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Construction of a Seismically-Resistant Earthbag Home and Rainwater Catchment System in Nepal

As civil engineering students at Santa Clara University (SCU), we are taught to use what we have learned for the benefit of others. The SCU School of Engineering strongly promotes the idea of "Engineering with a Mission." Therefore, the opportunity to contribute to the rebuilding efforts in Nepal following its devastating April 2015 Gorkha earthquake was an ideal senior capstone project for our team. To implement this project, we partnered with Conscious Impact, a social enterprise based in Takure, Sindhupalchok, Nepal. Conscious Impact promotes safe and sustainable building methods. We also received funding through SCU's Miller Center for Social Entrepreneurship's Roelandts Grant program and SCU's School of Engineering.

Takure was especially devastated in the April 2015 disaster; all but one of the village's 245 homes were left in rubble. In the fall of 2016, the government of Nepal began to provide families with aid to recover from the earthquake. For the village of Takure, this assistance would total about US $3,000 total per family. This is significantly less than the approximately US $12,000 needed for the common Nepali building style of concrete frame with infill fired bricks. When Nepal's Ministry of Urban Development later approved "earthbag" technology as an acceptable building method to receive government funding, we saw this as the perfect opportunity to put our skills to use and design an earthquake-resistant earthbag home that could serve as a guide for safe building at a very critical time. In addition, most of the residents in Takure are subsistence farmers, meaning that they live off of the land with no additional income from their crops. Therefore, many do not have funds to feasibly rebuild following the earthquake. To address this issue, we integrated a rooftop rainwater catchment system into our design to provide an additional water supply for cash crops to help fund the rebuilding process.

Conscious Impact acted as a community liaison in helping us network and connect with those living in Takure. With their help, Sunita Tamang and her family were chosen by the local community to be the recipients of the earthbag home and its accompanying rainwater catchment. Sunita is a widow *(continued on page 2)*

Uplifting Healthcare in Nepal: America Nepal Medical Foundation

The Idea: The America Nepal Medical Foundation (ANMF) is a non-profit organization that was founded in 1997. It is the brainchild of Dr. Arjun Karki while he was completing his residency at the State University of New York (SUNY) Upstate Medical University in Syracuse, New York. Those were the days when there were just a handful of Nepali doctors working or training in the United States. Desperate to contribute to the health of the people in their beloved home country, a group of like-minded Nepali intellectuals and a number of US friends enthusiastically worked towards establishing an organization with the overall mission "to help Nepal strengthen its medical capabilities through promoting academic and professional cooperation between Nepal and North America in the area of medical care, medical education, and medical research."

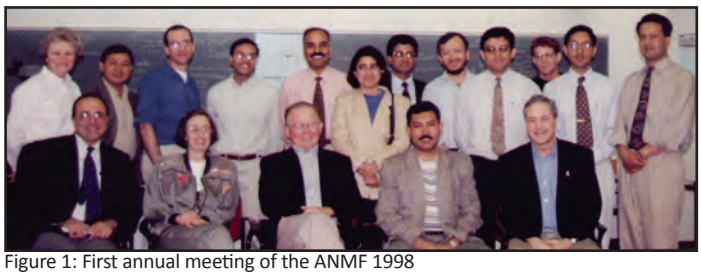
Figure 1: First annual meeting of the ANMF 1998

Non-Profit Registration: After long grueling hours of discussions among physicians, social scientists, and public healthcare experts, which took place between 1995 and 1996, the ANMF was finally established in 1997. Part of the conceptualizing team included Sanjay Khanal and Sunil Sharma (who were then co-residents at SUNY Upsate). Also, Professor Donald Blair, the founding chair of the board of directors, provided strong support. His office at SUNY Upstate became the secretariat of the fledgling organization. Vijay Sigdel,

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This journal is published twice a year by the Global Nepali Professional Network (GNPN). The GNPN is an American organization dedicated to the professional development of its members and technological progress of Nepal. It is a tax-exempt 501(c)(3) non-profit organization with members throughout the United States. The organization utilizes the creativity and talent of its members and the broader American community to develop technology-rich solutions that address some of Nepal's challenges.

