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FOROBA YELEN: PORTABLE SOLAR LIGHTING AND SUSTAINABLE STRATEGIES FOR REMOTE MALIAN VILLAGES

Ashley HALL[1], **Boukary KONATE**[2] **and Amrita KULKARNI**[1]
[1]Royal College of Art & Imperial College London, United Kingdom
[2]Cinzana Connect Villages Association, Mali

ABSTRACT
Foroba Yelen ('collective light' in the Malian Bambara language) is a collaboration between staff and students from the Innovation Design Engineering dual masters programme at the Royal College of Art/Imperial College London, Cinzana Connect Villages association and the eLand Foundation to design and build portable solar lights for two remote villages in the Segou region of Mali. Core to the project were a number of sustainable strategies including: social enterprise, off-grid lighting and local manufacture. The aims were to facilitate the generation of new businesses, support education and help maintain the cultural practices of festivals and ceremonies. The meta-level objectives lay in reducing rural-urban migration and supporting agricultural production by increasing the quality and opportunities of everyday village life. The rural-urban migration patterns in Africa are challenging food production, healthcare, cultural practices and education [1,2]. One of the key generators of economic improvement in a largely agricultural economy is the generation of surpluses [3]. As part of a coherent development strategy, increased lighting can allow working late into the night to facilitate economic benefit and social improvement. This paper will report on the project structure, sustainable strategies, challenges that arose, student learning and experiences and discuss methods employed by the globally dispersed project team. Conclusions will present initial findings and feedback from Malian villagers on light usage, rental incomes and educational reflections from participants.

Keywords: Solar, Lighting, Design, Sustainability, Social Enterprise, Mali

1 INTRODUCTION

Foroba Yelen is a project developed jointly by the authors, Ashley Hall from the Innovation Design Engineering (IDE) dual masters programme at the Royal College of Art (RCA)/Imperial College London, Boukary Konate of the Cinzana Connect Village Programme in Mali and Matteo Ferroni of the eLand Foundation. The aim of the project was to collaborate on the design and construction of portable solar lighting units for remote off-grid Malian villages to extend existing and facilitate new agricultural, educational, social and cultural activities.

The incorporation of electric lighting into towns and cities in the USA and many European and Asian cities began apace at the end of the 19th century. We often take this simple innovation for granted yet its ability to transform societies is very powerful as described by Marvin [4]. Accounts of the illuminated transformations of night-time cities remind us of how social interaction, education and enterprise can all benefit:

> "We can remember when the first electric lights appeared in the New York shop windows and over the doors. It was looked upon as a mere experiment, the continuation of which would soon prove more trouble than it was worth, and the neighboring stores took no stock in it. Soon, however, it was discovered that it was attracting the attention of customers and the general public to such an extent that its owners were compelled to enlarge their stock" [4]

It is clear that urban lighting has the potential to make such a big difference for many of the world's off-grid villages. The Foroba Yelen team set out to develop a locally sustainable model with an initial

seed fund to build two lighting units and supporting solar charging systems. Both Hall and the IDE department have experience of working on projects in BRIC and developing economies as part of the annual GoGlobal project series including India, Thailand, China and Ghana [5,6]. The main focus of these projects however was an educational exchange and the themes centred on connecting policy to implementation rather than immediate on-the-ground results. Foroba Yelen offered the opportunity to work on a focussed project that aimed to deliver results within the two-week timeframe of the Mali visit through using and testing the solar lights.

Mali is a sub-Saharan African republic with a life expectancy of 49 years, a GDP of $691 and is ranked 171 out of 174 countries on the global human poverty index. Child mortality is 191 per 1,000 births making it one of the highest in the world. The urban population has increased from 7% in 1950 to 36% in 2010 [7] Rural-urban migration is a key issue in sub-Saharan Africa as it displaces millions of people each year from socially supported rural communities into rapidly expanding under-resourced cities. One of the main issues revolves around agricultural industries that are heavily reliant on manual labour and when this is scarce, food supplies can drop below national self-sufficiency levels increasing the risk of famine. Therefore any activity that enhances village life and reduces the migration tendency is actively encouraged by regional authorities and governments [1].

The project initiated with a collaboration request to the IDE department in October 2010 and continued in a development phase up until April 2011. At this stage the student team was recruited and worked on the project in their free time from early July before full-time engagement in October. During the 3 month summer vacation, the project ran in a 'summer school' format. The implementation phase was planned for two weeks at the end of September 2011 to give maximum development time and to miss the rainy season in August and early September.

