Section 4

**6th Annual P3 Awards: A National Student Design Competition for Sustainability Focusing on People, Prosperity and the Planet**

**Research Category:** P3 Awards: A National Student Design Competition for Sustainability Focusing on People, Prosperity and the Planet

**Funding Opportunity Numbers and Associated Research Areas:**

?????

**Title:** Developing Affordable and Sustainable Water Solutions for the World's Rural Poor: Evaporative Cooling Refrigeration System

**Faculty Advisor:**

Dr Kenneth Schug
Professor, Chemistry
Primary E-mail: kschug@msn.com
schug@iit.edu
URL:http://www.iit.edu/~bcps/database/search.cgi/Schug/K/Chemistry/:/frontend/faculty/faculty_web_page

**Institution:**

Illinois Institute of Technology
3424 S State Street
Chicago, Illinois 60616

**Student Represented Departments and Institutions**:

Department of Architecture, Illinois Institute of Technology
Department of Biology, Illinois Institute of Technology
Department of Civil Engineering, Illinois Institute of Technology
Interprofessional Research Opportunity, Illinois Institute of Technology

**Project Period:**

9/1/2008 to 2/28/2010

**Project Amount:**

??????

**Total Project Amount:**

??????(would like to make sure if I should include travel expenses with Dr Schug)

**Project Summary:**

This project is based on the ideas and realization of students at the Illinois Institute of Technology who have enrolled in IPRO 325 "Designing affordable Energy, Shelter and Water Solutions for the World's Poor" over the past two years. The Evaporative Cooling Subgroup focuses on the following:

- Developing a zero energy, low cost refrigeration system for the world's rural poor
- Developing an evaporative cooling refrigeration system
- The design of this project will be made of all locally available materials in order to be low cost and will enable the rural poor to store food for longer periods of time to combat malnutrition. This system takes advantage of the natural process of evaporative cooling so that electricity is not needed for the system to work.
- We have been testing many different variables to make the system more efficient and

effective. By running tests over a period of time for multiple trials, we have been able to get more accurate results. We also intend to do field testing in Peru in order to determine the effectiveness of our system in a real world context. We will be running workshops to teach the local people how our system works and why it is beneficial to them as well as how to maintain it so that they will be able to use the systems by themselves. Visit these villages also gives us practice in implementation.

- By continuing this project, we can increase campus awareness of the problems facing the world's poor, especially that due to malnutrition. Allowing more people to join in our research and also displaying our progress at the end of every semester will enable more people to learn about and take interest in our project.

**Supplemental Keywords:**
Affordable - Sustainable - Micronutrient Malnutrition - Food loss - Food decay - Rotting food - Hunger - Poverty - Food storage

Section 5

Section 5.a.1
P3 Project Description

According to research done at Stanford University, although the world's supply of basic food has roug
their income on food. Couple this with the fact that they must often times travel many miles in order to
having to travel so far for food, but often the case is that most of the food they stock pile will spoil befo

In response to this rapidly growing problem, we are attempting to develop an affordable, sustainable, and energy efficient solutions that can be implemented by the local populace. To accomplish this, we must understand the cultural and economic differences involved, and not force

adapt to and improve their lives.

Section 5.a.1.i
Challenge Definition

The designed evaporative cooler will use the process of evaporation to extract heat from the system and cool the inner chamber containing the fruits or vegetables. The teams primary focus will be on utilizing local materials from a targeted region to develop the more effective cooling/storage method, and will ensure that the design remains relatively cheap, efficient, and above all self-sustainable. The goal is to test enough parameters so that the proposed evaporative cooler can be altered and implemented across the globe. A descriptive manual has also been created and translated so that implementation into the target region will be more successful. The team's manual will be comprehensible regardless of the language and level of literacy of the targeted region.

The intention is that a "Field Team," or on-site group of volunteers, will be able to fully implement our system in the targeted region during the field testing phase of the IPRO in the summer. There is the intent to send a small number of students

to rural regions of South America to meet with the communities that are in dire need of food storage methods. This field testing will provide extremely valuable information regarding the specific needs of targeted rural poor communities and will assist future IPROs in fine-tuning our design for greater efficiency and effectiveness.