The GNPN was originally established in July 29th, 2007 at the University of California Berkeley (UC-Berkeley) under the name CAN-USA.

Please visit our website at gnpn.org.

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Figure 1. Earthbags are stacked with barbed wire between each layer.

and mother of three children who lost her husband a mere two months before the earthquake. This project served as a demonstration house for the rest of the community.

Earthbag Technology

After assessing material options, earthbag technology stood out as the best method for rebuilding. Earthbag building is composed of soil stuffed inside polypropylene bags. The earthbags are stacked and staggered like masonry, solidly tamped, and bonded together using barbed wire as a "mortar" between the layers of bags as shown in Figure 1. Reinforcement such as buttresses, vertical rebars, and bond beams are used in earthquake-prone areas. As a final step, earthen plaster is used for the exterior of the walls in order to protect the bags from weather elements and UV light.

Reasons for Building with Earthbag

Earthbag technology is an ideal material option to use in our design for several reasons. It is sustainable, simple, inexpensive, and earthquake-resistant. This technology is more eco-friendly when compared to other similar materials commonly used in developing countries such as concrete blocks or fired bricks. Earthbags are not fired and use no cement, with the exception of a concrete bond beam. Therefore, the carbon footprint is less than those of fired bricks and concrete blocks. In addition, this material is cost-efficient since it is made mostly of local materials and does not require skilled labor, advanced technology, or transportation. The average price of a house using traditionally fired bricks is around US $12,000, while an earthbag house of the same size is only about US $6,000. In addition, this building method is proven to safely resist seismic forces. There were 55 earthbag houses known to exist in Nepal at the time of the 2015 earthquake and all survived. While this provided strong empirical evidence that earthbags are seismically-resistant, there are limited published code values available for earthbag material, which proved to be a challenge for us as engineering students to complete the engineering analysis.

Engineering Analysis

There are two main components of our project, first is the earthbag home and second is the rainwater catchment system. With the earthbag home, we focused on five main project deliverables: design of a steel roof truss for the roofing system of the house, design of the walls' connection to the roof, analysis of the earthbag wall behavior, study of the foundation connection to walls, and analysis of the stacked stone foundation, which is typically used for structures in Nepal. For comparison, we also designed an alternative concrete and rebar foundation, per the International Building Code but recommended the local Nepali masons build the traditional stacked stone foundation.

For the rainwater catchment system, there were three primary steps taken to complete the tank design. First, we conducted a hydrologic analysis to determine the precipitation values for Takure and Sunita's water demands. Since this rural village is not located directly near any urban centers or rain gages, these rainfall values needed to be interpolated. Secondly, we conducted a daily time series to analyze how a certain tank size would perform over a given year. We then selected the best tank size for Sunita's needs.

Project Implementation in Nepal

To implement the earthbag home and rainwater catchment design in Nepal, Conscious Impact played a significant role in managing the construction of the earthbag home site and acted as a community liaison. Also, thanks to funding from SCU, each team member was able to travel to Takure for two weeks to participate in the construction, gain a greater understanding of working conditions, visit material suppliers, and meet community members (including Sunita and her family). Team members Makena, Olivia, and advising professor Dr. Tonya Nilsson traveled to Takure in March to help construct the walls of the earthbag home. Team member Nabila Farah traveled in May to implement the rainwater catchment system. Sunita's final home design is shown in Figure 2.

Figure 2. Sunita's finished earthbag home with the final layer of plaster, including a unique elephant design on the buttresses.

Looking Forward

In conclusion, there are two primary takeaways that will improve the quality of this project and its greater impact on safe rebuilding efforts using earthbag technology. First, in terms of engineering analysis, more research needs to be done on the holistic behavior of earthbag structures. Although there is empirical evidence that 55 earthbag homes survived the Gorkha earthquake, there is limited engineering research on exactly what the design capacities of earthbag materials are. Next year, SCU students will be analyzing the behavior of earthbag walls as another senior capstone project. However, there is much work to be done on earthbag behavior, especially in areas such as foundation design. This research needs to include building a full-size model of an earthbag home and putting it through a series of shake-table tests.