2 PROJECT

Alongside Hall, Konate and Ferroni, five students from diverse backgrounds were chosen from the IDE first year cohort to form the main part of the design team. These were: Amrita Kulkarni (Co-author) – an architect from India, Peter Krige – an Electronics Engineer from South Africa, Aran Design – an Electrical Engineer from the UK, Kevin Bickham – a Product Designer from the USA and Joel Trotter – an Industrial Designer from London. The team were chosen for their backgrounds of developed and developing countries and a mix of engineering (including electrical) and design skills. The proposal was to design and build two lights, install two solar panels and charging units for two user groups organised locally as associations. The first is the 'TONs', a young male group who are either employed in the cities near-by or engaged in agriculture at home. The second is the Women's group who need lights for activities around agriculture, healthcare, education and family support. In summary the project aims were to:

- Test digital technology for remote research, communication and design
- Engage villagers in the co-design process
- Construct two portable solar lighting units
- Supply associated solar panels and charge controllers
- Use local materials, technology and skills for construction
- Generally improve the quality of village life as part of an effort to reduce rural urban migration
- Train villagers in charging the solar batteries and using the lights
- Generate instructions to allow for local reproduction of the designs

Through the research phase a number of activities that could benefit from night-time lighting were identified from contact with Boukary Konate of the Cinzana connect Villages Association via a Facebook group. Video and photographs were shared over this platform. Identified activities were further investigated upon arrival by visiting the sites upon which they take place and discussion with villagers. These discussions focussed on: keeping harvested crops safe against theft at night, making house bricks, maintaining ceremonies and cultural practices including funerals, weddings, mask dances, running businesses and starting new enterprises, education and healthcare, additional agricultural work to make profits to invest in education and healthcare

Fig.1 below illustrates the proposed enterprise and activity model. Following the initial design and prototyping phase it was hoped that the rental of the lights would generate a profit which could be re-invested into the production of more lights resulting in a self-generating activity which would begin slowly and then increase organically to light whole villages through improving the quality of life.

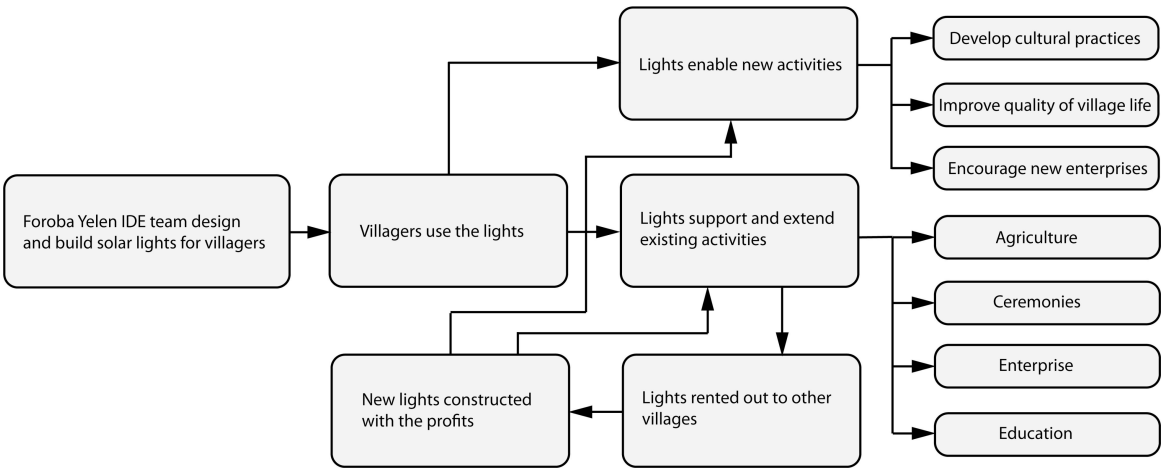

Figure 1. Enterprise and activity model

3 CHALLENGES

In the pre-project phase the main challenge arose from connecting all the diverse partners of the project. Reflecting the trend in global design teams, the students, staff and project partners worked remotely at some points from the United Kingdom, Italy, Spain, France, Mali, USA, India, Australia, Korea and Turkey. Researching and understanding Malian culture and local facilities was facilitated by partner and architect, Matteo Ferroni using a Facebook group as an exchange platform. Co-author Boukary Konate had earlier installed a solar powered Internet connection in one of the villages and this proved invaluable in communicating with the villager's daily lives and to receive insights into how the lights could be used.

Co-author and student Amrita Kulkarni remarks - "One of the most unexpectedly fascinating parts of the project was the remote introduction of Malian culture. Sitting comfortably in the studio in London, we discussed the problems faced by women in the sweaty, sunny and alien societal structure. As an Indian, I expected to be familiar with the rural make-up in remote villages – with the dominance of men, for example – but I was pleasantly surprised to learn that women are impressively entrepreneurial! Not only did they sustain an independent financial body, but also maintained a continuous cycle of activities like pottery, producing Shea butter and farming in the community gardens."