Section 5.a.1.ii

Innovation and Technical Merit

There are currently locations all over the world that are using food cooling and storage technologies, and they are achieving positive results. However, there is still much more that can be done. Previously, a Zeer pot evaporative cooling system and also a static evaporative cooler were used to tackle the problem and allow the world's poor to store their food for longer. The proposed evaporative cooler combines both of these previous designs into a hybrid of the two. This design has shown to be better in terms of ease of construction and maintenance, and also in terms of affordability. The team consists of students from a variety of engineering and architecture backgrounds who work together on the project. This combination of disciplines provides a complimentary base from which to draw ideas.

Section 5.a.1.iii

Relationship of Challenge to Sustainability (People, Prosperity and the Planet)

People

The specified evaporative cooler has been tested in the field and the feedback has been very positive and helpful in knowing what corrections to make and how to alter the design. They are very welcoming, hospitable and eagerly await the upgraded versions. This evaporative cooler is relatively easy and cheap to construct and only requires materials that are available locally. It requires no electricity and minimal maintenance once constructed. The design is also environmentally friendly while providing a cooler chamber to store produce in longer so that the local people have a better shot at avoiding micro-nutrient malnutrition.

Sustainable and energy efficient evaporative cooling devices provide tremendous economic, env
cooling device will utilize the already sunny environment to evaporate the water in the device in
keep food cold and give them the ability to store that food for prolonged periods of time.
Needless to say this would greatly reduce the amount of
energy that would be needed to keep
the food in storage. Evaporative cooling uses a combination of strategies to both cool and
store food. These include converting the heat of the sun in order to evaporate water from
the medium of the device, and utilizing the insulative properties of the adobe and clay to keep th

Prosperity

What are the short- and long-term costs associated with the project, including potential implementation and maintenance costs?

What are the economic benefits of the project?

There are several economic benefits as a result of this project. The local people will be able to store their food longer and so reduce their waste. This saves them money by not having to go to the market as often, and hopefully they will not suffer from micro-nutrient malnutrition and have to pay medical expenses to get better. The design itself does not require any energy to run and maintenance costs are minimal. Overall, this project requires a manageable initial investment for materials and construction, but the return value significantly outweighs the cost.

Planet

How will the design reduce impacts on the environment and human health, diminish resource consumption, and/or directly benefit the environment?

Introducing this evaporative cooler to the locals will appreciably contribute to their better health and environment. By being able to store their food longer, the chances of eating rotten food and suffering from micro-nutrient malnutrition will drop notably. This will also result in less food being wasted.

What are the impacts of the project on the local environment?

There are no significant impacts on the local environment due to the proposed evaporative cooler. The local resources will be extracted for construction purposes but that is minimal.

Section 5.a.1.iv

How will the identified goals and objectives be achieved?

[List goals]

What methods are applicable for quantifying the benefits of the proposed project?

The key benefits of the evaporative project are longer safer storage periods for perishable goods. As a result, food remains fresh longer and losses due to spoilage are reduced. With extended availability of nutritious food, micronutrient malnutrition is reduced as well. While the larger goal is reduction of micronutrient malnutrition, quantification of this outcome is difficult beyond generalized statistics. A more viable quantification is the storage period of the perishable goods themselves. For comparison, samples from an identical crop may be stored via existing methods, and compared to the length of storage the evaporative cooler.

Have necessary partnerships been developed, or will they be pursued?

There is an established partnership with a contact from a programs in Peru where our project has been implemented. These contacts provide the communications link and feedback loop required for further development. Partnerships with local material suppliers may improve accessibility to and availability of the required goods. Additionally, the increased demand for such materials will provide employment opportunities and growth of local businesses.

Can the design be replicate in other situations or locations?

The evaporative cooler system design is quite versatile and easily replicable. An intuitive and detailed manual has been written in English and translated by natives to Spanish. Understanding of the manual illustrations is not limited to a particular audience, and the system may be constructed from the illustrations alone.

Section 5.a.1.v

What are the educational benefits and how will the team encourage sustainability among participants, institutions and/or surrounding or involved communities?

The educational benefits of this project serve to educate the populations in which the evaporative cooler is implemented. A generalized explanation of microbial interactions with food products is presented within the manual. This information serves to provide an understanding of the problem and a basis for our solution. Certainly, the team will rely on resident support for the project to take hold and prosper within a community. Through the positive reception of our evaporative cooler within a community, members are able and expected to spread word of its benefits to their neighbors. If the community accepts the cooler to daily use, further education curriculum through schools may be established.

Section 5.a.2

What are the important steps and milestones for the project?