Secondly, the continued promotion of earthbag technology is necessary for the public acceptance of this material in Nepal. We are incredibly thankful to Sunita, who was willing to act as a pioneer of this new technology in Takure. While many community members may have had doubts about this foreign building method, Sunita took a risk and continues to act as an ambassador. To further educate community members about this technology, we are compiling our design work and recommendations into a design manual. We plan to share this manual with local masons in Nepal through Conscious Impact's connections. In addition, during the earthbag home construction process, we utilized the labor of Takure laymen and women, as well as local skilled masons. This not only strengthens community relations and gives these villagers a source of income, it also promotes awareness and trust of earthbag technology within the Takure community. We believe our project and corresponding design manual establish some good beginning steps toward the integration of alternative building methods into Nepal's building efforts; however, there is still an uphill battle to overcome the suspicion that stems from the unfamiliarity with this technology.

Authors:

Olivia Carreon graduates with her bachelor's degree in civil engineering from SCU in June 2017. She has internship experience in land development, transportation engineering, and construction. She will be starting her professional career in Pittsburgh, Pennsylvania working for Turner Construction.

Nabila Farah graduates with her bachelor's degree in civil engineering from SCU in June 2017. She has internship experience in architecture and construction and will be starting her professional career in Dallas, Texas working for McCarthy Building Companies.

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Makena Wong graduates with her bachelor's degree in civil engineering from SCU in June 2017. Her emphasis in civil engineering is water resources and management. She is originally from Sacramento, CA and has enjoyed working internationally as an SCU Global Fellow in Kolkata, India as well as on this project. She will be starting her professional career in San Jose, California working for RMC Water and Environment.

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Koe Koe Tech Revolutionizes Healthcare with Smartphone Technology

Since opening its borders in 2011, Myanmar (previously called Burma) has embarked on a mission of healthcare reform. After over fifty years of military rule, closed borders, and chronic under-development, the Myanmar Ministry of Health and Sports has begun investing in the healthcare of its people. Michael Lwin, the managing director of Koe Koe Tech (KKT) and his cousin, Dr. Yar Zar Min Htoo, CTO of KKT, took this opportunity to establish a social enterprise, which aims to improve Myanmar's health system by leveraging the exponential ownership of Android phones in Myanmar that began in 2014. The most recent data show that 92.7% of people in urban areas and 65.9% of people in rural communities have access to a phone. This allows KKT to offer accessible and convenient healthcare capabilities and information to the majority of Myanmar. KKT's initial and most well-known product is maymay, a women's health application that is used throughout the country.

Figure 1: An expectant mother uses the maymay app

One of KKT's core beliefs is that the development sector is plagued by a graveyard of "one-off" applications. These applications are designed to serve a single function and are rarely well distributed or maintained, rendering them useless. In contrast to this, maymay seeks to appeal to women of all ages by providing an ever-growing number of features. Through maymay, pregnant women and new mothers can gain access to weekly health messages and informational quizzes, which are timed to their particular stage in their pregnancy. KKT partners with a wide array of content providers to offer users a variety of health articles and surveys on topics that include maternal health, infant and child health, sexual and reproductive health, nutrition, infectious and chronic diseases, and gender-based violence. Users can access telemedicine through a registry of 1,500 Population Services International (PSI) Sun Clinic doctors, and 10,000+ Myanmar Medical Council doctors. Nurses and midwives will also soon be added from other clinical settings. The application also has an online shopping feature to allow users to purchase health products, clinician-monitored community chat rooms where women can discuss their unique experiences, hotlines for women in need, and many more features. KKT's team uses rapid prototyping and human-centered design to constantly improve the application and increase its feature list. This ensures that maymay is user friendly and truly useful for the population it aims to serve.

To ensure that maymay reaches as many people as possible, KKT partners with international non-governmental organizations that have large rural field staffs, such as PSI, local hospitals and clinics, and midwife-nurse groups. Additionally, the application's content is currently being translated into many of Myanmar's ethnic languages to enable women across the country to utilize the application. As of now, roughly two-thirds

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Addressing Psychological Trauma Related to the Gorkha Earthquake through Writing Therapy

In July of 2015, I had the opportunity to visit Nepal to learn more about the rebuilding efforts following the massive earthquakes just months before. My big question as an educational psychologist was, "What about the mental health of the children?" After talking to several sources working in different aspects of the rebuilding effort, I found out that the Ministry of Education had tasked teachers with the job of helping their students cope with the psychological trauma from the earthquake. Having taught school in Nepal myself, I realized what an imposition on Nepalese teachers this really was.

