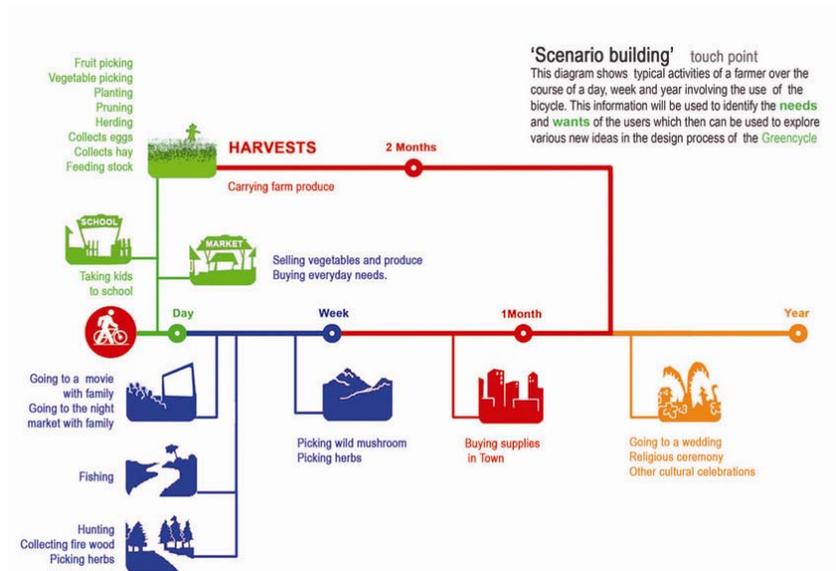


Fig 05. The diagram shows the scenario building of the proposed design research project. (Maringka, 2009)

#### 4.3.1. Case Study: Fire Brigade Bicycle in China

Rural access roads in Third World countries are normally narrow earth and gravel roads which form the last link in the road network connecting rural areas to primary roads, and they can carry only light traffic. Therefore,

access to some of these rural areas is very limited and this poses a real concern in the event of an emergency, such as a bush fire or when paramedics are urgently needed.

So in this case, three simple basic steps can be used to create the basis of this scenario:

*1. Establish a goal and context.*

*What makes the bicycle useful to the users?*

*2. Describe the usability.*

*When, how and what is the bicycle used for?*

*3. End with result.*

*Identifying the needs and wants of the user.*

This information was then used to explore various new ideas in the design process of this proposed project.

Akira is an administration worker for a government office in a small town in China. He has also been a member of the volunteer fire brigade for a number of years. Akira and a few other volunteers are responsible for the neighboring villages on the outskirts of his town.

In order to reach the hot spot in a relatively short time, he needs a simple vehicle to carry the firefighting equipment necessary. Because of the nature of the job, he requires a vehicle that can be used almost instantly and without having to rely on batteries or liquid gas. This means he can use the vehicle with ease and requires no special licensing to add extra costs for him.



Fig 06. Existing fire brigade bicycle in China.

#### 4.3.2. Expert Interviews

The 'experts' consisted of 4 experts (a product designer, a product developer, a manufacturer and a bamboo worker) who were interviewed to help assess the materials used and the manufacturing processes. The interviews reinforced and validated the information and knowledge gathered from the earlier research methods, and everything was then analyzed, synthesized and used to inform the design process.





Fig 07. Four expert interviews.

### 4.3.3. Design Evaluation

The design evaluation is intended to evaluate whether the criteria have been met from previous research findings and to establish any changes or modifications that need to be implemented to improve the final idea.



Fig 08.-11. Target user interviews.

Ten participants in Indonesia were selected and invited to enter into a consenting partnership to share with the interviewer their point of view on product prototypes based on their knowledge and experience. Potential participants were recruited from a targeted demographic whose

livelihood and income is derived from bicycle use. A local leader who knows the background of the participants chose them.

