Stefan Ruiter

"The design of the packaging, user manual and educative game for the Angkor Light."

Bachelor Report

Studies of Industrial Design Engineering, University of Twente

Commissioned by Kamworks

Mrs. dr. Angèle Reinders
University of Twente

Henry de Gooijer
Kamworks

October 23, 2007

Preface

Working for three months in Cambodia as a designer was combining my two main interests: travelling and design. In a time span of twelve weeks I've experienced first hand how it is to live and work in a third world country. I can look back on a very good time and have a lot of good memories about this beautiful country with its amazing people.

It all started when I was busy looking for a bachelor assignment. I had found three assignments myself but could not choose between them. A friend told me about an assignment in Cambodia about solar energy and I was interested immediately. After contacting university a meeting was arranged and two days later I got the assignment.

The first week in Cambodia was quite surreal. I had been travelling to the other side of the earth before, but had never set foot in a third world country. The children in the orphanage were very open, local people were very willing to help and the scenery was beautiful. After a week I bought a motorbike to be able to go wherever I wanted. In the first few weeks a lot of research was done which got me in close contact with the local population. I often went out on my motor bike to interview people or find shops in Phnom Penh. Every weekend I went to Phnom Penh or made a city trip in Cambodia with the fellow students.

After the concepts had been created the really interesting work began. I really liked going to the locals with a couple of ideas about packaging, asking them what kind of design they liked and continuously fine-tuning the design. Getting feedback from people with a very different background then your own was the best part of the assignment. I was very proud when people finally understood all the information on the packaging and liked the design.

All this research would have been impossible without a good translator. I was lucky to have a very good translator, named Leap, who understood the company, understood how we thought as a designer and translated even the smallest replies. Also the support from Kamworks, in Cambodia as well as in the Netherlands, was very good. There was always time for questions.

I can look back on a very good time in Cambodia and like to thank Leap for being the best translator and a good friend and showing us the Cambodian culture. I also want to thank Arjen, for the continuous support in Cambodia and good care even though we were a bit of trouble sometimes. I also want to thank Henry for his very extensive support and bright attitude from the Netherlands. Finally I'd like to thank the students, you made it unforgettable!

Figure 1: The students, Miriam, Martijn, Erik, Bas, me and Leap.

Summary

This is the report of a bachelor assignment for the study Industrial Design Engineering at faculty of Engineering Technology at the University of Twente. The report describes the design of a packaging, an educative game and a user manual for a lantern on solar energy in Cambodia. The design process will be illustrated, from a field research to the design, production and testing of a prototype.

The assignment was written out by Kamworks, a company based in Cambodia. The company was founded in 2006 by three Dutch entrepreneurs and is a spin-off from the foundation Pico Sol. Since 2001 Pico Sol has been installing and maintaining solar energy systems. In 2005 the company developed a prototype of a lantern, the Angkor Light. This resulted in the establishment of Kamworks. The Angkor Light is a lantern that charges on solar energy and was developed for the rural population of Cambodia. The target group is the middle class and poor rural population of Cambodia.

Kamworks' slogan is "Affordable energy for sustainable development". Besides creating a turnover, the aim of the company is to create a workplace for Cambodian orphans. Kamworks wants to refine the prototype into a real product. To achieve this goal, amongst other things, a packaging is needed. A user manual needs to be created as well. Kamworks decided to develop a game to educate people in a playful way about the Angkor Light. Kamworks approached the University of Twente with this assignment.

After spending the first week on orientation, an analysis was made of Kamworks. The next step was to conduct a participatory field research. The aim of the research was to obtain qualitative as well as quantitative information on how the local population view the current prototype, packaging and games. The research provided good insights in Cambodian culture and the standard of living. Next, a market research was conducted aimed to gather information on similar products on the market today and to see how Cambodian people buy their products. To finish up the analysis phase, a research has been conducted to see what kind of production possibilities were at hand at Kamworks and in the rest of Cambodia. This analysis phase resulted in a program of requirements.

A large number of packaging and game concepts were created (Appendix C.2). Amongst the concepts were packaging concepts ranging from a cotton bag to a plastic PVC tube and game concepts from a board game to an educational comic. All concepts were evaluated using a matrix containing ten criteria. The five best concepts were combined with three game concepts in a morphological diagram. The result of the diagram in combination with an evaluation, involving the local led to the choice of a cardboard packaging with a board game embedded in it. The user manual will be printed separately and included in the packaging on a sheet of a4 paper.

The final design stage consisted of a continuous correlation between graphical design and evaluation at the local population. This resulted in the final design of the packaging, user manual and game. The design was presented to Kamworks as a prototype as well as a digital file.

Samenvatting

Dit is het verslag van een Bacheloropdracht van de studie Industrieel Ontwerpen aan de faculteit voor Construerende Technische Wetenschappen aan de Universiteit Twente. Het verslag gaat over het ontwerp van een verpakking, een educatief spel en een gebruikshandleiding voor een lantaarn op zonne-energie in Cambodja. Het ontwerptraject zal worden toegelicht, van veldonderzoek tot ontwerpen, fabriceren en testen van een prototype van het eindproduct.

De opdracht is uitgeschreven door het bedrijf Kamworks dat in Cambodja is gevestigd. Het bedrijf is in 2006 opgericht door drie Nederlandse ondernemers en is een spin-off van stichting Pico Sol. Na een sinds 2001 aantal jaar installaties op zonne-energie gebouwd te hebben heeft het bedrijf in 2005 een prototype van een lantaarn ontwikkeld, de Angkor Light. Daaruit is Kamworks ontstaan. De Angkor Light is een lantaarn die wordt opgeladen op zonne energie en is ontwikkeld voor de landelijke bevolking van Cambodja. De doelgroep is de middenklasse en de arme, landelijke bevolking van Cambodja.

Kamworks is een bedrijf met als motto “Betaalbare energie voor een duurzame ontwikkeling”. Naast het genereren van omzet heeft het ook als doel om weeskinderen aan een arbeidsplek te helpen. Kamworks wil nu het prototype van de Angkor Light uitwerken tot een marktwaardig product. Om dit te bereiken is er onder andere een verpakking nodig om de lantaarn te beschermen. Ook zal er een gebruikshandleiding gemaakt moeten worden. Tot slot wil Kamworks een spel ontwikkelen om op een speelse manier de werking van de lantaarn uit te leggen. Kamworks heeft de Universiteit Twente benaderd om dit te verwezelijken.

Na een orientatieweek is er eerst een analyse van het bedrijf Kamworks gemaakt. De volgende stap was het uitvoeren van een veldonderzoek. Het doel van het onderzoek was om kwalitatieve en kwantitatieve informatie te vergaren over de visie van de lokale bevolking op het huidige prototype, verpakkingen en spellen. Ook werd er door het onderzoek een goed beeld gecreëerd over de Cambodjaanse cultuur en levensstandaard. Vervolgens is er een marktonderzoek uitgevoerd om inzicht te krijgen welke vergelijkbare producten er op dit moment op de markt zijn en hoe Cambodjanen hun inkopen doen. Tot slot is er gekeken naar de productiemogelijkheden bij Kamworks en de mogelijkheden die Cambodja verder te bieden heeft op het gebied van productie. Uit deze analysefase volgde een programma van eisen.

Vervolgens werden een groot aantal concepten gecreëerd van verpakkingen en spelletjes. Onder de concepten bevonden zich verpakkingsontwerpen van een katoenen zak tot een plastic buis en spelontwerpen van een ganzenbord spel tot een educatief stripverhaal. In een matrix zijn alle concepten aan de hand van tien criteria beoordeeld. De beste vijf verpakkingen en drie spellen zijn gecombineerd in een morphologisch schema. Het resultaat daarvan heeft er samen met een klein onderzoek bij de lokale bevolking toe geleid dat er een kartonnen verpakking ontworpen gaat worden met een kleurenopdruk, waar een ganzenbord achtig spel in verwerkt zit. De gebruikshandleiding zal op een los a4 vel in de verpakking meegeleverd worden.

De detaillering bestond uit een wisselwerking tussen grafisch ontwerp en evaluatie bij de bevolking, dat resulteerde in het uiteindelijke ontwerp. Het ontwerp van de verpakking, het spel en de gebruikshandleiding is zowel als digitaal bestand als in de vorm van een prototype aan Kamworks overgedragen.

Table of contents

1. Introduction

The problem

About ninety percent of the population of Cambodia does not have access to electricity from a power grid. Therefore its rural population has to rely on candles or car battery powered lighting to fulfil their lighting needs. Kamworks is a company based in Cambodia that specializes in solar energy appliances. Two years ago the company started a project aiming at providing the rural Cambodian population with a solution to their power and lighting needs. A student Industrial Design Engineering from the Technical University Delft in the Netherlands was asked to come up with a solution. He developed a lantern that charges its battery during the day using solar energy, providing four hours of light every night. The lantern was named the Angkor Light.

Figure 2: The Angkor Light

The design was developed into a prototype and last year Kamworks decided to refine the prototype into a real product. The Angkor light was not yet ready to be launched on the Cambodian market. An electronics design had to be made for the optimal charging and discharging of the battery. Also the electronics for the lamp had to be improved, making the lamp more efficient. The product itself needed to be redesigned, allowing a bigger battery, giving it better ergonomic aspects and improving other shortcomings. The product should be sold as well so packaging was needed. To fully understand the product a user manual had to be created. Another big issue is how to sell the product. A selling strategy had to be developed and selling locations had to be created. Kamworks selected five students to work on this project.

The assignment

The assignment described in this report is the creation of the packaging with possibly a holder for the solar panel, an educative game and a user manual for the Angkor Light. An action plan was made to define the assignment and a global roadmap was set up to complete it.

Figure 3: Flowchart of structure of assignment and report

The assignment started with an analysing phase (**Chapter 2**). First, a short analysis of the company Kamworks was conducted to understand how the company operates. Secondly, a participatory field research was conducted to gather information about the Cambodian people. The first goal of the research was to find out what they think about the current prototype of the Angkor Light. Other goals were to see how and if Cambodian people play games and how they want to mount the solar panel. Also an insight in Cambodian culture and situation of living was achieved.

Following the field research, a market research was conducted. The goal of the market research was to find out which similar products existed on the current market. Another goal was to find out what kind of packaging was used and what they looked like. The last goal was to gain more insight in how Cambodian people buy their products. The next stage of the analysing phase was the evaluation of

the local production capabilities. The goal of this evaluation was to find out what kinds of production options were available at Kamworks or nearby, in the capital Phnom Penh. This analysis phase resulted in a set of requirements concerning the packaging, the game and the user manual.

A large number of ideas where turned into a lot of concepts (**chapter 3**). With the help of matrices and a morphologic diagram the three best concepts were selected. These three concepts were put to the test in a small field research to find out which concept was most popular with the local population.

The development of the final design of the packaging (**chapter 4**) was a continuous process of graphic design and participatory research. After every change the local population was asked to give their opinion on the new design which resulted in another change in design. Along with the packaging, the educational game (**chapter 5**) and the user manual (**chapter 6**) were developed.

Conclusions were drawn and a roadmap with recommendations (**chapter 8**) was set up to guide Kamworks in the completion of the packaging, game and user manual.

2. Analysis

In order to design a packaging, a game and a user manual for a product, an understanding of the situation in Cambodia is important. Cambodia is different from the Netherlands. The culture is different, the environment is different, even the way of shopping differs from the way people do it in the Netherlands.

Figure 4: Flowchart of structure of analysis phase

After a week of orientation, the first task was to get an understanding of the company Kamworks to understand the Angkor Light project and understand what the expectations of the company were. The next step was to conduct a participatory field research to get an insight in the ideas of the local population about solar energy products. A market research was conducted to see how products were being sold in shops and to get an idea of which kind of products were available on the Cambodian market. The last step of the analysis phase consisted of gathering information about local production capabilities because Kamworks indicated to want to do as much work as possible to provide as much local employment as possible.

All this research resulted in a list of requirements to guide the developing process of the packaging, the game and the user manual.

2.1 Kamworks

Kamworks is a solar energy company in Cambodia and was founded in 2006 by three Dutch entrepreneurs. Besides being a commercial company it aims to provide work for Cambodian orphans as well. The company is located near the capitol of Cambodia, Phnom Penh, on the grounds of an orphanage called “peaceful children's home I” (Kamworks 2007).

Figure 5: Map of Cambodia

One of the three Dutch founders is living in Cambodia permanently and is the general manager of the company. A Cambodian bachelor student is the assistant manager and embodies the main link between the company and the local employees. Recently a project manager was added to the staff. His job is setting up of a network of solar shops / solar stalls in the villages.