The Psychological Impacts of the Earthquake

It is highly likely that there are deep psychological scars left by the trauma of the Gorkha Earthquake and the aftershocks which followed. Common mental health effects of children who survive significant natural disasters include high incidences of post-traumatic stress disorder (PTSD), high anxiety levels, anxiety-based disorders, depression, safety and security concerns (including separation anxiety), sleep problems, somatic complaints (e.g., feeling pain or other physical symptoms because of psychological reasons) and substance abuse (Le Greca & Sliverman, 2012). Furthermore factors that can exacerbate these negative mental health issues are generally present in many of the populations most affected by the 2015 Gorkha Earthquake. For instance, major life events following a disaster can increase the difficulty in coping (Le Greca & Sliverman, 2012). Major life events include loss of a significant person, displacement from the home or place of school or parental work. The Gorkha earthquake caused at least 8.1 million Nepalese to have major life events. Death of a loved one is related to higher incidences of PTSD (Le Greca & Silverman, 2012) and approximately 9,000 people perished in the quake. Furthermore loss of possessions and disruption of everyday life lead to higher stress, which leads to more difficulty coping and that can lead to higher incidences of PTSD. Additionally, the duration and intensity of the threat, especially multiple exposures to the threat can increase negative psychological symptoms (Le Greca and Silverman, 2012). The thousands of high-magnitude *(continued on page 10)*

More Than Lighting: Women Entrepreneurs Turn Solar Technology Into Opportunity

Note: this article is reprinted from nextbillion.net. For the more than 1.2 billion people in the world living without electricity, lighting at night is a huge challenge. Many rural homes rely on kerosene lamps, which cast poor light, can be toxic to their users, and (when knocked over) burn some 2.2 million children a year. Among the world's poorest people, purchasing kerosene can consume up to a third of their total income.

It is estimated that 95 percent of the world's people without electricity live in sub-Saharan African or Asian countries. In these areas, solar-powered lanterns offer a promising alternative to kerosene lanterns. Some observers have suggested that the solar-powered lamp will be the technology gadget that "can most quickly improve the lives of the world's poorest people," especially since many now incorporate phone-charging features.

In the summer of 2016, a team from Santa Clara University's Miller Center for Social Entrepreneurship conducted action research in Tanzania—a country where only 7 percent of the rural population has access to electricity. The Miller Center research team worked in conjunction with Solar Sister, a social enterprise that uses networks of local women to directly sell solar lanterns in remote communities in rural Africa. Solar Sister's mission is to eradicate energy poverty by empowering women with economic opportunity.

The survey research of more than 250 women in 20 villages found that beyond their ability to provide better lighting, solar-powered lanterns had even more comprehensive and far-reaching effects in the communities where they were used in areas such as education, health, productivity, finances and women's economic and social empowerment.

Solar Technology Meets Innovative Business Model

Solar-powered lanterns generate no smoke or noxious fumes. They don't start fires. They can be touched safely without burning people's skin. There's no liquid fuel for children to accidentally ingest, and once purchased they require no ongoing refueling costs.

A good technology solution for a problem such as energy poverty is necessary but not sufficient; the technology still has to get into the hands of the people who need it. For that, a distribution model that meets the needs of the communities affected is an equally powerful innovation.