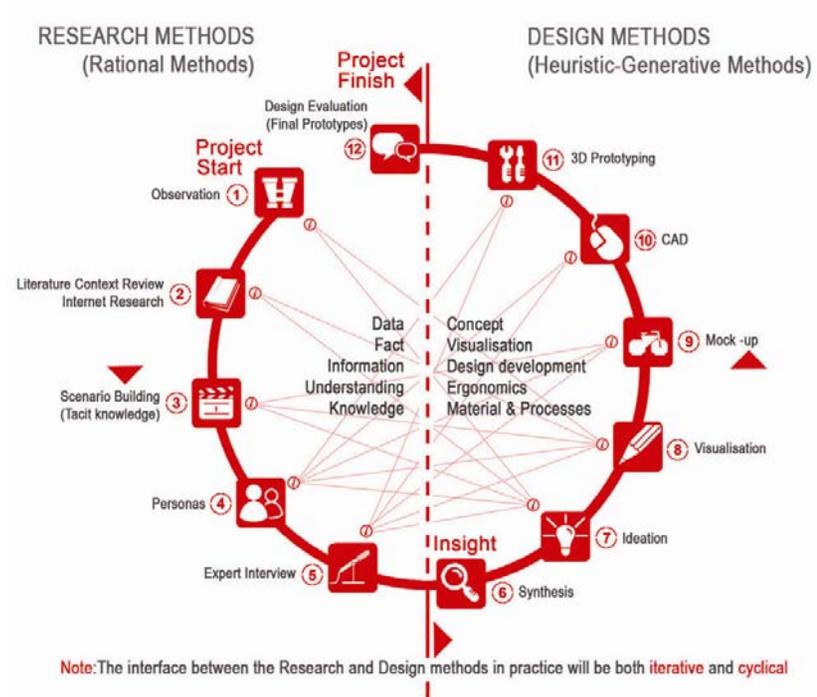


Fig 12. Diagram showing design research and design methods. (Maringka, 2009)

#### 4.4. Design Methods (Heuristic-Generative Methods)

##### 4.4.1. Ideation

Reflective practice was used to explore various new ideas that were informed by the data. Ideation also involves the use of imagination in an organizational context for problem solving in the conceptual phase.

##### 4.4.2. Mind Mapping

Mind mapping was used to recall existing knowledge on a subject. This uses a diagram to represent ideas, tasks, or other information linked to and arranged around a central key word or



A series of mock-ups of semi-working scale models were built to enable the designer to understand the entire product's workings and development which in turn gave a clear more realistic and animated concept (moving parts).



Fig 14. A Series of mock-ups were used in the design accessories exploration.

#### **4.4.6. CAD**

CAD software was used to give a more realistic representation to the design ideas. Using data and information gathered from interviewing experts and manufacturers, the design ideas were developed and improved with a focus on dimensioning, ergonomics, materials and processes.



Fig 15. CAD rendition of the ideal bicycle with the multi function trailer.

## 5. SIGNIFICANT FINDINGS



Fig 16. Bicycles used as push cart in third world countries.

Initially the research study focused on looking at how to improve the bicycle manufacturing process so that it was cleaner and didn't rely on unsustainable processes, together with exploring the use of renewable materials. Through the research study process and time spent in understanding the

culture of users in Indonesia, the focus shifted. It has become apparent that most bicycle manufacturers are only catering for the middle and luxury ends of the market instead of producing ranges suitable to and affordable for the people who need this form of transportation the most – the lower income bracket, whose livelihood depends on it to make ends meet.

Most target users cannot even afford to buy a bicycle and their needs have been neglected for sometime. Therefore, the focus of

this research study changed to look at ways of reducing manufacturing processes and costs while utilizing local resources and harnessing local craftsmen's skills to produce a design outcome that will be best utilized by the target users to meet their needs, wants and ways of life.