With the help of four workshop employees, Kamworks installed several solar energy installations in the last two years. The projects ranged from installing water pumps and electrifying small communities to installing lighting and sound systems in churches. Kamworks newest project is the development of the Angkor Light, the solar powered lantern that will provide light to the rural

population in Cambodia. In 2005, Kamworks asked a student Industrial Design from the Technical University of Delft to design a product to meet the lighting needs of the local population of Cambodia (Boom 2005). In 2006, Kamworks asked a student from the University of Twente to do research on possible product-market combinations (Rotman 2006).

Since one of the goals of the company is to create a working place for orphans, it is important to do as much work as possible at the company itself.

The Angkor Light will be sold in fixed market stalls and mobile stalls. The product will be produced as much as possible at the Kamworks workshop in Sre Ampil. A pickup truck or van will drive large amounts of products to a central location in Battambang and Siem Reap. From those central locations the lamps will be transported to small markets by motorbikes or pickup truck. The mobile stalls will pick up the products at either the central location or a local fixed market stall. The boxes will be stacked to a maximum height of four. No additional codes or labels are necessary.

2.2 Participatory field research

In a time span of five working days, ten interviews have been conducted at a ten kilometre radius around the orphanage in Sre Ampil. None of the interviewees had a connection to a permanent power supply, although some were connected to a generator at a neighbouring house for a fixed price and fixed hours. Most interviewees were in between 25 and 55 years of age and had families, all sitting around the interview. Interviewees were selected at random. Poor as well as wealthier rural people were interviewed. The interviews took about twenty to thirty minutes each and the interviewees seemed to enjoy all the attention and questions. All interviews were conducted by two people. The translator did a very good job, translating even the smallest, but always important, replies.

Figure 6: Participatory field research

As shown in Figure 6, the interviewee would usually sit opposite the interviewer, the prototype of the lamp would be in the middle and the translator would sit next to the interviewee. About ten people would surround the location of the interview out of curiosity.

The research had four goals:

- To get the target groups opinion about the current prototype of the Angkor Light.
- To get information about how and if the target group play games.
- To get an understanding on their ideas about packaging.
- To ask people where they wanted to mount a solar panel once they possessed the Angkor Light.

After the first two days two questions were added to the questionnaire to check the willingness of the interviewees to give long answers as well as honest “no” answers. The questions were: “Name all

Khmer holidays" and "Do you know the game Jalla, Jalla (non-existing game)?" These additions gave better insight in the value of the answers. All interviewees were willing to name all the Khmer holidays and were not afraid to honestly admit they did not know the game Jalla, Jalla.

After five days and ten interviews the results were evaluated to decide if the research questions could be answered or not. The answers to the qualitative questions were very similar and contained enough information to give a legitimate answer to the question. Only answers to the quantifiable questions are shown in table 1. Except for questions 19 and 20, the results were very unanimous. On average 9 out of 10 interviewees shared the same opinion. Question 19 and 20 were about spending a large amount of money on a product they could not imagine, therefore results on questions 19 and 20 were not very similar.

Based on the evaluation of the answers no more interviews were conducted and the participatory field research was completed. It was not expected that more interviews would give new information to answer the research questions. All the quantitative and qualitative questions can be found in Appendix A.1.

Table 1: Quantifiable results taken from the participatory field research. n=10 (number of interviewees)

Question #	Confirmation (n)	Decline (n)	Total (n)
1	10	0	10
6	10	0	10
10	7	3	10
14	9	0	9
15	10	0	10
17	2	8	10
19	3	4	7
20	3	0	3
22	10	0	10

Overall results

Packaging

10 out of 10 people want the packaging to be a firm box. 9 out of those 10 will use the box to store the lamp when it is not being used. The packaging is important to prove that the product is genuine as well. A lot of products on the Cambodian market are Chinese fakes and by having a box with the stamp of the retailer, the risk of buying a fake product is reduced.

Solar panel mount

6 interviewees wanted to mount the solar panel on the roof. 4 wanted to put the solar panel on a dedicated chair. 8 out of 10 interviewees want to be able to store the solar panel inside when it is not being used.

Because none of the interviewees wanted to use the packaging itself as a base for the solar panel, it was decided not to embed a mount for the solar panel into the packaging.

Game

People don't play a lot of games in Cambodia. Children play games like soccer, volleyball or jump a rope for example, but games involving a play board are very uncommon. The reason is that there is not a lot of money to spend on luxury goods or games. A limited number of games that are played are very basic and often involve throwing small rocks or shoes. During national holidays some traditional games are played by adults as well as children.

These results show that it is very important the game should be played without the need of additional items, because people are not willing to spend money on it.

Prototype

9 out of 10 people had never heard of solar energy before. After some explanation everybody understood solar energy and they all understood the advantages of not having to charge the battery in a generator shop.

None of the interviewees knew what to do with the lamp at first sight. Few noticed the tube light inside, but even if they did notice, they did not know how to switch on the lamp. They like the looks of the lamp, but had never seen anything like it before. A lot of people had problems switching on the lamp as well, because once the on/off button is pushed, it will take about two seconds before the lamp lights up.

These results show that it is important to explain the principal of solar energy on the packaging. The packaging has to make clear what kind of product the Angkor Light is and what its functions are.

2.3 Market research

A small market research on lanterns and photo voltaic products was conducted to determine what kind of products are available on the Cambodian market today and what kind of packaging they come with. Another goal of this research was to find out how Cambodian people buy their products. Rural people use three kinds of light in the evening. The most basic way of obtaining light is through fire. An oil lamp or kerosene lamp is used in the middle of the room, but provides a very flickering light, is dangerous and is vulnerable to wind. The most widely used solution is to get light through a system of a car battery and a tube light. The battery has to be recharged regularly and degrades quickly due to bad quality recharging (RECambodia 2004). The third option is to use a battery powered lantern or flashlight. The solar lantern of KamWorks will fit in the last group of products.

Figure 7: Typical city electronics shop

Currently there are quite a large number of lanterns, candles and flashlights on the market. All lanterns are quite similar and come in cardboard boxes that all look alike. These products are currently sold at all markets and in most electronics shops. A stereotype box has the following features:

- A big picture of the lamp at the front of the box
- A small user manual on the side of the box
- Explanation of features of the lamp, company details and quality standards at the back
- Different ways or situations to use the lamp on the other side of the box

Figure 9: Stereotype box, front: big picture, side: user manual, back: specification, other side: ways to use the product

The packaging of flashlights is more varied. Some come in small boxes, others in plastic blister packaging and some do not even have a packaging at all. Blister packaging usually does not have a big picture of the product on the front side, because the product itself will be visible. The backside is used to display product features, a user manual and some properties of the torch.

Figure 8: Blister packaging

How Cambodian people shop

There is a big difference between people living in cities and people living in the rural areas. People in rural areas do not go out of their community often. They like to buy their products on a local market, from a salesman they know. It is common to tell the salesman what you are looking for and he or she will show the customer some products. Every market has a selection of electronic equipment. Also, products like eggs and fresh food are sold on mobile market stalls.

People in cities travel more and are not bound to one local market for their products. People from the city tend to go to a street or area full of the same kind of products and ask salesmen about their products. For people from the city as well as for rural people it is the salesman who has a lot of influence on what the customer buys.

If the salesman is able to explain the rules of the educational game easily it is a unique selling point providing the buyer not only with light at night but with something to do as well.

2.4 Local production capabilities

2.4.1 Kamworks workshop

The goal is to do most of the work involved in producing the Angkor Light at Kamworks (see chapter 2.1). Tools for cutting plastic, paper and wood are available at the Kamworks workshop. A vacuum forming machine is available as well. An electronics workshop is present as well, allowing basic electronic processing. At this moment Kamworks has four employees, who can use all the tools in the workshop. More orphans will reach the age of 18 soon and they can all work for the company.

Two black & white laser printers are present, but they are limited to printing at a4 size. A budget to acquire new machines is available, but the cost per packaging must be kept under $1.50 according to the budget found in the report of Kranen (Kranen 2007) (Appendix B.2).

Kamworks has a motorbike and a pickup truck. Three out of six employees have their own transport and are eligible for fuel compensation.

2.4.2 Phnom Penh

Phnom Penh has 2 million inhabitants and is growing rapidly. The city hosts a big range of workshops. Finding the right workshop is quite a challenge though. The Cambodian Yellow Pages, printed as well as online, are terribly out of date and shops move around all the time. A big advantage is that clusters of shops of one type can be found everywhere. Once one shop is found, there will be a number of similar shops around it. Fabrication of printed work, plastic basic shapes and all kinds of metals are found throughout the city.

The Don Bosco technical school is a school in Phnom Penh for practical Cambodian students. The school has some offset printing and cutting facilities. A connection between Kamworks and Don Bosco has already been established. The school offers good prices because the work is done by students trying to get some experience.

Eight print shops were visited in Phnom Penh. All print shops are able to make copies and print paper up to a3 size. Two print shops were able to produce packaging by offset pressing, but neither could give a price quote without the final design. Four out of eight print shops are able to produce silk screen prints.

Four cardboard box manufacturers were visited in Phnom Penh. Two of the manufacturers were able to print the packaging in one colour and at a low quality. At three out of four manufacturers it was possible to order standard sized packaging as well as custom sized packaging. The only material available at all manufacturers was corrugated cardboard.

2.5 The requirements

There are three guidelines for the design of the packaging, the game and the user manual.

The first guidelines were taken from the recommendations of the graduation report of Stephen Boom[1] (Boom 2005). This report is about the initial design of the Angkor Light.

The second guidelines were taken from PV-GAP. PV-GAP is the Global Approval Program for Photovoltaic (solar generation), a non profit international organization, dedicated to the sustained growth of global photovoltaic markets to meet energy needs world-wide in an environmentally sound manner (PV-GAP 2004). The lantern will be designed according to these standards and so are the box, game and packaging. Kamworks wants their product to meet the PV-GAP standards to distinguish it from similar fake products from the Chinese market.

The last guideline is the information obtained in the analysis phase.

2.5.1 Requirements resulting from the graduation report of Stephen Boom

Guidelines from the report:

- The packaging should express the functionality of the product with simple illustrations or symbols.

[1] Original recommendations from graduation report of Stephen Boom: Appendix B.3

- On the packaging an illustration of the reference of the product shape to the temples of Angkor Wat should be put.
- At least the following aspects should be able to see and read from the outside or should be enclosed in a user guide:
  - Clean solar panel once in a while. There is a lot of dust in rainy season.
  - How to charge the lamp.
  - Put the solar panel in sun, with cell side up.
  - How to replace batteries.
  - How to replace the light bulb.
  - DO NOT put the lamp in the full sun. This will lower the life time of the battery.
  - DO NOT put the panel in shade.
  - DO NOT put the lamp on off too often in a row.
  - Address of Kamworks etc.
  - The mark of PV-GAP
  - The amount of autonomy.
  - The amount of hours of light.

Almost all requirements will go to the program of requirements. It is no longer needed to inform the user about changing the battery and light bulb because according to the report of Kranen (Kranen 2007) the user is unable to perform this action. The mark of PV-GAP will also not be present on the product, because it is not allowed to use the logo before the product has been tested.

2.5.2 Requirements resulting from the PV-GAP standards

All components must be provided with relevant documents concerning their rating, certificates and specifications in the language of the user and/or technician. Instead of a written user's manual, illustrations may be used where appropriate. Labeling on equipment shall be in accordance with good ergonomic principles so that warning notices, controls, indications, testing facilities, fuses etc., are sensibly placed and logically grouped to facilitate correct and unambiguous identification.

A manual, including a list of spare parts and tools should be provided with the product.

The manual shall be written in English and the user's language and shall include

- A complete list of all system components and spare parts, with associated manufacturers literature, specifications and warranties,
- A complete set of electrical schematic, mechanical composition, functional block diagram and layout,
- Battery safety requirements including maintenance/replacement procedures,
- Lamp maintenance/replacement procedures,
- Installation instructions that ensure proper placement of the PV module and lamp assembly. The lamp must be installed in a protected environment to be consistent with the scope of this specification,
- Procedures for proper system operation, including load conservation during periods of inclement weather, and/or a low voltage disconnect event. A checklist that contains what to do in case of a system failure shall be included. The procedures for checking that the PV module is not shaded and how to prevent shading must be explained,

- Maintenance items and □ □a troubleshooting guide referencing all the system components. This must include repairs and diagnostic procedures that can be done by the supplier.