Many organizations, including a number of social enterprises, offer solar lanterns to rural households in developing countries as an alternative to kerosene lamps or candles. Solar Sister is *(continued on page 7)*

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of maymay's 30,000 monthly active users are pregnant women and one-third are single women and new mothers. One significant challenge that maymay faces regarding increasing user acquisition is Myanmar's low levels of technological literacy. The country offers an interesting dichotomy wherein most people have access to smartphones but few know how to truly use their features. For example, user testing carried out by KKT's team has shown that the average citizen in Myanmar does not know how to download an application, does not always understand what buttons on a screen are for, and does not have an email address. KKT finds the latter to be a serious barrier to user acquisition as email addresses are required for application downloads from the Google Play store. Some platforms, like Facebook, have moved towards accepting phone numbers in place of email addresses, allowing Facebook to flourish in Myanmar. Over 800,000 people have tried to download maymay, but only a tiny fraction have succeeded, as most people get stuck at the Google Play store due to the lack of an email addresses. KKT is currently user testing various methods to work around this issue, such as utilizing direct download sites and increasing partnerships with networks of rural community health workers.

Figure 2: Nurses use the maymay app

One key strength of KKT, and a firmly held belief, is that there is great power in local people producing products for the local population. Health development is often led by foreigners and supported by local staff. However, KKT started as a local company and continues to prioritize the hiring, training, and empowerment of local staff members. In a company of 42 individuals, 40 staff members are Myanmar nationals. This emphasis on the importance of local staff also helps build the capacity of Myanmar's health and technology sectors. KKT states that this mentality is what enables them to create products that are significantly more relevant to the local context, meet the unique needs of Myanmar's people, and have an agility that is not present in many development organizations.

The Global Social Benefit Institute (GSBI) of the Miller Center for Social Entrepreneurship at Santa Clara University aims to mentor social entrepreneurs who seek to develop sustainable and innovative solutions to the world's most pressing social problems. As a participant in the GSBI Accelerator program, KKT was mentored through its initial stages of development and business scaling by experts at the Miller Center. To expand their work to include students, the Miller Center annually recruits students to form interdisciplinary research teams for the Global Social Benefit Fellowship. In 2017, this prestigious program was awarded the Cordes Innovation Award in Academic Student Learning by AshokaU for extraordinary university involvement in social entrepreneurship education and innovation. This summer, the Miller Center is partnering with KKT by sending three undergraduate students to consult and produce social impact assessments, training videos, and marketing materials to supplement the efforts of KKT. The authors and 2017 Global Social Benefit Fellows, Esther Bartlett, Athena Nguyen, and Emily Alonso, will spend six weeks in Myanmar exploring the holistic mission of KKT and to help the company accomplish the United Nation's third Sustainable Development Goal, which is to "ensure healthy lives and promote the well-being of all at all ages."

Currently, KKT operates using grants and fellowships as revenue streams. For instance, KKT recently received US $150,000 from USAID Development Innovation Ventures. However, KKT hopes to move towards a more financially sustainable business model as revenue begins to come in from advertisements featured in the maymay application. While KKT is a fairly young social enterprise, its potential to scale and promise to revolutionize access to health information in Myanmar has attracted investors and organizations all over the world. The fellows aspire to evaluate and assist KKT with defined metrics and data that will help increase KKT's ability to measure and accelerate its progress.

The maymay application is primarily distributed by midwives, nurses, and KKT marketing staff, who promote the benefits of the application to their female patients. However, in an effort to expand this client base, Bartlett and Nguyen will conduct interviews and surveys with customers and potential-customers on the outcomes and perceptions of the application. In total, data patterns will be analyzed to understand how the application influences changes in knowledge of women's health information, services, and changes in key health behaviors. This information will help understand why—and potentially why

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Figure 1: Solar Sister SSE demonstrating products. (Photo Courtesy of Santa Clara University)

(continued from page 5) one of the most successful of these organizations, at least in part because of its innovative business model.

Solar Sister's social enterprise business model centers on women-run direct sales networks made up of Solar Sister entrepreneurs (SSEs). Once trained by Solar Sister, the SSEs purchase solar-powered lanterns from the social enterprise and resell them to family, friends and neighbors—thereby building "trust networks."

According to Miller Center survey research results, these trust-based social networks are one of the main reasons participants chose to purchase their solar-powered lanterns from Solar Sister.

Solar-powered Lanterns: More than just Lighting

The Miller Center survey found that in addition to lighting homes, solar lanterns are transforming what rural Tanzanians do at home when it's dark.