The Greencycle uses the Triple Bottom Lines of Bob Willard (2002) to instill social responsibility while "designing for the other 90% at the bottom of the pyramid" in order to assist target users to become economically sustainable and reduce the environmental impact. This includes:

## 5.1 Environmental Issues

The Greencycle explores the use of renewable materials such as bamboo as the main material, which is also less problematic to dispose of at the end of its useful life. By using bamboo strips, which are economical and readily available as a commonly used material in Indonesia (mainly for basket weaving) to construct the Greencycle frame, it is possible to use an economical green material that is biodegradable and can be used to reduce the cost of producing the Greencycle.

## 5.2 Local Resources

Our study shows that various types of human powered transport in Indonesia make the best use of locally available resources, like recycled materials and user or craftsmen's skills in terms of modification and operational skills. These vehicles also provide a functional and economical means of transport as shown by all the case studies. Because they own it, bicycle users have generally been doing their own modifications to meet their needs as transport and as a way to make a living due to their limited financial

resources. However, most of the work done relies on a very basic knowledge of materials and technology with very limited design resources. Interviews conducted with the two major bicycle manufacturers in Indonesia indicated that there is very little financial gain to be made in developing and producing these types of work horse bicycles as the target user is mainly in the lower income bracket and thus there is no interest in producing them in the near future. There seems to be no shortage in skilled craftsmen or blacksmiths in rural areas, so perhaps what's lacking is design thinking, ideas and choices. All rural bicycle users indicated they would pay a modest amount for a considerable improvement. As stated by Fisher (2007), the poorest people are also the most entrepreneurial, they do not want hand outs; they want opportunities.

Harnessing the local skills and resources to create the new bicycle



Fig 17. Cottage industry in Indonesia.

this will empower target users in the lower income bracket to be independent and rely less on big corporations who focus on dollar value instead of the cultural needs and wants of a society.

## 6. DESIGN AND DEVELOPMENT PHASES

### **Designing in a Sustainable Way**

Designing in a sustainable way means choosing the most suitable resources for a product and its function, not just satisfying the

market trend. Good design is not only about showing off a product and enhancing its aesthetic. While operating within a set of social, cultural and ethical values, designing in a sustainable way must also take into account the relationship within which the products are generated. Therefore, based on the principle of the Triple Bottom Line, Greencycle looked at “The Sustainability Advantage of the Triple Bottom Line” in the following ways:

- Reducing The Material Intensity Of Goods And Services*
- Reducing The Energy Intensity Of Goods And Services*
- Reducing Material Toxic dispersion*
- Enhance Material Recycling*
- Maximize Sustainability Of Renewable Resources*
- Extended Product Durability*
- Increase The Service Intensity Of Products*
- Economic Opportunity*

## 6.1. DESIGN OUTCOMES: MODELS AND PROTOTYPES

Informed by the findings captured in the research, the following models and prototypes were constructed to develop meaningful form and function, technical viability, and to test users acceptability:

1. A scale model was built using SLA or rapid prototyping to illustrate the ideal bicycle to provide a realistic representation of a semi-working prototype.



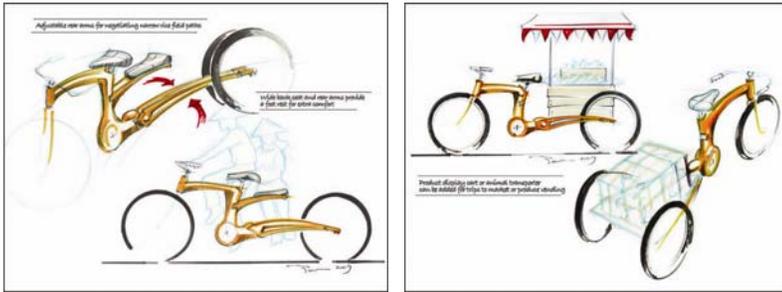


Fig 18. -21. A Series of ideation sketches of the ideal bicycle.



Fig 22. -25. Semi working scale model rapid prototype.