Research

During previous semesters, much research has been gathered and reviewed. Information regarding the current levels of poverty, malnutrition, eating habits and lifestyles of rural poor citizens was gathered. Micronutrient malnutrition stands out as a leading cause of disease in rural poor communities, and an attempt to minimize its effect was initiated. Success with the evaporative cooling Zeer Pot system from Nigerian teacher Mohammed Bah Abba provided inspiration for modification and improvement of the design. A location in Sincape Peru was decided on for the initial round of in-field testing, based on its level of poverty, accessibility to required materials, and location with respect to the climate and weather patterns optimal for evaporative cooling.

Design

The basic design of the Zeer Pot, or pot-in-pot cooler consists of a large pot with a smaller pot placed inside. The gap between their walls is filled with sand, and saturated with water. Perishable food products to be cooled are placed within the dry inner pot and covered with a wet cloth. Modifications on this design were explored and tested for improved efficiency.

Development

The various prototypes of cooling devices were compared in a head-to-head test across several semesters. Through various stages of testing, the most effective model was decided upon and tested further by altering features such as location and lid design.

Demonstration

Multiple presentations of the system have been delivered to various audiences. Feedback from observers and the suggestion of colleagues has been incorporated into the design and development cycle.

Implementaton

A semesterly trip to implement the cooler in the field has been established. Both the previous and current semester's team incorporated a trip to Sincape, Peru where a demonstration and construction seminar are conducted. This trip serves to inform locals of the system's benefits and educate the public of the risks involved in consuming spoiled food.

How long is the duration of the project?

This project has been running in various stages since [***YEAR***]. The team has demonstrated continuing success and anticipates to continue further development and implementation. Pending the reception of the system in various regions, continuation plans are expected to revolve around the education of locals and spread of knowledge to new communities.

What is the process from research to design to development to demonstration to implementation.

Research

During previous semesters, much research has been gathered and reviewed. Information regarding the current levels of poverty, malnutrition, eating habits and lifestyles of rural poor citizens was gathered. Micronutrient malnutrition stands out as a leading cause of disease in rural poor communities, and an attempt to minimize its effect was initiated. Success with the evaporative cooling Zeer Pot system from Nigerian teacher Mohammed Bah Abba provided inspiration for

modification and improvement of the design. A location in Sincape Peru was decided on for the initial round of in-field testing, based on its level of poverty, accessibility to required materials, and location with respect to the climate and weather patterns optimal for evaporative cooling.

Design

The basic design of the Zeer Pot, or pot-in-pot cooler consists of a large pot with a smaller pot placed inside. The gap between their walls is filled with sand, and saturated with water. Perishable food products to be cooled are placed within the dry inner pot and covered with a wet cloth. Modifications on this design were explored and tested for improved efficiency.

Development

The various prototypes of cooling devices were compared in a head-to-head test across several semesters. Through various stages of testing, the most effective model was decided upon and tested further by altering features such as location and lid design.

Demonstration

Multiple presentations of the system have been delivered to various audiences. Feedback from observers and the suggestion of colleagues has been incorporated into the design and development cycle.

Implementaton

A semesterly trip to implement the cooler in the field has been established. Both the previous and current semester's team incorporated a trip to Sincape, Peru where a demonstration and construction seminar are conducted. This trip serves to inform locals of the system's benefits and educate the public of the risks involved in consuming spoiled food.

What are the roles and tasks of each team member involved?

The most recent semester's team worked with Dr. Kenneth R. Schug. The team leader was Amber Heinz, who guided the timeline of work from research to implementation. Casey Franklin served as the cultural liaison and worked to teach basic spanish to the non-fluent members as well as translate the english manual text to spanish. She also researched the target regions and coordinating travel arrangements. Carl Ekstrand worked with overseas contacts and pursued interest among additional parties, as well as constructing the grant proposal. August Sylvain updated an engineering notebook, compiled and analyzed test data and worked on the grant proposal. Justine Banda provided illustrations and typesetting of the manuals, administrative work and test location preparation. Mark Chiu coordinated the scheduling of tests, illustrated and compiled the information for the two manuals. Much of the actual work was shared among team members however; everyone participated in monitoring over 20 days of testing.

What are the anticipated interactions with the partners involved?

Interactions would ideally serve to benefit the community in which the device is implemented. Partnerships with local sellers of adobe brick and pots would benefit the individual merchant. If the product is well received, a partnership with the local school to provided education on the matter is a future goal.

Section 5.b
Indicate and and all types of partnerships or planned partnerships and their contribution

Section 5.c
List of references.

Section 5.d
Important attachments.