Based on survey findings, here are some of the ways that solar lighting technology is making a difference in the lives of the communities that Solar Sister serves:

- More time for education. In households using solar lanterns, children have more time to study, read, and complete homework at night. An overwhelming 90.6 percent of survey respondents reported that their children's academic performance improved after they started using solar-powered lighting.

- Reduced health risks. More than two-thirds of the Miller Center research survey participants experienced negative health effects such as coughing and cold or flu symptoms while using kerosene lamps. In addition to not causing these health problems, the solar lanterns also prevent the developmental impairment suffered by children exposed to even low levels of kerosene fumes.

- Increased productivity. According to survey respondents, solar lanterns boosted productivity by eliminating travel time required to purchase kerosene, increasing available lighting time after sunset, and allowing people more flexibility to shift the timing of tasks throughout the day. Respondents who increased lighting at night by 1.8 hours daily were able to gain approximately 657 hours, or 27 days, of increased productivity per year. And solar lantern users can now perform activities such as cleaning clothes or preparing school lessons at night, rather than during the busier afternoon hours.

- Larger household incomes. Solar lanterns increased household incomes among Miller Center survey participants in many ways. Families saved money by not having to pay weekly kerosene refueling costs, and they used that money instead to invest in their children's education or to pay for food and water. Some Solar Sister customers used their savings to join a savings group and take out loans, which gave them more control over their financial decisions. In addition, people had more time to devote to income-generating activities, such as making items to sell (e.g., woven baskets, chapatis and other food items, and jewelry), farming, taking care of animals and providing services such as sewing or making repairs. And, of course, the SSEs themselves were able to generate incomes to boost their family budgets.

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Khagendra GC, Esq., and Tara Niraula were instrumental in the formulation of bylaws for ANMF and its successful registration as a 501 (3)(c) organization in the state of New York. After a one-day meeting held in July 1997 at the Brandeis University in Waltham, Massachusetts during the annual convention of the Association of Nepalis in the Americas (ANA), the first board members and executive committee members were nominated, Dr. Arjun Kaki became the founding president of the ANMF.

In 1998, the first independent annual convention of the ANMF was held in the meeting hall at Columbia University, New York and was organized by Tara Niraula (a PhD student at Columbia at the time). Dr. Seaborn Beck Weathers was the first person to obtain a lifetime membership. It is noteworthy to mention that Dr. Beck Weathers' death-defying expedition to the "top of the world" was later featured in the 2015 movie Everest.

Important individuals: Many contributed to the establishment and early growth of the ANMF, namely Shankar Rai, Kristin Stueber, Libby Wilson, Gaury Adhikary, Bhargab Dixit, Janak Koirala, Robert Gerzof, Brendan Thomson, Richard Katzman, Roshan Shrestha, Shiva Gautam. Fred Shepardson developed the website and introduced ideas for soliciting, funding, and managing projects in Nepal. Julia Shepardson brought invaluable expertise to guide the financial, tax, and legal aspects for the foundation. It is with pride that we can affirm that many of these stalwarts of the ANMF are still actively supporting the organization. Subsequently, individuals who contributed their time and effort include Rupa Hamal, Bill Brewster, Hillary Liss, Scott Meskin, Rekha Hamal, Allison Brustin, Marvin Brustin, and Nabin Shrestha, among others.

ANMF-Nepal: As the ANMF started its work of supporting health-related projects and conducting CME (continuing medical education) activities in Nepal, the acute need for a partner within Nepal was recognized; thus, America Nepal Chikitsa Pratisthan (or alternately the ANMF-Nepal) was registered in Nepal in 2000 and was initially led by Dr. Prativa Pandey. Other members at the time included distinguished physicians of Nepal including Bhagwan Koirala, Mahesh Khakurel, Shankar Rai, Mark Zimmerman, Saroj Dhital, and Ram Kumar Ghimire. The ANMF-Nepal has successfully identified and prioritized needs, maintained oversight of various projects, and has disbursed funds to approved projects.