2. Two full-size, multi-function trailers were built and distributed to target users and feedback gathered to inform the future design idea.





Fig 26. A series of scale mock-ups of multi-functions trailers.

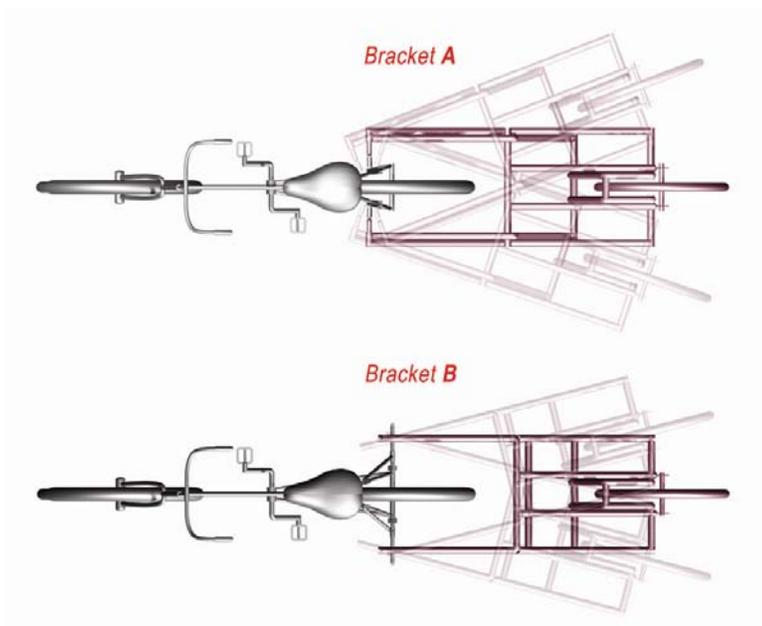


Fig 27. Diagram showing bird's eye view movement of two selected trailer ideas.

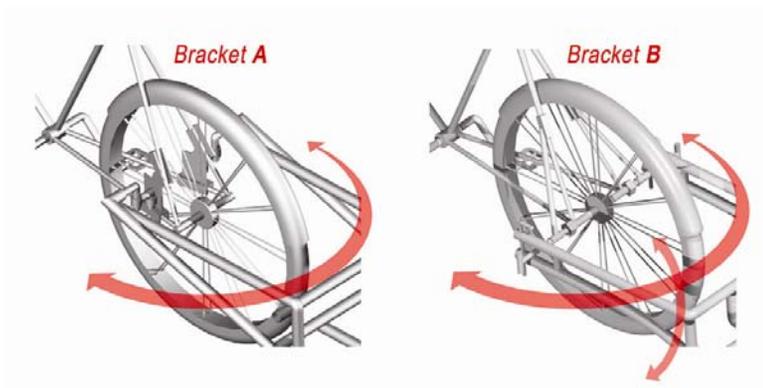


Fig 28. Diagram showing the different movement of two selected trailer ideas.



Fig 29. Diagram showing 2 Full-size multi-functional trailer prototypes

3. Two full-size bicycle frames made of experimental laminated bamboo were built to explore the possibility of using bamboo as a main material and utilizing local skills.