Lantern performance must be specified in

- Rated average energy supply (Wh/day),
- Autonomy (days without sunshine the lantern can service the load),
- Hours of use of lamp,
- Test conditions.

2.5.3 Requirements resulting from the analysis

The packaging should cost $1,50 at most.
The packaging has to keep out dust and insects.
The packaging has to be able to withstand the weight of three full boxes.
The packaging has to be light.
The packaging has to explain the contents of the packaging.
The packaging has to help the salesman.
The packaging has to prove the product is genuine.
The packaging has to stand out of current packaging designs.
The principal of solar energy has to be explained on the packaging.
The Angkor Light has to be stored in the packaging.
The materials of the packaging should be found locally.
The game has to educate the user about working with the lamp.
The three functions, torch, standing light and hanging light have to be explained.
Illiterate people (25 percent of population and even more in rural areas (UNDP 2006)) have to be able to understand the Angkor Light.

2.5.4 Program of requirements

The requirements from the Stephen Boom, PV-GAP and the analysis phase were combined and sorted in a program of requirements.

Packaging
All information on the packaging has to be in the English and Khmer language.
The total costs per packaging should not exceed $1.50.
Dust and insects should not be able to reach the product inside the packaging.
The packaging hast to maintain its shape when a pressure of 8 Kg is exerted equally on the top of the packaging.
The weight of the packaging should not exceed 200 g.
The print of the packaging has to explain the contents.
The print of the packaging should assist the salesman in selling the product.
A proof of a genuine product has to be present.
The principle of solar energy has to be explained by the print of the packaging.
The packaging has to be able to be used for storing the Angkor Light.
The materials should be found in Cambodia.

Game
The game has to educate about working with the Angkor Light.
The game has to be played without additional items.
The salesman should be able to explain the rules of the game in two minutes.

User manual
A user manual has to be provided with the purchase of the Angkor Light.
A complete list of all system components and spare parts, with associated manufacturers literature, specifications and warranties should be present.
A complete set of electrical schematic, mechanical composition, functional block diagram and layout has to be present.
Battery safety requirements including maintenance/replacement procedures have to be present.
Lamp maintenance/replacement procedures have to be present.
Installation instructions that ensure proper placement of the solar panel have to be present.
Procedures for proper system operation, including load conservation during periods of inclement weather, and/or a low voltage disconnect event have to be present.
A checklist that contains what to do in case of a system failure shall be present.
The procedures for checking that the solar panel is not shaded and how to prevent shading must be present.
Maintenance items and □ □a troubleshooting guide referencing all the system components including repairs and diagnostic procedures that can be done by the supplier have to be present.

Information
It has to be clear that the solar panel should be clean.
It has to be clear how to charge the Angkor Light.
It has to be clear that the solar panel should be put in the sun, with the solar side up.
It has to be clear that the Angkor Light should not be exposed to bright sunlight.
It has to be clear that the solar panel should not be placed in the shade.
It has to be clear that the Angkor Light should not repeatedly be turned on and off.
The address of Kamworks has to be present.
The amount of autonomy, full light strength as well as dimmed has to be present.
The amount of hours of light without charging has to be present.
A reference to the temples of Angkor Wat should be present.
Rated average energy supply (Wh/day) has to be present.
The number of hours of use of the lamp has to be present.
The test conditions have to be present.
The three functions, torch, standing light and hanging light have to be explained.
Illiterate people should understand the functions of the Angkor Light.

3. Concepts

3.1 Packaging concepts and user manual

In the market research and participatory field research, a lot of different packaging methods were observed. Fifteen of the observed packaging methods were combined in a packaging matrix, found in Appendix C.2. The different packaging methods were all tested on the individual requirements stated in the last chapter. The result of the packaging matrix is that five concepts stood out. The user manual will be printed on a piece of a4 paper. This choice was made because a better alternative was not found. The user manual will be written in English and Khmer and will also contain a small comic to educate the illiterate.

The five packaging concepts are stated below:

1) A printed glossy cardboard box; information printed on the outside in full colour
2) A plain brown box; with additional printed paper glued on
3) A plastic tube with lid; PVC-like material with additional printed paper glued on
4) A cardboard tube with lid; additional printed paper glued on.
5) A stitched cotton bag; with a label containing information

Original drawings of the concepts can be found in Appendix C.1.

3.1.1 A printed glossy cardboard box

The first concept is similar to the common box-shaped packaging. A design will be printed on a sheet of glossy cardboard. The cardboard will be die-cut and folding lines will be pressed in the material.

The box can be folded and glued at KamWorks, but an offset press is needed to produce the print.

Dust and insects will be kept out by the closable lid with two flaps on the slide to ensure a proper sealing. The base will be glued together to create the strength needed to carry the box and lamp around.

Figure 10: A design of a printed glossy cardboard box

Figure 11: A plain brown box

3.1.2 A plain brown box

The second packaging solution is quite similar to the printed glossy cardboard box; the difference is the material and the ability to print it in full colour. The costs are lower because a standard size can be chosen and printing is in one colour only and in lower quality. The look of the product is less attractive because it looks less qualitative. An additional full colour print can be glued on to make the packaging look better, but will also cost more.

3.1.3 A plastic tube with lid

The third solution is based around a plastic tube with a diameter of about twenty centimetres. A plastic cap will be glued on at the base of the packaging, making sure the packaging is water proof. A printed sheet of paper will be glued around the tube containing the graphics and information. There will be a lid on top of the packaging to make the top water proof as well. Depending on costs, the paper can be plasticized as well to make the print water proof too.

Figure 12: Plastic tube with lid

Figure 13: Cardboard tube with lid

3.1.4 A cardboard tube with lid

The fourth packaging solution is quite similar to the plastic tube with lid; the difference is the material of the tube, which will be cardboard. The packaging will be lighter, but not water proof.

3.1.5 A stitched cotton bag with label

The fifth and last concept is a big cotton bag with a label containing information about the lamp. The bag will fit loosely around the lantern, keeping dust and insects out. The information will be printed on a separate label, attached to the bag with a rope. The user manual will be kept inside the bag. The top of the bag can be closed by pulling two ropes and tie them together with a knot.

Figure 14: Stitched cotton bag with label

3.2 Game concepts

After the analysis phase, four ways of educating the user about the Angkor Light on a playful way were devised. The concepts were the result of memories of older games and the few games observed in the market research.

The four game concepts are stated below:

1) Non-powered game; a small board game about solar energy
2) Powered game; a game based on the 'elektro game', using power from the solar panel
3) Explanation comic; a comic about good and bad usage of the lamp and solar panel
4) Power indicator; use a power indicator to optimize solar panel performance in a fun way

3.2.1 Non-powered game

The general idea behind the non-powered game is to give the user some information about the input and output power of the lamp. Users will learn that the solar panel should be pointed towards the sun and to keep the panel clean at all times. They will also learn to save energy by dimming the light and not to connect large devices to the battery.

The game will be played at one side of the packaging which will look like a 'walking track'. There will be a number of 'stepping stones', in five different colours. Four out of five colours mean a side game. The purpose of the side games is to earn points, called 'watts' and give the user information about the input and output power of the lamp. The fifth colour means a safe spot; you can not earn or lose 'watts'. The four side games displayed on the other side of the packaging:

The user can not get a negative amount of points, since a battery cannot lose energy when it is empty. The game is finished when the first user gets to the end of the track.

Shell Solar has developed a board game aiming to educate users about charging and unloading batteries. The game is depicted in Figure 15.

Figure 15: The Shell Solar 'Power Game'

3.2.2 Powered game

The basic idea about the powered game is to hook up the solar panel to the packaging, powering the game. This way people will automatically find out how the panel works, if they do not do it right the game can not be played. The game will be based on the 'elektro game'. The game consists of a number of aluminium dots on the box which can be connected with a wire. A circuit board of aluminium strips will make sure a light will burn when the correct aluminium dots are connected.

The game "Electro" is depicted on the right.

Figure 16: Powered game, Electro

3.2.3 Instructional comic

The instructional comic will depict two users working with the solar lantern. One user will do everything right, resulting in a cosy family with light at night. The other user will do everything wrong, resulting in a pair of eyes in the dark. The information will be presented in a graphical way, without any text. This way any user can understand the comic.

Good sequence depicts the user:

- Exposing the panel to the sun.
- Keeping the panel clean.
- Placing the panel with the right side up.
- Pointing the panel towards the sun.
- Dimming the light at night.
- Connecting nothing or a small device.

This sequence results in a picture of a cosy family, sitting around the Angkor Light.

Bad sequence depicts the user:

- Placing the panel in the shadow.
- Not cleaning the panel, resulting in a dirty panel.
- Placing the panel up side down.
- Pointing the panel away from the sun.
- Setting the light to full brightness.
- Connecting a big TV.

This sequence results in a picture of two eyes in the dark.

Another possibility is to embed a row of icons on the packaging or user manual to inform the user on how to use the lantern. The comic style can still be used but this time there is no sequence with a happy or sad ending.

Figure 17: Instructional comic

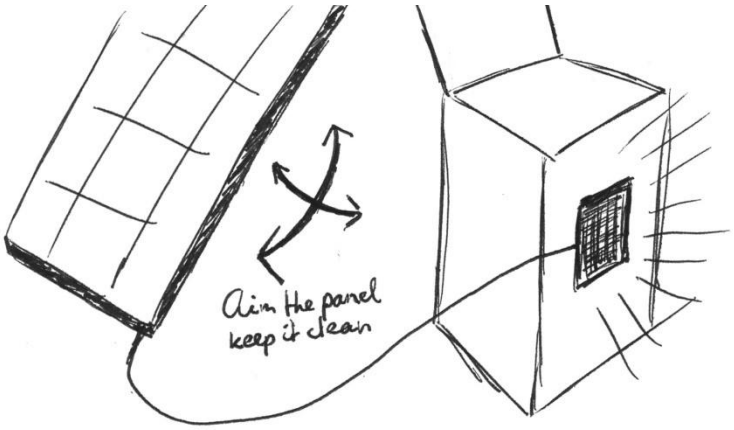
3.2.4 Power indicator

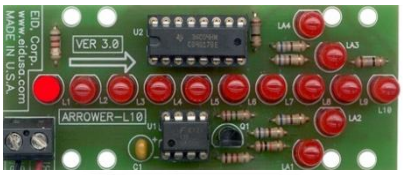
The basic idea about this concept is to connect the solar panel to an 'indicator' embedded in the packaging. The indicator can produce light, sound, motion, heat or some other kind of noticeable output. The output of the indicator will specify how much power is being transformed by the solar panel. This way people get direct feedback whilst aiming the panel at the sun. They will also notice that cleaning the surface of the solar panel will increase the power output. This indicator will result in a fun factor in the product with people trying to get the best power output. It will also help to optimize the performance of the lamp, the more power it gets from the sun, the more light it gives at night.

There are a number of ways to visualise a current from a solar panel. A row of LED lights[1] can be used to show the amount of current from a solar panel. Also a pointer or a sound[2] can be used with a scale of zero to the maximum output. A satellite finder works in the same way, giving the user feedback in the shape of a sound and a moving pointer. Another way is to use a thermo chromic strip[3] like the ones used as a battery tester label at Duracell batteries[2]. Another way is to tell the user to make the shadow created by the solar panel as big as possible, blocking as much sun as possible. The shadow is the indicator and if a cloud or a tree is blocking the sun, the shadow will be gone.

[2] Battery testers: http://electronics.howstuffworks.com/question423.htm

It is not important the indicator will state exactly how much power will come from the solar panel. It is more important to indicate which power output is the best under the actual circumstances. People will create their own idea about the meaning of the indicated value and will challenge themselves to get the highest value.





1

2

3

Figure 18: Power indicator: a row of LEDs[1], pointer[2] and tester strip[3]

3.3 Selected concept

A morphologic diagram (Appendix C.4) was made to make combinations of game and packaging concepts. All combinations include a user manual in English and Khmer. Three combinations stood out, the non-powered game with the glossy printed box, the non-powered game with the PVC tube + lid and the non-powered game with the cardboard tube + lid. These three combinations are quite cheap and all materials can be found and processed locally. The powered game turned out to be too expensive, as well as the power indicator which was patented (StormPatent 1996).

