

ECE 481
Professional Aspects of Electrical and Computer Engineering
Dept. of Electrical and Computer Engineering
Ohio State University

Final Project:
Design Proposal for a Sustainable Low-Cost Light

Your company designs, manufactures, and distributes lighting systems. It has a world-wide market. It feels that there is a large untapped market for a low-cost “personal” hand-held renewable lighting system for persons in under-developed countries. Your company did some preliminary investigations and compiled the information below. This information is not complete, but the company wants you to work with it to conduct a design feasibility study and a preliminary design.

Regional constraints: It has found that the following constraints must be met for the villages and people who would be interested in purchasing such systems:

- There are no nearby electricity sources.
- There is no nearby phone.
- There is no nearby potable water source.
- There is a stream nearby about half of the village locations; however, its water flow level is uneven. During rainy season, there is good current. During the rest of the year it only has enough flow to meet drinking water needs of the village. In about half the other cases the dwellings are distributed far from a stream.
- Living quarters are of the “hut” type (e.g., tree branches with a piece of plastic for a roof or sheet metals sides and top). None are wired for electricity. Many of the huts in the “village” are at distances of 1 km from each other (since they are surrounded by either their crops or there are mountains in the way).
- Most of the villages are remote, and will take almost a day of driving, plus a 5-6hr walk in mountainous terrain.
- Diesel fuel or gasoline in large portions (e.g., to run an electric generator, which is much too expensive anyway) is prohibitively expensive in most areas (partly due to problems with transporting it).
- During rainy season there is sometimes no sun during the day, or at most 2-3 hours of sun. During dry season it is sunny almost every day and it gets quite hot. At night it gets cold in most locations since most of the villages are up in the mountains.
- In some locations, since many of the villages are up in the mountains, there is a relatively constant source of wind. However, that is above the forest canopy in many cases. And, the company has not done the very expensive survey that would be required to determine the wind characteristics in the many remote locations.
- A number of the persons in the situations described above have taken to using kerosene lanterns for light at night. They purchase fuel at the market once a month (cheap, but heavy to carry). These lanterns have been the cause of a

number of fires. Also, since it is cold in the mountains at night, the huts are closed pretty tight, and the smoke from the lantern is causing significant health problems for them and their children who endure years of such contamination. *This is the main reason for wanting a new technology.*

Lighting Needs: Their needs for light are prioritized in the following order:

1. **Income:** The parents find 1-2 hours of lighting at night useful for crafts-making and other “cottage” industry type jobs they sometimes can get. The increase in their return from sales at the market (that is around 20km away) will provide clothing and better nutrition for their family, but no surplus funds.
2. **Education:** Children go to school in the morning, and then work in the fields in the afternoon until nightfall. It would be quite useful to have at least an hour of lighting at night for the children to read and study.

There is no hope that the government or anyone else will run electrical lines or a water supply to the village in the next 20-30 years. Some say that would “never happen.”

Conditions of operation: Most of the huts leak some, and there is a 2-3 month rainy season. There are some periods of high humidity. Most of the huts have a dirt floor. Temperatures in the targeted areas range from 20 degrees F to 110 degrees F.

Operators: It must be possible for young children and adults to easily operate the device. It must be safe. The company is quite concerned about safety and liabilities.

Cost: Here is some relevant information that your company has gathered. Nearly all persons could not sacrifice more than a few days to 1 week of income for the purchase. If it is more, they will just stick with the kerosene lanterns since they need to eat. Customer expectations are that the product would operate failure-free for at least two-years of continuous operation. It must last at least 10-15 years in total. A significant challenge is that the costs of operating it must be as low as possible. It is not feasible to simply expect them to purchase batteries, not to mention concerns about disposal/pollution.

Service and repair plan: Discuss a plan for service and repair that is consistent with the above constraints. What type of warranty can the company offer? What is your return policy? What qualifies as a valid return (if the device was left out in the rain for a month and now does not work, does it qualify for a full-refund, or at least a pro-rated one, or for some credit toward a new device)? What is the outlet for servicing these returns? Keep in mind that there is no one in this type of village with knowledge of electrical technology, nor is there anyone nearby with such knowledge.

Competition: You must research who the competitors are. For this you should provide: (i) a description of their products and their functionality (specification sheets can be put

in an appendix; include URLs); (ii) their cost; (iii) their warranty and support services; and (iv) their market penetration (what countries, how many devices in service).

Company image: The company is quite concerned about its image; it cannot be perceived that it is a multinational corporation trying to exploit under-advantaged persons. This impacts cost, safety/liability, and service plans. Someone has suggested that a survey of some of the local communities be conducted (the above information was gathered by an executive's visit to one country that he thought would be "typical"); you must evaluate in your plan how this should be done (e.g., what should be studied, what questions should be asked, and whether local engineering services in target countries should be sought).

Assignment:

Design feasibility/competitiveness study:

1. Assess the competition as discussed above. Provide information to support your assessment.
2. Develop a strategy to gather more information to support the next stage of the design process (see comments under "company image" above).

Preliminary design:

1. Provide a preliminary design that best fits the above constraints. Explain how it meets the constraints. Provide a clear explanation of costs, relative to customer's financial condition. Pay attention to recurring costs.
2. Defend your choices against competing technologies.
3. Explain your service and repair plan.

Questions/discussion:

1. Explain how the concept of "sustainable development" applies to your design. Discuss a plan for "design for environment" (see text for an example). Discuss life-cycle costs.
2. Explain how the ideas of technology transfer and "appropriate technology" apply to your design.

Design Team: You must form a team to complete the project. Your team must have between 2 and 4 persons on it. All must contribute to the assignment. List on the cover of the final report the title of the report, the persons on the team, the email address of the person who holds the master of the electronic document, and the percentage contribution of each individual.

Report: Type your report using standard font sizes and margins. The main body of the report must be less than 10 pages, but appendices can be attached (e.g., competitor product specification sheets). It should be in Word. Submission of your report indicates a

willingness to have it posted on the web (as a sample solution of this problem). Submission must be done via paper (not electronically). If an electronic version of your report is needed you will receive an email request.

Due Date: Due Thursday, Dec. 8, at 5pm. Submit a *paper copy* to the Receptionist at Rm. 405 Dreese Labs and ask her to put it in the mailbox of Prof. Passino in 405 DL, with the time/date written by her at the top. It is highly recommended that you complete the project well before the deadline.