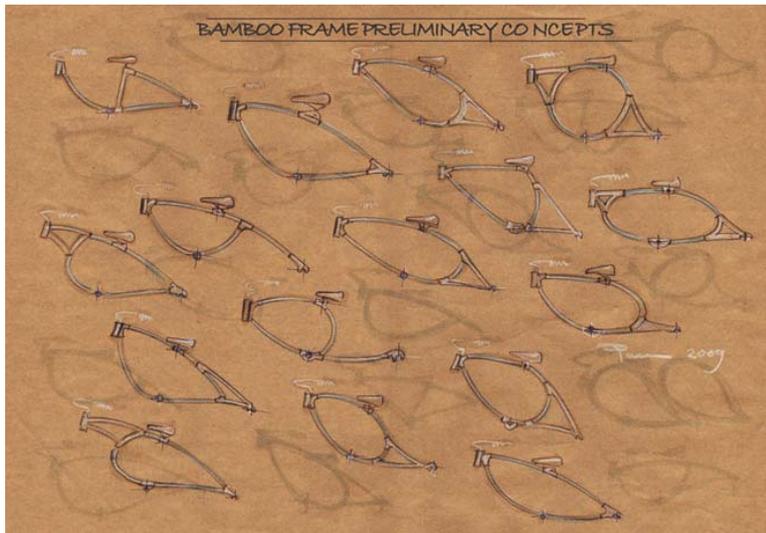


Fig 30. Preliminary bamboo frame ideation.

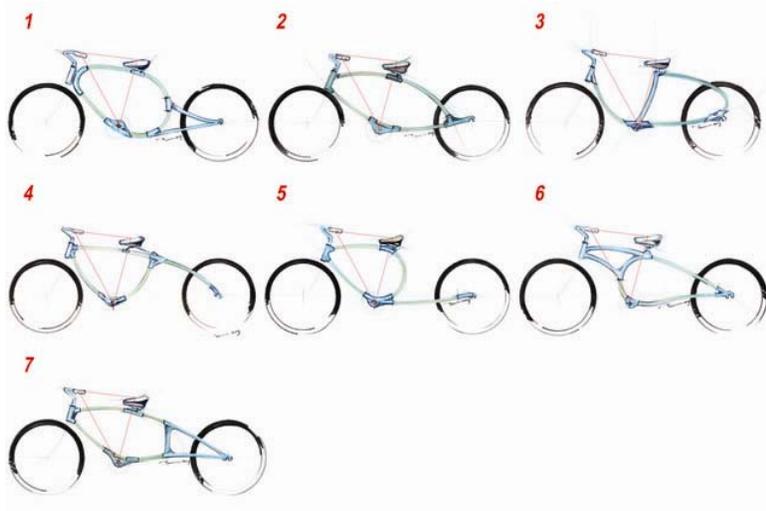


Fig 31. Seven bamboo frames selected for further development.



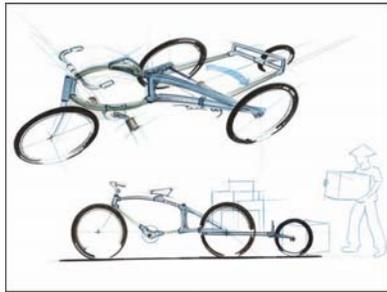


Fig 32. Three developed bamboo frames.



Fig 33. Construction processes of bamboo laminated frame no.1



Fig 34. Laminated bamboo frame no.1

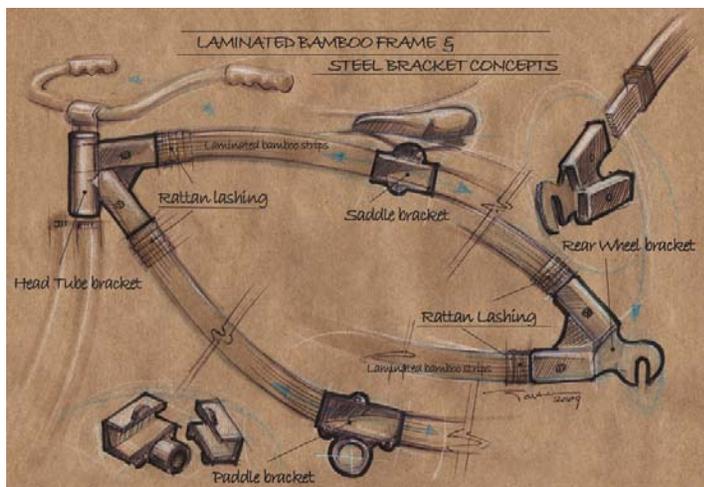


Fig 35. Proposed bamboo laminated frame construction no.2





Fig 36. Construction processes of bamboo laminated frame no.2



Fig 37. Laminated bamboo frame no.2

4. A full-size working prototype of the final design was built using current technology to explore the possibility of mass production, while maintaining a focus on affordability, the needs and wants of the target user and environmental considerations by using cleaner materials and processes.