Figure 19: Square box, PVC tube and designs

In order to find out what the user thought about the packaging concepts a small research was set up combining the packaging material with a global packaging design. 25 randomly selected people, aged from 8 to 60 were involved in the research. Every person had to choose between an existing square box and a home made plastic cylinder. Secondly they had to choose between four basic graphical designs. The first design resembled a stereotype Khmer design. The second design resembled a western design. The third design was a flashy pastel coloured design because previous research showed people liked pastel colours and flashy designs. The fourth design was based on a Japanese design, because Japanese products are the most technologically advanced and best products in their eyes according to the market research. The designs can be found in Appendix C.6.

Figure 20: Selecting a design (top design is the flashy design)

The results are combined in a packaging material, shape and design matrix, found in appendix C.5. The outcome of the research is that people like square paper boxes, because it has a more solid look. Also interviewees state that a square box will be more stable than a round one. In total 15 out of 20 interviewees preferred a square box instead of a round one. Besides the square box, people also like the flashy design, which was accountable for 15 out of 24 votes and secondly the western design with 5 out of 24 votes. Surprisingly nobody liked the stereotype Khmer design.

The winning concept is a combination of the non-powered game with the glossy printed cardboard box because 75% of the interviewees wanted a square packaging. A manual will be included in English and Khmer and will contain an instructional comic for the illiterate.

4. The Packaging

One of the main results of the assignment is the design of the packaging. A small version of the packaging is depicted on this page. A full size, fold-out version of the packaging can be found in the back of this booklet.

During the weeks of research it became clear that packaging in Cambodia is quite different from packaging in the western world. A big difference is that in Cambodia 25% of the population is illiterate. In rural areas that percentage is ever higher. Another difference is the way Cambodian people buy products; the salesman plays a much bigger role in this process. To accompany both the illiterate people and the way Cambodian people buy their products, all information on the packaging is written in English and Khmer, as well as depicted in icons. This way illiterate people understand the information on the packaging and the salesman can use the packaging as a tool to share the information about the product.

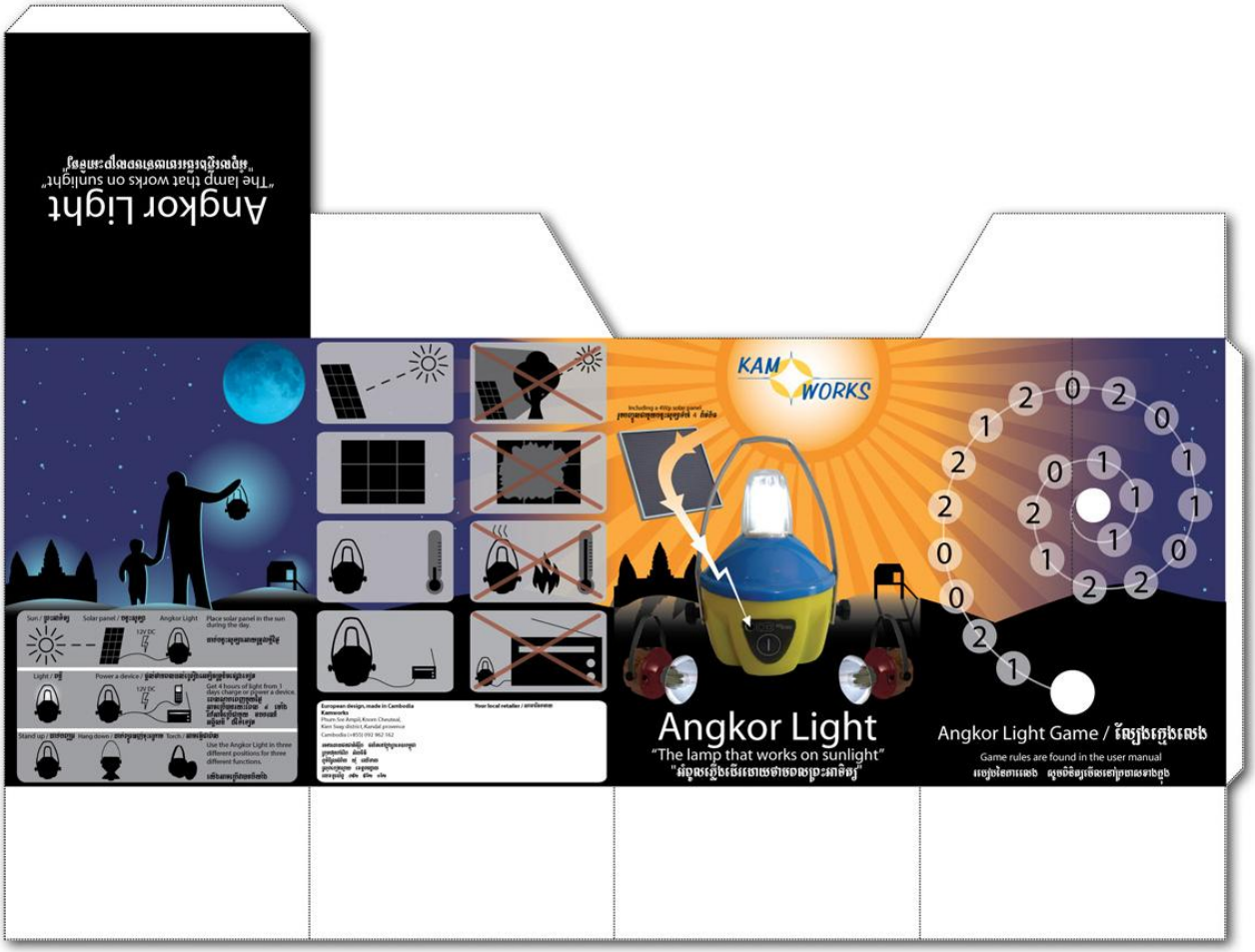


Figure 21: Fold-out of the packaging

4.1 The design process

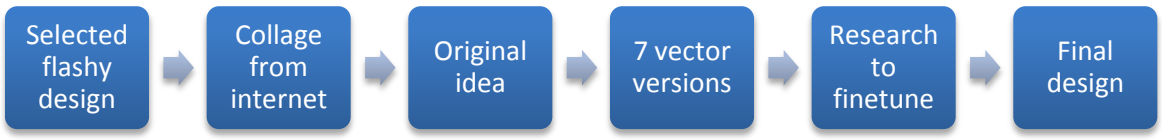


Figure 22: Block chart of design process

The process of designing the packaging started with the interviewees' favourite design, resulting from the 'packaging material, shape and design matrix' (Appendix C.5). A small collage (Appendix D.1) was made with pictures similar to the 'flashy design' chosen by the interviewees.

Figure 23: Design, from 'flashy design' to collage to original idea. Bigger pictures can be found in Appendix C.6 and D.

Next, a low resolution graphical file was created to determine the global layout of the packaging. This layout resulted in the idea of making a day side and a night side on two opposite sides of the packaging. The other two sides were intended to accommodate the graphics of the game. The result of that original idea can be seen in the picture above, on the right hand side of Figure 23.

The original idea was developed into a full size vector file in Adobe Illustrator. After seven versions, which can be found in Appendix D.2, a small user research (Appendix D.3) was conducted to find out the opinion of the local population. A full size packaging was constructed with a print of the newest version of the packaging (Figure 24). Five randomly selected families were interviewed. The selected families had not been interviewed before. The interview took about ten minutes. The research was aimed to find out if the interviewees understood the icons and the basic principle of solar energy. The interviewees got to take the box with the print of the packaging in their hands and look at it for two minutes before the questions were asked.

Figure 24: Design used in research.

The outcome of the research was that all the families understood what the global meaning of the packaging was, but some of the icons were still unclear. For example, one family had never seen a thermometer before and did not associate it with heat. The symbol for electric current is not widely known either. Finally, none of the interviewees understood the icon of the dirty solar panel.

The Icons were modified, the contrast between the background and the icons was enhanced and the research was conducted again. This time, all icons except for one, were clear. The icon of the dirty solar panel was still not understood. The next day another small research was conducted to understand how the local people would depict a dirty solar panel. A sheet of paper was printed with eight icons of a clean solar panel. Eight interviewees were asked to make the solar panel dirty with a permanent marker. The result is shown in Appendix D.4. Finally, with the help of the outcome of the last research, an icon of a dirty solar panel could be created.

The last step in the design process was to add the three different positions the lamp can be used in, move the address section to create more space for the stamp of the local retailer and remove one set of icons which was not very useful.

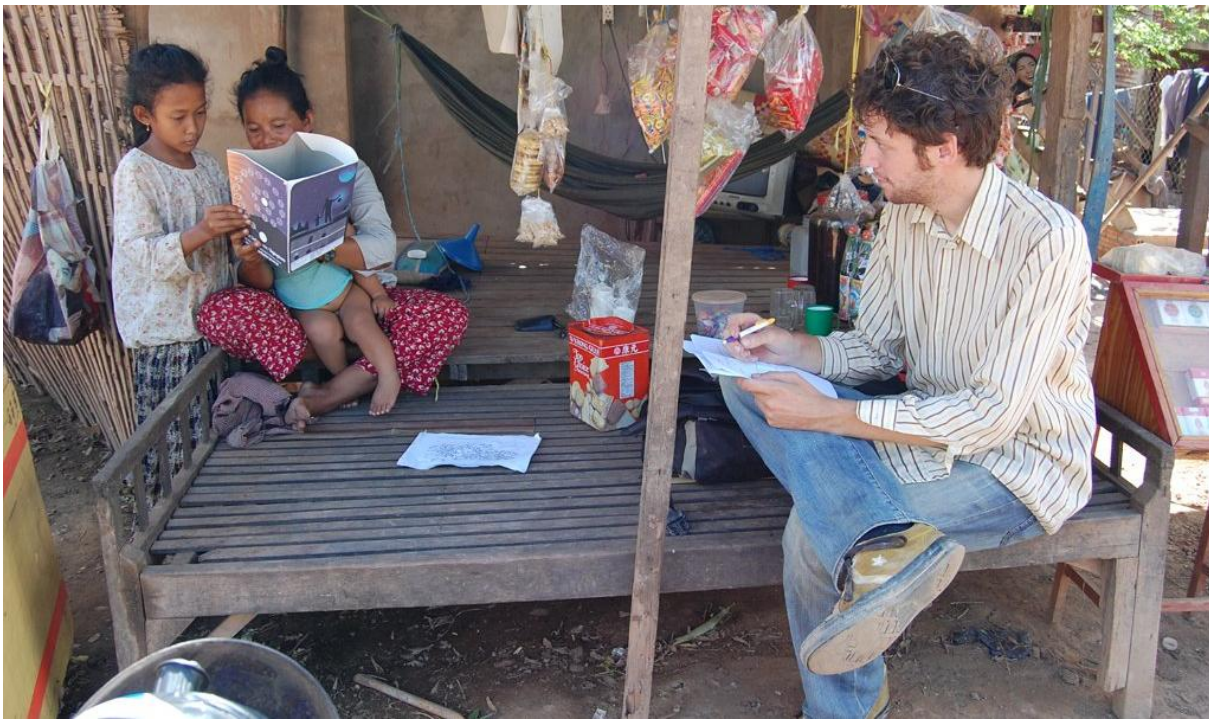


Figure 25: Continuous changing of final product

4.2 Final graphical design

The design is very image-oriented, because the participatory field research showed that the interviewed people found it very hard to imagine something they had not seen before. Solar energy is new to most of the people and it is very important to explain the advantages of it. The design is full of colour as well to make it fit in and stand out of all the similar products on the market today.

The packaging has a day and a night side. On the day side, which is the front side of the packaging, the principle of solar energy is being explained. On the night side, which is the back side, the functions of the lantern are explained. Even the game on the right hand side of the packaging uses the day and night graphics.

4.2.1 Front side

The front side of the packaging is the business card of the product inside. The Kamworks logo and product name are present and a big picture of the product sits in the middle of the design.

Since most Cambodian people do not know anything about solar energy the principal of solar energy had to be explained. A ray of sunshine is depicted coming from the sun, hitting the solar panel and being transformed into electricity which goes to the lamp. Simple English and Khmer text underlines the principal with “The lamp that works on sunlight” and “Including a 4Wp solar panel”.

The product is made for the Cambodian market and therefore two typical Cambodian items are displayed on the background; the temples of Angkor Wat on the left and a typical Cambodian house on the right.

The function of the reflector is explained visually by showing the lantern in the “torch” position.

Figure 26: Front side with lantern in full color

The Latin font used for the packaging is Myriad. Myriad is a strong font with a modern look that fits the modern looks of the Angkor Light. When production of the packaging starts, Kamworks has to buy the font for 35 dollar[3]. The Cambodian font is called Limon F2. This font has been used by Kamworks before and was chosen for its clarity, even when printed very small.