Peter Krige recounts early challenges on arrival: "Once the major project partners and designers converged in Mali for the final stage of the project, many previous concepts and assumptions were discarded. This was a valuable insight that the team was aware could happen; yet it is worth reiterating that these projects have to be designed in location with local people. This is not to say that the preparation in London was useless, quite the opposite. Earlier work activated ideas that might not have been possible to conceive in Mali and it gave the opportunity to anticipate challenges….Much value was found in the presentation of the project intentions to the two community groups. A sense of partnership and cooperation was fostered. The co-visioning of the lights was of immense importance for a transformational cultural exchange between those involved." [8]

Once the design team arrived in Mali and travelled across the country to Cinzana Gare various challenges were encountered - both known and unknown. The first of these arose from our proposed activity of co-design. The students through their research phase realised that there were too many unknown variables in remote design and focussed instead on identifying a series of modules or elements which could be discussed with villagers in order to identify the most promising configuration for the design. This process bears much similarity to a morphological analysis [9]. Once the students

began working with the villagers two problems emerged: the realisation that while it was possible to present the modules and jointly select the most promising, it would need a much longer series of conversations (than the project timeframe allowed) and some design education to move beyond basic element selection towards full co-design. The second revolved around the reluctance of the Women's group to speak out openly about their specific needs. The first was resolved by the design team making their own observations around more detailed product requirements and the second by discussing with the Women's group on their own. It quickly became apparent that although the villages are not far from large rivers, the arid climate of the Sahel is not conducive to growing construction-grade timber. All houses in the area are built of mud mixed with straw, demonstrating the scarcity of building materials. The team decided to use tubular steel for the main frame of the lights to provide durability for moving over dirt roads, rough handling in village life and agricultural uses. Segou, the nearest city and Mali's 3rd largest had one steel supplier. After some investigations it became clear that the steel is transported in trucks across 2-3 countries before it reaches Mali resulting in poor quality integrity and high expense from trading middlemen. The team were surprised that even after extensive negotiations prices in Mali were similar to those in London, which they assumed would be much higher.

The construction took place at Moussa's welding shop, along the main roadside to Segou. The entire process took three days. At first impression Segou appeared to have a high density of construction facilities with a sizeable number of roadside fabricators. With more investigation it became clear that roadside fabricators were in fact menders - repairers of western technology comprising engines, buses, cars, wheelbarrows and the like. At one stage in the construction, the light frame needed holes drilled though a set of steel plates. The plates were taken away and returned with large off-centre holes that had been punched through the plate with a steel chisel, the local solution for making holes in steel. The group had little success trying to buy drill bits as they were unavailable. This narration illustrates the challenges to local people of maintaining technology and even greater one of initiating new design solutions. Allied to the challenge of sourcing materials was the desire of the design team to produce lights that would be aesthetically harmonious to the village and its surroundings. The choice of steel for the structure and visibility of the lighting components made this difficult and discussion with villagers reinforced the aim of delivering robust functional lighting as a primary objective over visual features.

One of the most unexpected discussions revolved around sourcing lighting components. There emerged two options, the first using local parts that turned out to be expensive and very low quality and the second using 'best western' high quality imported components. After some discussion on the advantages and disadvantages of each approach the team decided on a final solution to build one light from each to benchmark performance of locally sourced parts verses the best western available lighting technologies. The thinking behind this strategy was to use the donated high quality imported Philips LED lighting components with their long product life so that by the time they needed replacement similar quality parts could be available locally. With an average use we calculated roughly 10 years for this cycle. Moreover the higher quality construction would give better protection against dust ingress and humidity in the aggressive Sahel climate. Due to working with a fixed budget and high cost of local solar panels, the team also decided to build their own solar panel with leftover cells from a RCA teaching module sponsored by Sharp solar. Energy storage was via 65 amp deep charge gel batteries which are available locally and specified for solar usage.

A remaining challenge concerns the information legacy enabling reproduction of the lights following the design team's departure. Boukary Konate followed all aspects of the project and was aware of the components, suppliers and fabricators used, and Moussa the welder also prepared some drawings of the lighting structure and joint details.

4 SUSTAINABILITY

During the project development a number of sustainable goals were described as part of the project brief, or became desirable through research and project development [10]. Sustainable benefits included: less need for the government to invest in electricity grid infrastructure, portable technology that can be moved with users and activities which allows 'lending and mending', renting the lights

generates a new income for villagers which can be used for building new lights, lighting allows new activities generating additional income, education and healthcare, cultural practices are maintained reinforcing social cohesion. The project sought to deliver benefits in the three core areas: Firstly - local manufacture of lights to ensure employment, lower costs, reduce materials transportation and encourage refinements of the design with feedback. Secondly, off-grid power supply providing an inexpensive and portable low maintenance energy supply. Finally, a social enterprise model allowing the villagers to rent out lights to make a small profit that would be reinvested in building more lights in a scalable model.