Fig 38. Ideation sketches of Greencycle frame.



Fig 39. Producing the full scale of Greencycle frame pattern.

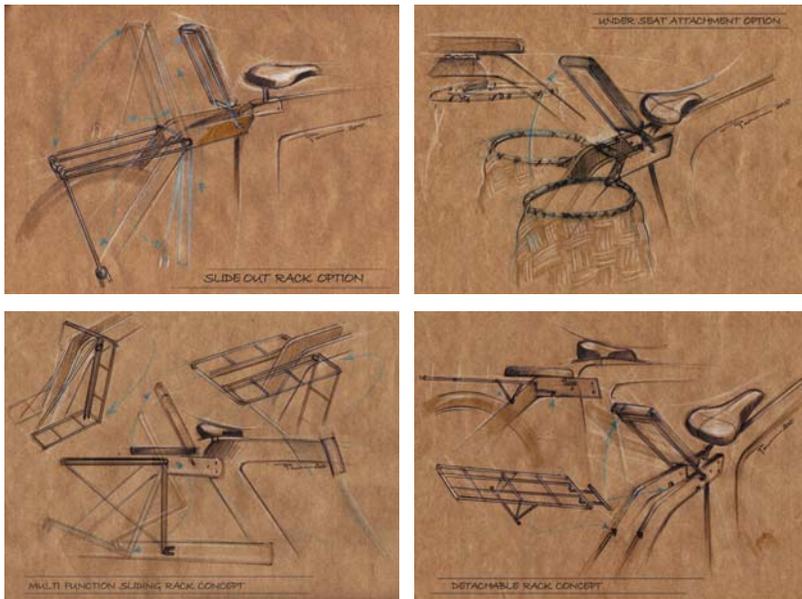


Fig 40. Ideation sketches showing different attachment opportunities.



Fig 41. CAD rendition of attachment point options on the Greencycle.

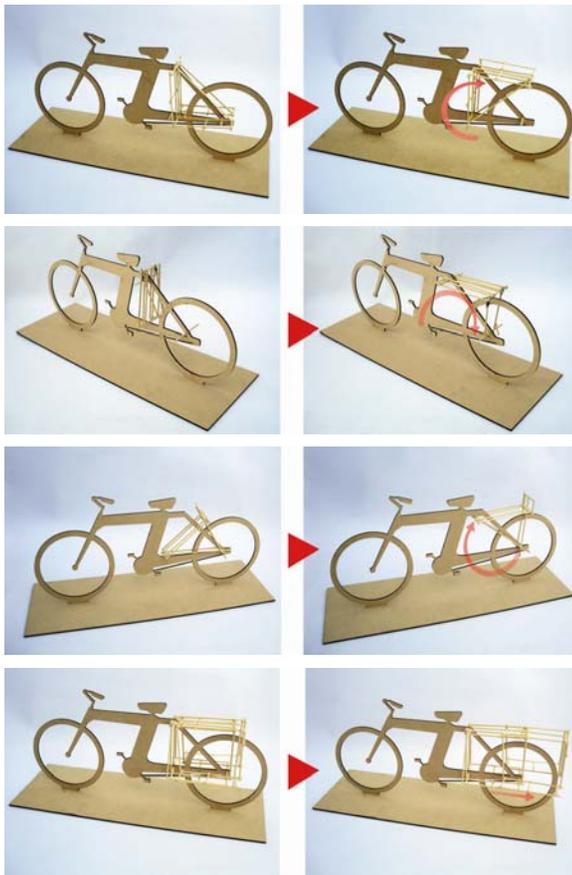


Fig 42. A series of mock-ups were built to explore Greencycle attachment options.