[3] http://www.adobe.com

4.2.2 Icons – left hand side

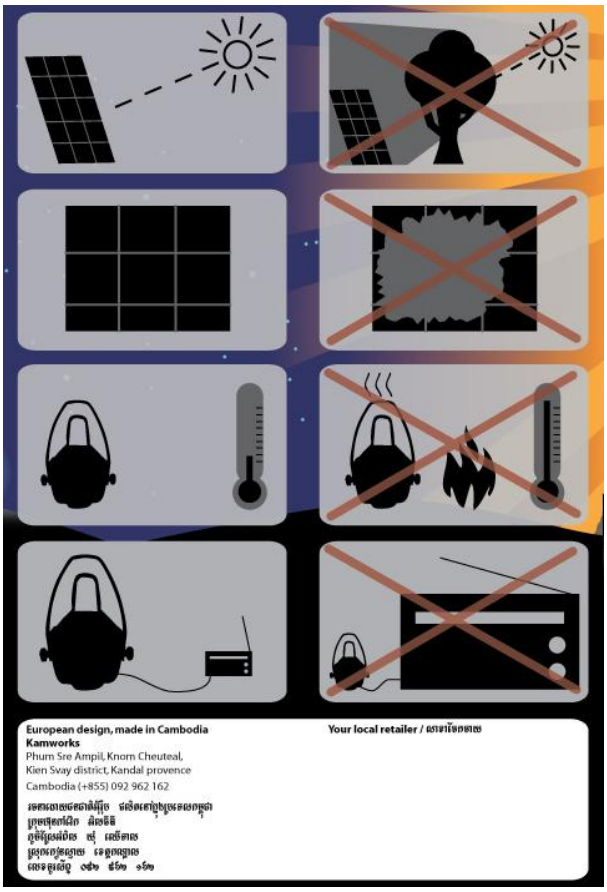


Figure 27: Left hand showing icons.

On the left hand side of the packaging a series of icons is placed to form a user manual for the illiterate. This side of the packaging will also be used by the salesman in the shop to get buyers to understand the functions of the product. The address of Kamworks is printed in English as well as Khmer in a white rectangle below the icons. Next to the address a space has been created for the stamp of the local retailer as proof of a genuine product.

The first set of icons shows the user to put the solar panel directly into the sun.

The second set of icons shows the user to keep the solar panel clean.

The third set of icons shows the user to avoid overheating the lamp.

The fourth set of icons shows the user it is possible to power small devices. It is not recommended to power large devices.

4.2.3 Back side

The back side shows the opposite of the front side, night instead of day. The top part of the graphics shows that the lamp gives light at night. The references to Cambodia; the temples and the house; are lit up now. A father and his son shine light in the darkness with the Angkor Light to show the Angkor Light is an investment in the family. The bottom part sums up all the big plusses of the lamp in English, Khmer and icons.

- The first row shows the principal of solar energy, the sun shines on the solar panel and the solar panel powers the lamp.
- The second row shows the lamp shining and the possibility to power a small device like a mobile telephone or a radio.
- The third row shows the three different positions and functions of the lamp; stand up, hang down and torch.

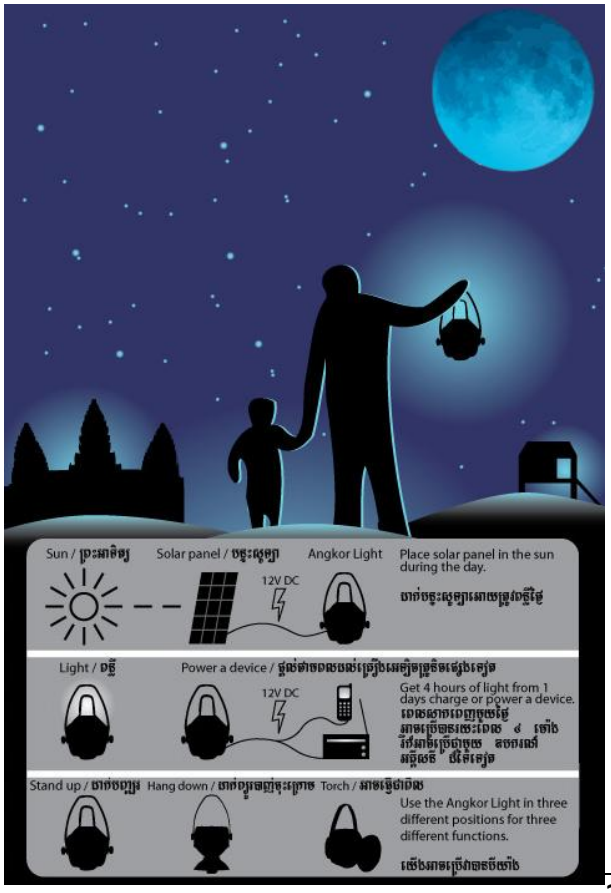


Figure 28: Back side showing rules of use

4.3 Usability, protection & distribution

Most packaging in Cambodia is very basic; basic materials and basic graphics. If the package can not be used it will be thrown away. Cambodia has a big pollution problem (EEPSEA 2006) and anywhere you look there is garbage. Also the participatory field research showed that people want to use the packaging to store the lamp when not used to protect it from the children. The packaging has to keep out dust and insects as well. The material has to be found and processed locally.

All these demands were taken into account when filling out the morphologic packaging diagram. The result was a strong cardboard packaging in a conventional shape. The conventional shape has the advantage of being cheap to produce and is known by the users. The box is perfect for storing purposes as long as the box will be kept dry under or inside the house. The lid and two side flaps seal the box so no dust and insects will enter the box.

The outer dimensions of the solar panel are 400x400x15 mm (length x width x height). The outer dimensions of the Angkor Light are 150x150x250 mm (length x width x height). The dimensions of the solar panel and the Angkor Light deviate a lot. Therefore the choice has been made not to combine both products in one packaging. The solar panel will be delivered in the original box from the factory which is made from cardboard and offers good protection from dust and insects as well. Kamworks will put a sticker on the cardboard box

There is no permanent distribution plan for the Angkor Light yet. After discussions with Kamworks it is most likely there will be about four main distribution points throughout Cambodia. All products will be manufactured and put together at the main office near Phnom Penh. From there the boxes will be transported with a pickup to one of the four distribution points. From the distribution points the boxes will be transported to the local fixed market stalls either by pick-up or car. The boxes will be stacked to a maximum height of four boxes, so one box needs to be able to bear the weight of a maximum of three others, 6 kilograms.

4.4 Costs and production

The packaging is finished, but Kamworks decided to design a new logo. Besides a new logo there will be another change. The design of the Angkor Light will be finished after the design of the packaging, so only renders or pictures from the prototype could be used for the current packaging. The source file has been set up to allow changes of such a nature. The only disadvantage is that a price quote is unavailable without the finished design, even if the colours are about the same.

Without a price there is also no possibility to decide exactly which material to use and thus no possibility to decide exactly which shape the bottom and the lid of the box will get. The print house has standard templates for boxes of all sizes and materials. When the final product pictures are present, Kamworks can decide what material and shape to use, guided by the requirements from this report. A roadmap (a step-by-step plan) to the final product can be found in Chapter 8.

The packaging will be printed using offset printing. The print will be cut out using a die-but machine. Both operations will not be undertaken at the Kamworks workshop because it is not cost efficient to acquire the machines. The fold-out packaging will be transported to Kamworks where workers fold and glue the box together.

The user manual will be printed on 80 gram/m^2 paper using the B&W laser printer at Kamworks.

5. The game

On the right side of the box a game has been placed to teach children how to use the Angkor Light. The game is a board game and players will go from dot to dot using a dice which will be included in the packaging. The game board has two sides, the left side is the sunny day side and the right side is the dark night side. Split by a dashed line they resemble day and night. The players' aim is to get as many points called 'Watts' before getting to the end of the track. Watts can be gained on the day side and lost on the night side. Anything can be use as a pawn, a stone or a stick for example.

The game was created as a variation of the Dutch game called ganzenbord.

The game rules are printed in the user manual because they would take up too much space on the packaging.

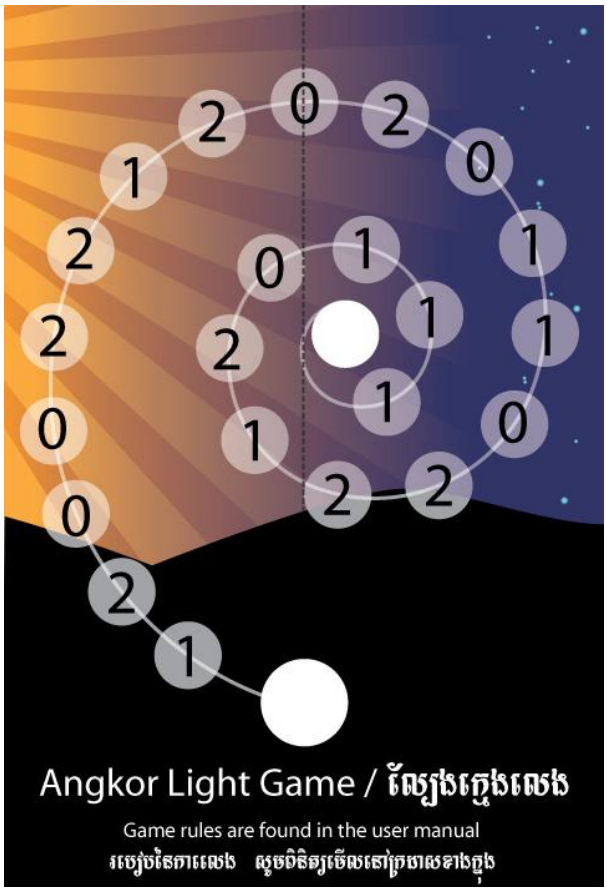


Figure 29: Game side

5.1 Rules

The rules are located in the user manual and are quite simple, but should be explained by the salesman, because the buyer will probably have no experience with board games. Basically hitting a dot with "1" or "2" means you have to play side game "1" or "2". Depending on what side of the playing board you are, you play a "day game" to gain Watts or a "night game" to loose Watts.

The side games teach the player about getting as much power from the solar panel as possible and saving as much power while using the Angkor Light.

Day game 1 teaches to aim the panel straight at the sun to get as much power as possible. The number of pips on the dice corresponds with the numbers in the game. In this game for example, if you throw a 3 or a 4 the arrow aims in the direction of the sun and you gain most Watts.

Day game 2 teaches to clean the solar panel, night game 1 teaches to dim the light to save energy and night game 2 teaches connecting big devices drains the battery.

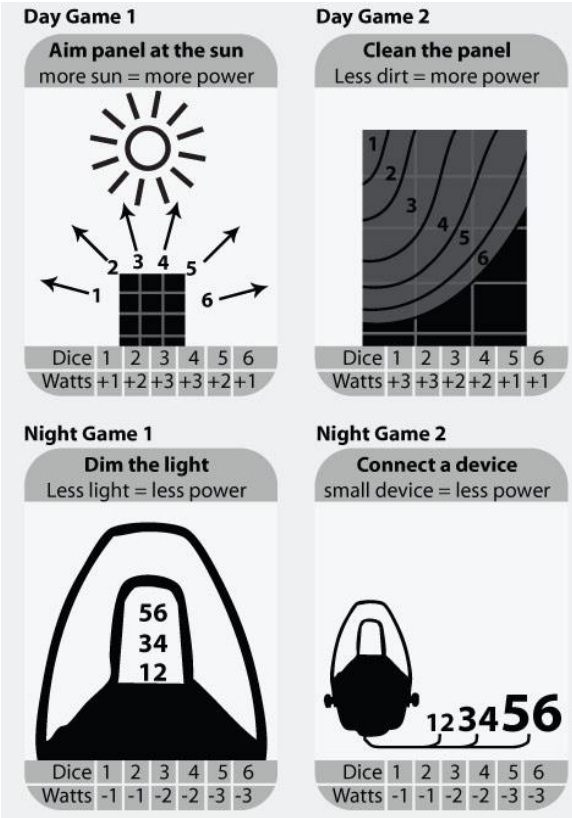


Figure 30: Game rules in user manual

6. The user manual

The user manual was created as a result of the list of demands in chapter 2.5 and the PV-GAP standards, found in B.1.

The end result of the user manual is a set-up of the final user manual. All information currently available was processed in the user manual, but it is not complete yet. Only after the test phase of the final product all the specifications and maintenance items will be clear.