When designing in developing economies it is important to consider locally relevant design features that may well be opposite to those desirable in western markets. In a visit to Mohammed Khalil, leader of design for the third world at Philips in Eindhoven (and one of the technology sponsors for Foroba Yelen), he outlined four 'R's for design in developing economies:

1. Robust – products that can cope with the realities of being transported on dirt road, extremes of temperature, dust, low maintenance, manhandling and humidity.
2. Reliable – a long product life with low maintenance and planned obsolescence.
3. Repairable – design for disassembly, repairable using fabricated and easy to source spare parts.
4. Resalable – a product that can be resold and accommodate multiple owners, maintain its resale value and justify the initial investment.

5 FINDINGS & CONCLUSIONS

Boukary Konate of the Cinzana Villages Connect Association reports on examples of the solar lights being used for village activities from October to December 2011:

October 2011: The lights have been used first for the funeral of an old man who died in Bamoussobougou. They have been used for three nights. The lights have been used in Niatia, a village at about 3km from Bamoussobougou. The young people association of Niatia went to rent the lights with the villagers to use them for the traditional feast. It's a kind of a dancing party that young people organize at the end of crops. The ceremony took place in the public space of Niatia.
November 2011:
The lights have been used in Bamoussobougou during Wali's baby's naming ceremony. Wali is a young man in Bamoussobougou. The ceremony took place in Wail's family yard. The lights have been used by the young people of Bamoussobougou during the traditional dancing party. The ceremony took place for two nights in the public space of Bamoussobougou.
December 2011: Some families in the village of Bamoussobougou rented the lights and used them during their work on the farm to cut crops. The lights were used in Cinzana village for two nights. The young people association of Cinzana village went to rent the lights and used them for their masks dance. The ceremony lasted two nights and the public space has been lit thanks to the initiative of Foroba Yelen.

Activity so far illustrates widespread use of the lights for activities ranging from funerals to traditional feasts, dancing parties, naming ceremonies, agricultural works and mask dances, and supports the aim of enhancing the quality of daily life in the villages. Based on a rental income of £5.41 (Malian CFA 4,000) per event with an average of 15 events per month minus £5 month maintenance offset against a new light cost of £449.55, one new light could be funded every 5.6 months.

Both positive and negative effects of introducing a new technology can impact on standards of living and quality of life. When new technologies are introduced they need to be supported and maintained locally or are withdrawn at a later date leading to disenfranchised local populations. The assumptions of a co-design model and the ability levels amongst various project partners' need to be assessed in advance as far as possible. Locally relevant design features may well be opposite to those desirable in western markets and contrast to traditional western design education and perceived wisdom. The success of using imported 'best western' components over locally sourced lighting components will be evaluated over a longer period of time in collaboration with reports from Mali on usage of the lights.

Amrita Kulkarni reflects on the educational values: “Intellectual company, warm outdoors and dark nights brought to the surface many a philosophical question – something an ordinary classroom should evoke but usually doesn’t – *Why has this project not already happened?* Whether in the ancient context or modern, why has light not touched lives of these villagers? Fire was discovered a long time ago, yet not visible as a light source in this context. Reasons could be fundamental or accidental, but the question lingered in our minds. I have been wondering for a while what the value of design is – what is the highest reward of a designer? In times when money is the direct indication of value, Foroba Yelen disrupted my understanding. Watching tears rolling down from the villagers’ eyes, I realised that there was a need for a re-assessment of value. Gratitude was reflecting in the body language and smiles of the villagers – is that not payment enough? Design school curriculums rarely include financial advice on payment and value – and while we spend our lives quoting suitable prices, projects like Foroba Yelen can be life-changing.

The power to affect change, I firmly believed, had to do with experience – how long one has been pursuing a certain cause is proportional to success rate. As a student, therefore, I expected my goodwill footprint to be rather insignificant, but this project surprises me again, as I see the difference these lights are making to villagers’ lives. If by sheer will, passion and desire to reach out, one can create such an impact, it is education worth a lifetime.”

Based on the early success of Foroba Yelen, the team has been invited to discuss an initiative to design and manufacture solar powered lights for Mali’s schools as part of a national project to provide school internet connections. It is hoped that with additional support a return visit can enable the refinement of the original lights and sustain the manufacture of new improved lighting units co-created with the villagers and ultimately improve village life and reduce the pressure of rural-urban migration.

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