ANMF members: strength of the organization

Today, the organization has over a 100 lifetime members and thousands of supporters. Many members are physicians originally from Nepal, currently residing in America and who have completed their medical schooling in Nepal and even worked in local rural or urban hospitals there. They are, therefore, well


Figure 2: ANMF in Nepal 2001

acquainted with the realities of health issues and health-care delivery in Nepal. Other members are Americans who have traveled to Nepal, have worked or lived there, and have maintained a deep desire to help Nepal. This provides an opportunity to foster extensive local connections to medical schools, health facilities, medical personnel, other local organizations, and the Nepali government. Furthermore, ANMF-Nepal members are distinguished physicians who practice in various institutions within Nepal. This allows the ANMF to accurately and promptly identify health care needs in Nepal, not only in delivery of care but training and transfer of skills as well.

One of the important collaborations of the ANMF has been with CAN-USA (the former name of GNPN) and American Society of Nepalese Engineers (ASNEngr). These Nepali professional organizations used their expertise in the fields of medicine, engineering, and communications to publish the comprehensive position paper on earthquake preparedness in Nepal. In a strange twist of fate, the position paper was in final edit and publication phase when the 2015 earthquake struck in Nepal.

ANMF works: Highlights

Post-Earthquake: Following the catastrophic earthquake of 2015 that killed thousands and rendered thousands more homeless in central Nepal, the ANMF expanded its mandate to provide acute medical needs (i.e., food and shelter to the suffering villages.). The moment the world received the heartbreaking news of the earthquake, our newer, energetic and tech-savvy members like Bijay Acharya and Ruma Rajbhandari started using social media to raise funds. Other newer members—Prakash Thapaliya, Nitesh Upadhyay, Santosh Sapkota, Bhupesh Khadka, Dinesh Mainali, and several others—worked day and night with experienced senior members to assist Nepal in this tragic moment. Money raised from online and

traditional fund-raising drives amounted for well over US $1.5 million. The world poured out their hearts and the ANMF did not disappoint. While the ANMF in the US was collecting donations and sending funds to Nepal, members of the team in Nepal—Jyoti Bhattarai (president), Bhagwan Koirala, Bhupendra Basnet, Arun Kunwar, and several others, along with US board members, Janak Koirala, Sunil Sharma, and Scott Meskin—rallied young doctors in Nepal. They not only travelled to provide acute relief to the earthquake-stricken villages but also conducted needs assessments and guided other global organizations to the neediest areas.

The ANMF's support efforts have now transitioned into long-term goals involving public health, physical and psychological rehabilitation, and rebuilding of health infrastructure that was destroyed by the great earthquake. Twelve health posts have been built and handed over to the government. Funding support has been provided to build other such health-delivery structures including health posts built by Possible (formerly Nyaya Health) and the Tilganga Institute of Ophthalmology. There are other ongoing activities and training still being carried out in Nepal.

Even prior to the earthquake, the ANMF recognized and supported several worthwhile healthcare-delivery projects, infrastructures, research, and training. These include (and are not limited to) Possible prenatal and pediatric care in far West Nepal, surgical repair of prolapsed uterus in rural Nepal (Prolapse Project in Dolakha, Nepal), first and only Skin Bank, Lumbini Corneal Transplant Project, Karing for Kids rural laboratory project in Rasuwa, Kirtipur Primary Eye Care Service, equipment and machines to several hospitals including Bhaktapur Cancer Hospital and Hospital and Rehabilitation Centre for Diabled Children (HRDC), and BP Koirala Institute of Health Science Pediatric Ophthalmology Unit

Training: Training and the transfer of knowledge and skills to Nepal is of utmost importance to ANMF members. Accordingly, ANMF supported a one-year training program in Singapore to the first and only electrophysiologist in Nepal. It has provided funding and logistic support to pediatric echocardiography training in Canada and externships for Nepali doctors in several subspecialties in the US. In Nepal, ANMF provided training to establish an exemplary neonatal and pediatric intensive-care unit at Patan Hospital. ANMF also funded speech-therapy training to manage post-surgical cleftlip patients and courses aimed at training critical-care nurses in Nepal..

Furthermore, ANMF members have conducted CME activities in conjunction with respected established institutions in Nepal including the Society of Internal Medicine of Nepal (SIMON) and Nepal Pediatric Society (NEPAS) on topics such as internal medicine, critical care, pulmonology, surgery, radiology, neurology, emergency medicine, cardiology, infectious diseases, gastroenterology, advanced cardiac life support (ACLS), and pediatric fundamental critical care support (PFCCS) courses.