The design is very simple, the contrast very high. The design is made in Adobe Illustrator so the contents can easily be changed when all the specifications are clear.

The user manual consists out of four parts.

- How to use
- Maintenance
- Specifications
- Game rules

How to use

The first sections explains the user the controls, where to connect the solar panel and the external devices. All possible handlings are covered in this section. The battery status indicator will be explained in the Battery Status Indicator Table.

Maintenance

The maintenance section contains advice on how to properly take care of the Angkor Light. A couple of values could not be filled out yet because the Angkor Light has not passed the testing phase yet. Some space has been created for extra maintenance advice resulting from further testing of the Angkor Light.

Specifications

The specifications of all the components of the Angkor Light will be specified in this section. Specifications for the battery, lamp and solar panel were available at the moment of creating the user manual, but the amount of autonomy and the exact daily run time are unclear.

Angkor Light Game rules

The rules for the Angkor Light Game are placed in this section. The rules are placed on the user manual because there was no space available on the packaging. The four side games are placed on the right side of the game rules.

User Manual Angkor Light

How to use

Charge the lamp by connecting the solar panel to the lamp at the power input connector (1)

Connect a small external device to the power output connector (2).

Turn the lamp on by pushing the indicated "on/off button (5)" once.

Turn the lamp off by pushing the indicated "on/off button (5)" once more.

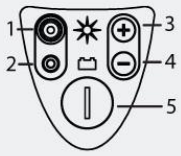
Dim the light to decrease the output of light and save energy by pushing the "- button (4)".

Increase the light by pushing the "+ button (3)"

Aim the solar panel directly at the sun for optimal performance.

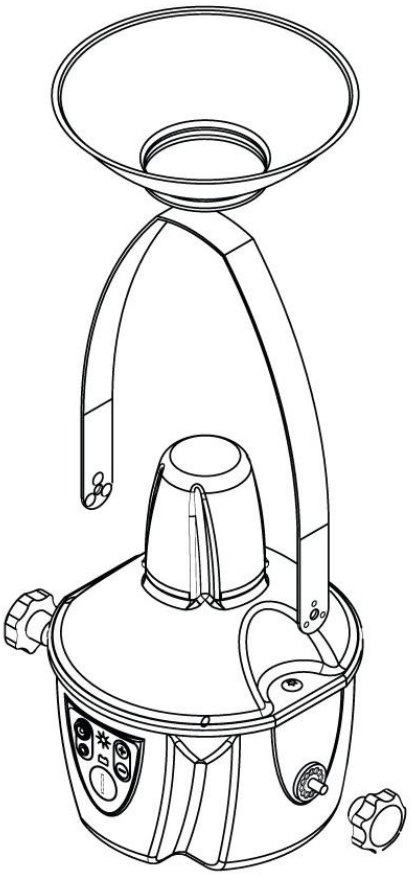
Attach reflector facing upwards for a focussed beam of light.

The battery indicator will show the state of the battery and charging status as shown in the table on the right. During charging with the solar panel the indicator will continuously be on.



battery status indicator table

0-5%	blink every 0.5 second
5-25%	blink every 1 second
25-50%	blink every 3 seconds
50-75%	blink every 6 seconds
75-100%	blink every 9 seconds



Maintenance

Keep the lamp and the solar panel clean and store the lamp in a dry place, free of dust.

Keep the Angkor Light out of bright sunlight and hot places.

Do not turn the lamp on and off repeatedly for a long time.

Bring the product to your local reseller in case of malfunctioning.

Do not leave the battery uncharged for londer then XX days.

Specifications

Battery: 4.5 Ah, 12V Lamp: 5W CFL Solar Panel: 4Wp, 12V
The amount of autonomy: XX hours
The lamp will burn for 4 hours from the charge of one good day (5 full solar hours) .

Angkor Light Game rules

2-4 players, play time 10-20 minutes, all ages.

The aim of the game is to collect as many "Watts" as possible before the first player reaches the finish of the game. "Watts" can be earned or lost by playing side games.

Every player needs a small stone to indicate his or her position in the game. Everybody will throw the dice once, the person with the most pips on the dice will start the game.

To play, you throw with the dice one time and move your stone forward the number of pips the dice indicates.

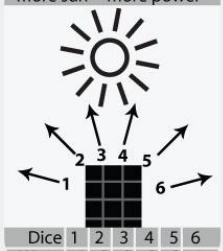
The game board on the packaging consists of a day side (sunny) and a night side (stars). On the sunny side you can earn "Watts", on the night side you can lose "Watts". The day side is everything on the left side of the dashed line, the night side is everything on the right side of the dashed line.

A player can not have less then 0 "Watts". The white circle in the middle is the finish, a player will have to land exactly on the white spot and in case of more pips on the dice the extra steps have to be taken backwards.

Once playing there are six options:
Your stone lands on a "1" at the day side; it means you play "day game 1".
Your stone lands on a "2" at the day side; it means you play "day game 2".
Your stone lands on a "1" at the night side; it means you play "night game 1".
Your stone lands on a "2" at the night side; it means you play "night game 2".
Your stone lands on a "0"; this is a resting spot, you don't play a game, the next person can throw the dice.
Your stone lands on the white circle in the middle; you get 5 bonus "Watts" and the game is finished, everybody counts their "Watts" and the person with the most "Watts" wins.

Day Game 1

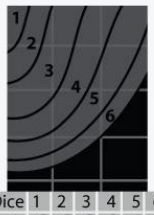
Aim panel at the sun
more sun = more power



Dice	1	2	3	4	5	6
Watts	+1	+2	+3	+3	+2	+1

Day Game 2

Clean the panel
Less dirt = more power



Dice	1	2	3	4	5	6
Watts	+3	+3	+2	+2	+1	+1

Night Game 1

Dim the light
Less light = less power

Dice	1	2	3	4	5	6
Watts	-1	-1	-2	-2	-3	-3

Night Game 2

Connect a device
small device = less power

Dice	1	2	3	4	5	6
Watts	-1	-1	-2	-2	-3	-3

Figure 31: User manual

7. Evaluation

Accepting an assignment in Cambodia is taking the first step into an unknown culture. In the first four weeks a lot of research helped to get a good insight in the Cambodian culture. Field research and market research added a lot of insight about Kamworks, local culture and on how Cambodian people shop. A lot of concepts were created and with the help of a morphologic diagram five concepts were picked out. The local population was continuously asked for their opinion on the packaging and played a big role in selecting the material of the packaging. The same strategy was being used to select the global design of the packaging and later on the details. The entire process of creating the final packaging was a mix of field research and design, resulting in a packaging specially made for the Cambodian market. In the end the user manual and the game were added to finish the packaging.

Cambodia itself posed some challenges as well. The mentality of the people differs a lot from the western mentality as we know it. Nothing is done in a rush and when something is done, quality is far from assured. It is impossible to meet more then two people in Phnom Penh in one day for example, because everybody turns up late and traffic can be busy. Internet was available at the company, but the connection was not very stable. A cloud, cow or truck could interfere with the signal, resulting in the loss of the internet connection. Rain was another problem, flooding Phnom Penh as well as our own rooms, leaking through the roof and turning sand into thick, sticky mud.

It is very hard communicating with local people on your own. There are almost no English speaking people, especially not in the rural areas. The only people that do speak some English are college or university students. Luckily the assistant manager of Kamworks does have good English skills. He knows what the company is about, he understands the way the students think and he is a native Khmer speaker. Sometimes the assistant manager would be busy and a translator had to be found somewhere else. Another translator was found in a neighbouring village, but he was more eager to try to sell the products then to actually translate.

Finally, the guidance from the accompaniment was very good. Even though he had to run a business in big solar installations, whenever there were questions he was eager to answer them.

8. Conclusions and recommendations

The original assignment was to create the packaging (with possibly a holder for the solar panel), an educative game and a user manual for the Angkor Light.

The result of the assignment is a nearly finished design of the packaging including an educative game and a set-up for a user manual. The assignment can not be completed before the Angkor Light is in a production phase. Conclusions can be found in the rest of this chapter, followed by a roadmap which is a step-by-step guide for Kamworks to complete the packaging, educative game and user manual. The recommendations can be found in the roadmap.

8.1 Conclusions

The requirements (Section 2.5.4) about the packaging have partly been met. Requirements about the materials and strength will have to be taken into account in the roadmap in 8.2.

The requirements about the game have been met.

The requirements about the user manual have partly been met. The required information will result from tests on the finished product.

The requirements about information have been met.

A design for the packaging was created and by continuously adapting the looks of the design it was made sure that Cambodian people like the product.

A game has been developed and embedded in the packaging. The game has not been tested due to time restrictions.

A set-up of a user manual has been created. Because the Angkor Light did not go through the testing phase yet, a lot of specifications were unknown.

Fifteen against zero interviewees chose the global new graphical design above the stereotype Khmer design.

Due to the addition of two checking questions in the participatory field research it was made sure that the answers were genuine.

Cambodian people do not play a lot of games. Therefore it is very important the game is very simple and easy to explain by the salesman.

The influence of the salesman is very big. The game is a unique selling point for the salesman.

A lot of print shops were found in Phnom Penh, some of them use off set printing as well. A price quote can only be obtained with a final version of the design.

By combining games and packaging methods in a morphologic diagram a good understanding was created about the best combinations.

It is very important to explain the principal of solar energy on the packaging, otherwise people do not understand the profits of the Angkor Light.

8.2 Roadmap with recommendations

Packaging

Once the final product is being produced, product photographs will have to replace the photographs of the Angkor Light at the front side of the packaging.

Once the logo is complete it will have to replace the old logo on the packaging.

The graphical files are in the possession of Kamworks. Adobe Illustrator CS2 will be required to edit the design. The graphical files will have to be saved as a PDF file.

As many print shops as possible will have to be contacted for a price quote with the finished design. Often print shops do not offer off-set printing at

The packaging has to meet the following requirements:

Packaging
The total costs per packaging should not exceed $1.50.
The packaging hast to maintain its shape when a pressure of 8 Kg is exerted equally on the top of the packaging.
The weight of the packaging should not exceed 200 g.
The materials should be found in Cambodia.

Optionally an extra layer of glow-in-the dark paint could be applied to improve the validity of the packaging. Two silk screens will have to be produced, costing $40,-. The graphical design is embedded in the Adobe Illustrator file already.

User manual

Once the final product is ready and tested, the missing specifications and maintenance items in the user manual have to be filled out.

The product will also have to undergo a PV-GAP test before the PV-GAP logo can be used.

The user manual has to meet the following requirements:

User manual
A complete list of all system components and spare parts, with associated manufacturers literature, specifications and warranties should be present.
A complete set of electrical schematic, mechanical composition, functional block diagram and layout has to be present.
Battery safety requirements including maintenance/replacement procedures have to be present.
Lamp maintenance/replacement procedures have to be present.
Installation instructions that ensure proper placement of the solar panel have to be present.
Procedures for proper system operation, including load conservation during periods of inclement weather, and/or a low voltage disconnect event have to be present.
A checklist that contains what to do in case of a system failure shall be present.
The procedures for checking that the solar panel is not shaded and how to prevent shading must be present.
Maintenance items and □ □a troubleshooting guide referencing all the system components including repairs and diagnostic procedures that can be done by the supplier have to be present.

The information can be entered in the Adobe Illustrator file. If there is not enough space a new page can be created and printed on the back of the existing user manual.

Game

It is recommended that the game should be tested before the final production of the user manual so small changes can still be made in the game rules, making sure the salesman can easily explain the game rules.

Literature

Boom, Stephen. “Affordable lighting for people living in rural areas of Cambodja.” Technical University, Delft, 2005.

EEPSEA. *Pollution Prevention Pays: Pollution Charges in Cambodia.* http://www.idrc.ca/uploads/user-S/11703876621SidethPB1.pdf, EEPSEA, Economy and Environment Programme for South East Asia, 2006.

Kamworks. *Kamworks.* 2007. http://www.kamworks.com (accessed May 2007).

Kranen, Martijn. “Prototyping, redesign and production plan for the Angkor Light, a solar lantern for the rural population of Cambodia.” University of Twente, Enschede, 2007.

PV-GAP. *PV GAP Recommended Specification PVRS 11A, chapters 6, 7.1, 8, Portable solar photovoltaic (PV) lanterns – Design qualification and type approval.* 2004.

RECambodia. *RECambodia.* 2004. http://www.recambodia.org/energoverview.htm (accessed April 2007).