Fig 43. CAD rendition of the Greencycle final design .



Fig 44. The Greencycle.

## 6.2. SOCIAL RESPONSIBILITY

This Greencycle project is a socially responsible endeavor. Social responsibility is the idea that future generations should have the

same or greater access to social resources as the current generation. Social resources include ideas as broad as understanding cultures and basic human rights. One of the aims of this research project is to empower people by giving them an opportunity to have control of this project by improving their working conditions and labour relations, reducing the visual impact of factory and commercial sites on the local landscape, helping employees develop transferable job skills and fostering community relations. Rom and Markowitz (2006) believe the environment plays a big role in the result of productivity. The following three aims help drive social responsibility:

1. *Create sustainable solutions for the target demography by taking advantage of their biggest asset which is their land and their strongest skill which is basic farming.*
2. *Make this project as cost effective as possible, based on the way of life and the standard of living of the target users who are poor farmers. It is essential to develop a line of low cost parts that possibly can be manually produced thus making the Greencycle affordable. We believe that if the cost is low enough and the cost savings significant enough then it is more likely the product will be successful.*
3. *Create employment or to create local jobs. This will help to move as many people out of poverty for the least amount of money. It relies on the romantic notion that this project could be made by the end user or locals in their communities spread across the country. By providing an economic structure where they can learn skills, earn money and become self-supporting over time would make this project more sustainable and diversify reliance on agricultural output.*

## 7. CONCLUSIONS

The design and development of a new product for the current market is not an easy matter. A good design is not simply a functional and usable artifact. What is now required of designers and manufacturers is to consider design as a more holistic endeavor; the design must not only satisfy the user's needs and way of life, but also satisfy the manufacturer's need for competitive advantage as well as being good for the environment. Therefore, this research project has applied a trans-disciplinary approach involving human, artifact and environmental factors to ensure that the Greencycle is beneficial to the users, manufacturers and the environment.

The Greencycle project has taken note of the wisdom of the Triple Bottom Line, and has gone beyond just the use of a sustainable material by also ensuring that the product is sustainable in other areas, such as the socio-cultural factors, the skill level of the community and their needs and wants, and, last but not least, the competitive advantage of the product/design that could exist in the market place. The creation of the Greencycle is intended to improve people's way of life and the functionality and usability of a widely used form of local transportation in poorer Third World economies such as parts of Indonesia, China, India and Africa.



Fig 45. Greencycles.

Improving the humble bicycle, currently being used by over a hundred million people, with cultural relevance through a human centred design approach, could add significant meaning,

functionality, usability, sustainability and a greener operational mode of transportation for the millions of people in Third World countries. This paper has outlined the problems and opportunities and the research and design methods that were used to design a Greencycle as a more functional form of human powered transportation.

At times the process has been challenging, however evaluation of the test rig, models and prototypes has received a very positive and enthusiastic response from the stakeholders, signaling a likelihood that the products will be adopted and be commercially viable when put into the market place. While this project focuses mainly on farmers and the lower income demographic group in Third World Countries, we believe that the strategic design thinking and model can be applied to any First World Country to achieve greater sustainability. There is now a global consciousness of the need to reduce carbon footprints and promote healthier living, and the bicycle, as an intermediate means of transportation, is the perfect vehicle to achieve greater sustainability socially, economically and environmentally.

Many academic studies stop at the point when the written thesis is complete. This project went a step further by testing and implementing its findings on users back in its intended marketplace to ensure the design will be adopted by, and be successful for people not only in Indonesia, but other Third World countries. Feedback for the Greencycle design and its accessories has so far been very encouraging, with participants showing a significant level of enthusiasm. To take advantage of this success, a business proposition to market these sustainable products now seems plausible as a first step to developing this business venture by the local people for the local people to sustain and improve their way of life.

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