Reinders, A.H.M.E., Pramusito, Sudradjat, A., Dijk, V.A.P. van, Mulyadi, R., Turkenburg, W.C. *Sukatani revisited: on the performance of nine year old solar home systems and street lighting systems in Indonesia, article in Renewable & Sustainable Energy Reviews, Vol. 3, pp. 1-47.* PDF available by Science Direct, Elsevier, 1999.

Rotman, Mando. “Exploratory research for appropriate Product Market Combinations in Cambodian rural areas.” University of Twente, Enschede, 2006.

StormPatent. *Battery voltage tester for end of cell having indicator disposed on battery side - US Patent 5525439:.* 1996. http://www.patentstorm.us/patents/5525439-description.html (accessed may 2007).

UNDP. *Factsheet Cambodia.* 2006. http://hdr.undp.org/hdr2006/statistics/countries/country_fact_sheets/cty_fs_KHM.html (accessed may 2007).

WorldBank. *Astae: Asia alternative energy program.* 2007. http://www.worldbank.org/astae/enpogen/ (accessed may 2007).

Appendix

The table of contents can be found at page 5 & 6.

Appendix Thesis Stefan Ruiter

Contents

Appendix A: Analysis

A.1 Analysis of participatory field research

Questions concerning the game:

1. At what age do Cambodian people play games?

    Mostly children play games. Ten out of ten adult interviewees stated not to play games at all. Children do play games, but board games are not included. On side trips though, people playing board games have been observed, elderly playing chess and middle aged women playing a numbering game were spotted, but it's not seen frequently.

2. Which members of a family pick up new things fastest?

    Children or young adults tend to use new things most. Interviewees under thirty years of age state to use new devices themselves, whereas older interviewees state that their children use new devices most.

3. Which family member will use the lamp most frequently?

    All family members will use the lamp, but some people are afraid their children will damage the solar panel. The lamp is quite heavy in comparison to a torch, but children can still walk around with it.

4. How does the target group play games?

    Children often play with two groups against each other. Simple materials are used to play simple games.

5. Why does the target group play games?

    Children play games to have fun and to pass the time. Elderly play games because it's part of the tradition of Khmer holidays.

6. What is the share of informative/teaching games?

    Ten out of ten interviewees does not know a single informative game. This question will have to be resolved during the market research.

7. What activities does the target group have in their spare time?

    Most of the rural populations in Cambodia are fishermen or farmers. After their work they just want to relax. When they have a television or radio they will use that in the free time. Women state to do domestic work in their free time. Children read and do homework besides playing soccer, volleyball or some other physical game.

8. What is the role of games in Cambodian culture?

    Games seem to be a way of having fun, socializing and killing time. There seem to be three traditional games, all played at Khmer New Year.

    Kob Wong

    The objective of Kob Wong is to throw a shoe at an object, trying to move the object out of a bounding box. Whoever forces the object out of the bounding box first wins.

Tjuh Meh

The same as Kob Wong, but now you kick the shoe instead of throwing it.

Boh Mah

Boh Mah is the Khmer equivalent of the game hopscotch (in Dutch "hinkelen").

9. What do current games look like?

All games involve basic materials. From a football or volleyball to a simple rope or some sticks and stones, Cambodians find a way to entertain themselves with whatever is available.

10. How good are the language skills of the target group?

Seven out of ten interviewees read and write Khmer. Older women do not have a high literacy level, older men do usually read and write. Most of the children go to school, where they are being taught in the Khmer language. Overall 80% of all men read and write and 60% of all female read and write (source: http://www.nis.gov.kh/CENSUSES).

11. Which games does the target group actually play?

Soccer, volleyball, jumping the rope, small games with few basic materials and traditional games.

Questions concerning the lamp

12. What will the lamp be used for by the target group?

Interviewees want to use the lamp for both indoor and outdoor purposes. Eating is mentioned by all the interviewees, as is indoor lighting. Farmers tend to like the torch function to catch frogs, work on their land or check for animals. Other outdoor functionalities include going to the toilet, checking around the house for animals and attract people to their local business. Other indoor functionalities include reading and making homework.

13. Which functionalities will be used?

The prototype has basic functions, all of them were used. People understood how to hang the light to resemble a normal lamp. People put it on the table and understood the function of the reflector, using it as a torch.

14. Does the target group understand how the lamp and the solar panel work?

Not without explanation. Nine out of ten interviewees had never heard of solar energy before and ten out of ten people had never seen a device like this and did not know what to do with it. After explanation, people understood the advantage of not having to charge the battery at a generator shop and they understood the basic functions of the prototype as well.
All the functions of the lamp are understood as well, people tried to hold it as a torch, used the reflector in both positions and understood how to switch it on and off.

Questions concerning redesign of the lamp from Martijn

What is the opinion of the target group about the product?

15. What is your first impression of the product?

Ten out of ten interviewees stated to like the looks of the product. Since they had never seen a device like it, most did not know what to do with it at all. The colours look good, they can not imagine the lamp in other or better colours because they have never seen it. Two out of ten interviewees wanted to buy the product straight away, even though they did not know what it was.

16. What are good things of the product?

People like to have one product for indoor as well as outdoor usage. The absence of recharging costs is another big plus. People like the modern and solid looks of the lamp. Six out of ten interviewees like the quality of the light.

What are the problems during the use of the product?

17. What aspects of the product should be changed?

Eight out of ten people find it very hard to come up with a good answer to this question. They have never seen anything like it before and have not ever worked with something like it either. Their answer is that the product looks good and nothing should be changed about it. Two people did know something to change. One person stated the lamp was too heavy, she would rather prefer a torch. The other person stated the reflector came off too easily and suggested a better connection.

What are the interests of the buyers?

18. For what reasons would you buy this lantern?

Interviewees want to use the lamp for both indoor and outdoor purposes. Eating is mentioned by all the interviewees, as is indoor lighting. Farmers tend to like the torch function to catch frogs, work on their land or check for animals. Other outdoor functionalities include going to the toilet, checking around the house for animals and attract people to their local business. Other indoor functionalities include reading and making homework.

19. Would you buy the lantern when it costs $50?

After explanation of the benefits, wealthier rural people find fifty dollar a good price for the lamp, but only if the quality of the lamp is really high and the lamp will last for a long time. A period of about two years is sometimes mentioned. Three out of ten interviewees would buy the lamp if it would cost fifty dollar. For four out of ten interviewees the price was way too high. These people indicated a price in between five and twenty five dollar would be a good price.

20. Would you buy the lantern when it costs $40?

The same three out of ten people would buy it for forty dollars too, but the price is still too high for the poorer rural people.

Questions concerning the packaging

21. Where does the target group want to mount the solar panel?

Six out of ten people want to mount the solar panel on the roof. Four out of those six want to be able to remove the panel from the roof when not used. People are afraid of damage by rain, wind and especially children. Also they are afraid of thieves climbing on their roof to steal the solar panel.
Four out of ten people want to place the solar panel on a dedicated table or chair in front of the house. All four people want to take the table or chair inside when the panel is not used. They want to put it inside for the same reasons.

22. What makes a packaging 'good' in the eyes of the target group?

Ten out of ten interviewees want the lamp to be packed in a firm box. Nine out of ten people want to use the box to store the lamp when it is not being used. The box is quite important in the interviewees' point of view, because it is prove of a genuine product, no fake replica from China. The company details, places to repair and quality standards must be present as well. Because it is a very modern looking product, people want to keep it clean and tidy in the box. A box will prove the product comes from a company and is not some form of charity from abroad as stated by a monk. People like to use the box for transporting the box as well, protecting the lamp from the rain.

Appendix B: External documents

B.1 PV-GAP standards

6. Marking

All components must be provided with relevant documents concerning their rating, certificates and specifications in the language of the user and/or technician. Instead of a written user's manual, illustrations may be used where appropriate. Labeling on equipment shall be in accordance with good ergonomic principles so that warning notices, controls, indications, testing facilities, fuses etc., are sensibly placed and logically grouped to facilitate correct and unambiguous identification.

Figure 32
logo PV-GAP

7.1 Solar lantern completeness

The lantern shall be complete and contain the following elements:

- specification by the manufacturer of Daily Run Time (DRT) under testing conditions. For the purpose of this test, DRT is based on the irradiation class III, as shown in Annex A;
- specification by the manufacturer concerning the design load (Wh), the irradiation level for which this design load can be energized by the solar lantern, the autonomy and the classification under design conditions (see Annex A). These specifications enable the test lab to verify the manufacturer's calculations;
- specification by the manufacturer concerning the days of autonomy under testing conditions;
- certificates;
- manual, including list of spare parts and tools, as described in clause 8.

8 Manual

The manual shall be written in English and the user's language and shall include

- a complete list of all system components and spare parts, with associated manufacturers literature, specifications and warranties,
- a complete set of electrical schematic, mechanical composition, functional block diagram and layout,
- battery safety requirements including maintenance/replacement procedures,
- lamp maintenance/replacement procedures,
- installation instructions that ensure proper placement of the PV module and lamp assembly. The lamp must be installed in a protected environment to be consistent with the scope of this specification,
- procedures for proper system operation, including load conservation during periods of inclement weather, and/or a low voltage disconnect event. A checklist that contains what to do in case of a system failure shall be included. The procedures for checking that the PV module is not shaded and how to prevent shading must be explained,
- maintenance items, and
- a troubleshooting guide referencing all the system components. This must include repairs and diagnostic procedures that can be done by the supplier.

Lantern performance must be specified in

- rated average energy supply (Wh/day),
- autonomy (days without sunshine the lantern can service the load),
- hours of use of lamp, and
- test conditions.

B.2 Product cost breakdown

Components	Subtotal	Total
Plastic components	$3,77	
Electronics	$9,94	
Metal components	$2,07	
Screws, Nuts, bolds etc	$2,05	
Electronic parts	$6,99	
Solar panel	$17,82	
Subtotal		**$42,64**
Transport	$0,31	
Packaging	$1,50	
Breakage	$1,32	
Subtotal		**$3,13**
Marketing	$1,42	
Overhead	$6,24	
Profit	$5,09	
Subtotal		**$12,74**
Margin retailer	$6,50	
Subtotal		**$6,50**
Selling price		**$65,01**

Table 3: Product cost breakdown

Category	Percentage	Name	Price	Total
Transport/Packaging/Breakage				
Transport/Packaging/Breakage		Transport	$0,31	
Transport/Packaging/Breakage		Packaging	$1,50	
Transport/Packaging/Breakage	3%	Breakage	$1,32	
Totaal Transport/Packaging/Breakage				$3,13
Total product costs				$45,77
Kamworks				
Kamworks	3%	Marketing	$1,42	
Kamworks	12%	Overhead	$6,24	
Kamworks	10%	Profit	$5,09	
Totaal Overhead and marketing				$12,74
Total product cost + costs Kamworks				$58,51
Profit distributors				
Profit distributors	10%	Profit distributors	$6,50	
Profit distributors				$6,50

Table 2: Product cost breakdown

B.3 Recommendations report Stephen Boom

The packaging

The packaging should express the functionality of the product with simple illustrations or symbols. At least the following aspects should be able to see and read from the outside or should be enclosed in a user guide:

- 1 Clean solar panel once in a while. There is a lot of dust in rainy season.
- 2 How to charge the lamp.
- 3 Put panel in sun, with cell side up.
- 4 How to replace batteries.
- 5 How to replace the light bulb.
- 6 DO NOT put the lamp in the full sun. this will lower the life time of the battery.
- 7 DO NOT put the panel in shade.
- 8 DO NOT put the lamp on off too often in a row.
- 9 Address of Kamworks etc.
- 10 The mark of PV-GAP
- 11 The amount of autonomy.
- 12 The amount of hours of light.

On the packaging an illustration of the reference of the product shape to the temples of Angkor Wat should be put.

B.4 3D render final design Angkor Light

Figure 34: 3D render of front of Angkor Light

Figure 33: 3D render of Angkor Light in torch mode

Appendix C: Concepts

C.1 Original concept sketches

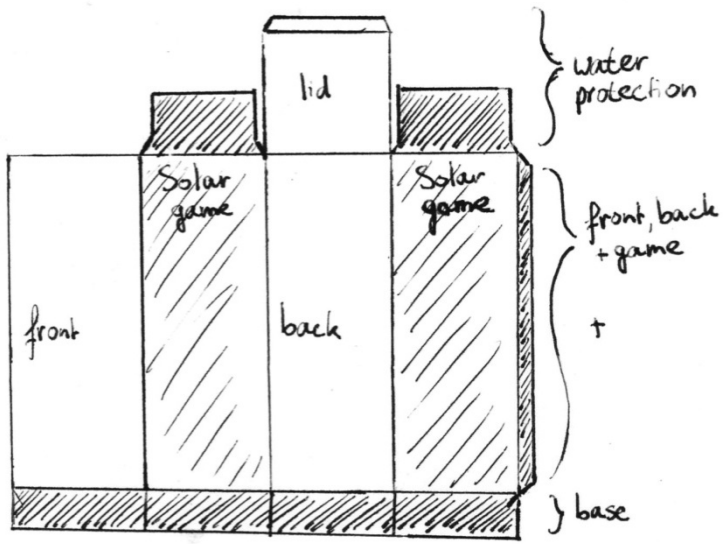


Figure 35: General design of packaging including a manual

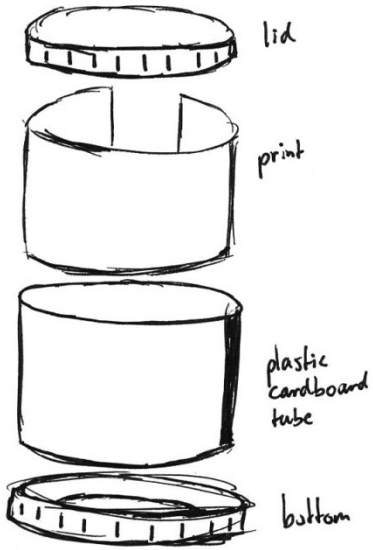


Figure 36: Plastic/cardboard tube with print

Figure 37: Stitched cotton bag with label

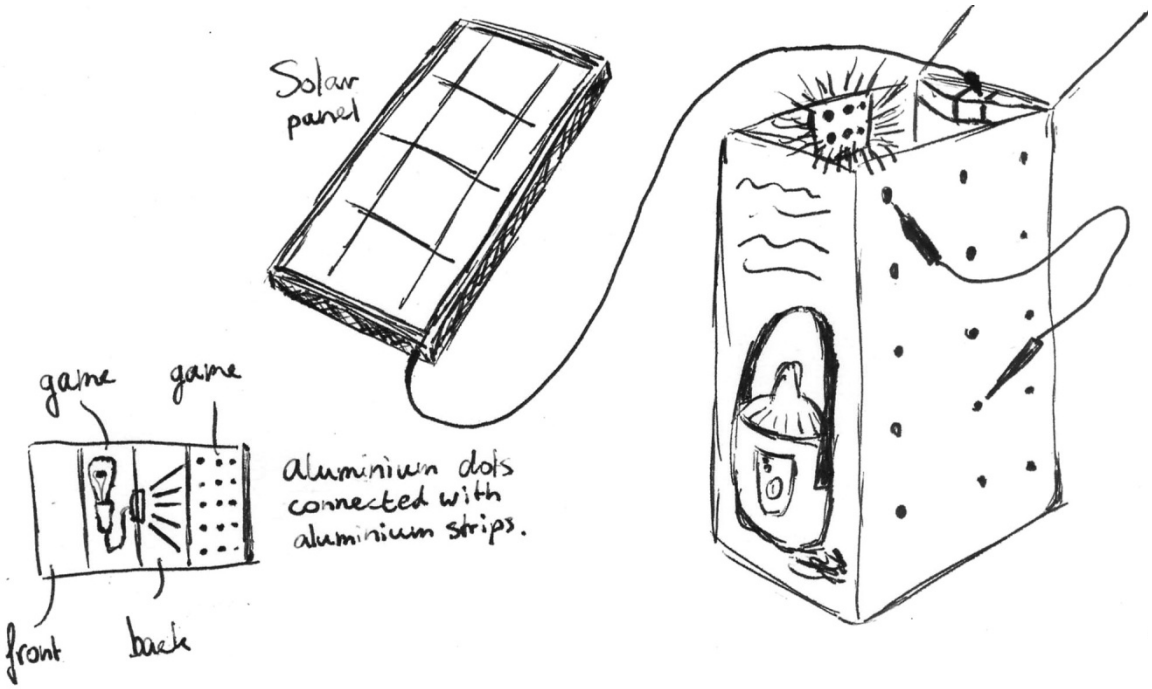


Figure 38: Powered game

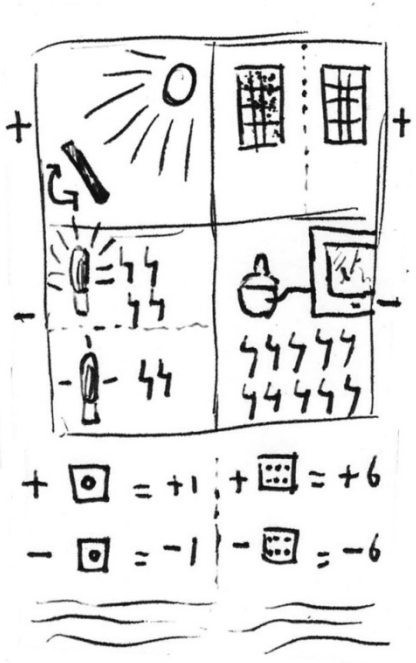


Figure 39: Non-powered game

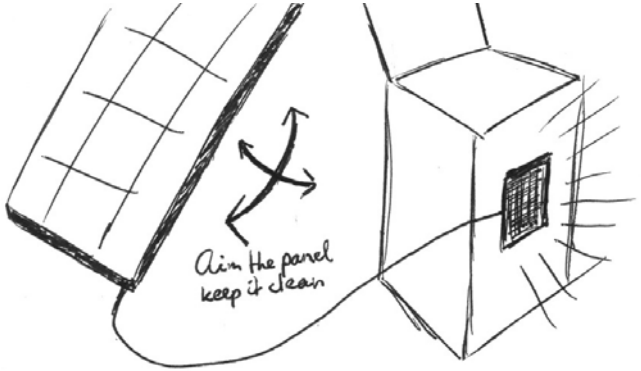


Figure 40: Power indicator

Figure 41: Instructive comic

C.2 Packaging matrix

Packaging matrix	Costs	Appearance	Used for storage	Dust & insects	Support weight	Own weight	Local material	Local production	Environment friendly	Space for information	**Totals**[1]
Glossy box	+/-	+	++	+	+/-	++	++	++	+/-	++	**15**
Brown box	++	--	++	+	+/-	++	++	++	+	+/-	**10**
PVC tube	+	+/-	++	++	++	-	++	++	--	+	**9**
Poster holder	+	+	+	+	+	-	+	++	+	+	**9**
Cotton bag	+	+/-	++	+	+	+/-	++	++	+/-	+/-	**9**
Wooden box	--	+/-	++	+/-	++	--	++	++	+/-	+	**5**
Aluminium cylinder	--	++	++	++	++	+/-	--	+/-	+/-	+	**5**
Cotton cloth	++	--	+	+/-	+	+/-	++	++	+/-	--	**4**
Paper bag	++	--	-	-	--	++	++	++	+	-	**2**
Banana leafs	++	--	--	--	+/-	++	++	++	++	--	**2**
Wooden basket	+	--	-	-	+/-	+	+	+	+	--	**-1**
Plastic blister	+/-	+	--	++	-	++	--	+/-	-	+/-	**-1**
Leather backpack	--	+	+	+/-	++	+/-	-	+/-	+/-	--	**-1**
Leather bag	-	-	+	+/-	+	+/-	-	+/-	+/-	--	**-3**
Rubber bag	-	-	+	+	+/-	-	-	-	+/-	--	**-5**

Table 4: Packaging matrix

[1] Calculation: ++ = 2; += 1; +/- = 0; -=-1; --=-2; no weight factor was used.

C.3 Game matrix

Game matrix	Costs	Fun factor	Local production	**Sub-total**	Clean the panel	How to charge	Location solar panel	Dimming the light	External devices	**Totals**[1]
Non-Powered game	++	+	++	**5**	+	-	+	+	+	**3**
Educational comic	++	+/-	++	**4**	+	+	+	+	+	**5**
Intensity meter	-	++	+/-	**1**	+	-	+	-	-	**-1**
Powered game	-	+	+/-	**0**	+	-	+	+	+	**3**

Table 5: Game matrix

[1] Calculation: ++ = 2; += 1; +/- = 0; -=-1; --=-2; no weight factor was used.

C.4 Morphologic diagram

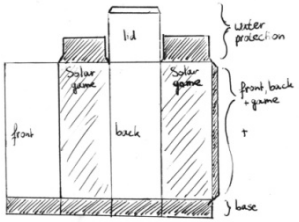
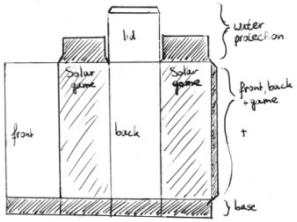
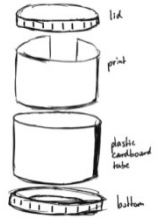
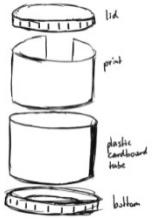
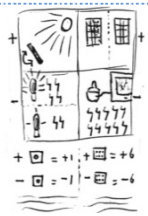
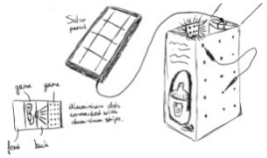
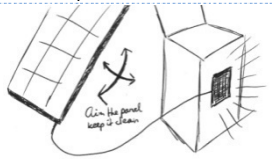
Morphologic diagram with packaging horizontally and games vertically	 A printed glossy cardboard box	 A plain brown box	 A plastic tube with lid	 A cardboard tube with lid	 A stitched cotton bag with label
 Non-powered game	Good combination	Limited detail, limited colours	Good combination	Good combination	Not enough space on the label, printing on cotton is not accurate
 Powered game	Optional, but an expensive combination	Optional, but the brown cardboard may not be able to support the pressure	Optional, but an expensive combination	Optional, but an expensive combination	No space for the game
 Explanation comic	On user manual[1]	On user manual[1]	On user manual[1]	On user manual[1]	On user manual[1]
 Power indicator	Optional, but an expensive combination	Optional, but an expensive combination	Optional, but an expensive combination	Optional, but an expensive combination	Optional, but an expensive combination

Table 6: Morphologic diagram

[1]All combinations include a manual, printed on a4 sized paper, with text in Khmer and English and an explanation comic.

C.5 Packaging material, shape and design matrix

Packaging material, shape and design matrix	Square box	Round tube		Khmer[1] design	Western[2] design	Flashy[3] design	Japanese[4] design	Reason
1	x				x			Attractive colours
2	x				x			Attractive colours, sharp design
3	x					x		Nice background
4	x							All good colours
5		x				x		
6	x					x		Beautiful sunshine
7	x				x			
8		x			x			
9 (six children)	x					xxx	xxx	
10	x					x		Like it because of nice colours and the sun
11	x					x		
12	x					x		
13	x					x		
14	x				x			
15		x				x		Round box is a new packaging
16		x				x		
17	x					x		
18	x					x		
19		x				x		
20	x						x	Square box will not tip over
Totals	**15**	**5**		**0**	**5**	**15**	**4**	

Table 7: Packaging material, shape and design matrix

[1, 2, 3, 4] correspond to the global designs figure 11, 12, 13 & 14.

C.6 Global designs

Figure 42: Stereotype Khmer design

Figure 43: Western design

Figure 44: Flashy design

Figure 45: Japanese design

Appendix D: Packaging design

D.1 Collage

Figure 46: Collage from images from www.deviantart.com similar to "flashy design"

D.2 Different versions of packaging design

Figure 47: Version 1: original design

Figure 48: Version 2: first vectorized design

Figure 49: Version 3: Added visualizing solar energy

Figure 50: Version 4: Added "rules of use" section

Figure 51: Version 5: Added address and improve frontal graphics

Figure 52: Version 6: Created icons

Figure 53: Version 7: Game added. This version was printed for the research

Figure 54: Version 8: Enhanced the contrast of background of icons, improved icons 2, 3 & 5

Figure 55: Version 9: Final version, address block moved, icon 4 removed, improved icon 1

D.3 User research about packaging

User research, final design of packaging.

Overall

Let the user look at the packaging and ask them what kind of product will be in the box.

Do they see the solar panel?

Do they see the lamp?

Do they understand that light from the sun will be turned into power to power the lamp?

Icons

Per icon: Do they understand what it stands for?

1
2
3
4
5
6

Backside

Understand the charging principle?

Understand the product will give light?

Understand the product will power small devices?

D.4 Scan user research dirty solar panel