Telemedicine can be a great resource to manage patients in rural Nepal. It can also provide a huge training and consultation opportunity between specialists within Kathmandu and doctors in the US. The ANMF is already supporting such telemedincine projects and is looking into supporting more.

The existence of the ANMF is a result of hard work and dedication of many passionate individuals over the years (many names have not been mentioned here due to lack of space) who had the one vision in mind: to improve healthcare delivery to the people of Nepal. All members are voluntary and donate their time, expertise, and money to the organization to accomplish its goal "to promote the advancement of medical training and practice in Nepal."

Author:

Sangita Basnet, MD, CPE, FAAP, FCCM, is an associate professor and chief of pediatric critical care at Southern Illinois University School of Medicine and medical director of the pediatric critical care unit at St. John's Children's Hospital in Springfield, Illinois. She completed her medical school at TUTH in Nepal and pediatric residency training at Cook County Children's Hospital in Chicago, Illinois. She went on to complete her fellowship in pediatric critical care at Washington University School of Medicine in St Louis, Missouri.

Dr. Basnet's overarching vision is to improve child health and health outcomes nationally and internationally. She is keenly interested in healthcare in Nepal. She led a team of 22 medical experts from all over the world to establish a six-bed pediatric and a six-bed neonatal intensive care unit at Patan Hospital in Nepal. She is now leading a taskforce to standardize pediatric critical care in Nepal. She has published and presented widely on pediatric critical care in resource-limited countries and visits Nepal frequently to continue working in the units and training local pediatricians in pediatric critical-care delivery. Sangita has served as a board member of the ANMF for several years and is currently the president of the organization. ▲

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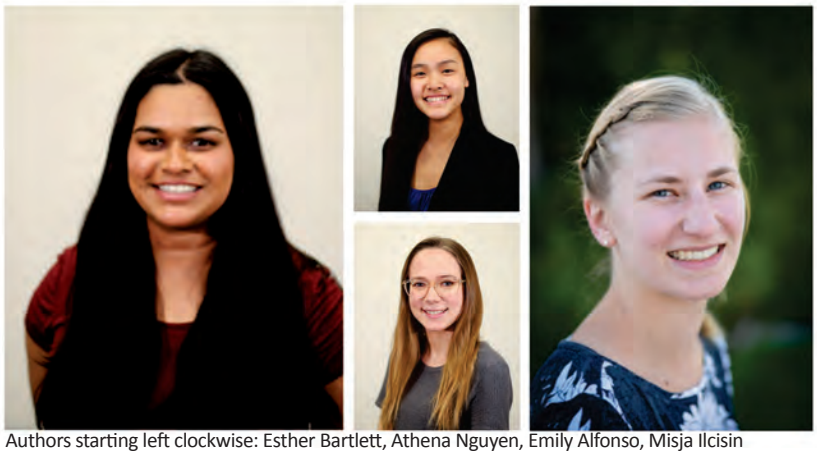
not—the product has been adopted by certain communities and clinicians. Additionally, Alonso will produce two videos for KKT, a short instructional video narrated by a trusted healthcare professional in Myanmar and a marketing video that will follow three women who have successfully used maymay and are now raising healthy babies. The purpose of these videos is to market maymay to potential buyers and inform new users of the application's many functions. The instructional video will play on KKT's and maymay's website, Facebook pages, and potentially in the application itself. The marketing video will be distributed to hospitals and played on televisions in rooms and waiting areas; it will also be on KKT's website and potentially sponsored on social media platforms such as Facebook and Twitter.

The partnership between KKT and the Global Social Benefit Fellows creates a plethora of opportunities for both groups. Through the maymay application, KKT has the potential to create sustainable and effective social change in Myanmar. By spearheading the technological revolution in Myanmar's health education and access system, KKT's team strives to not only provide maymay users with an application that is accurate, convenient, and timely, but also with a truly unprecedented level of access to necessary health services, products, and information.

Authors:

Esther Bartlett, Emily Alonso, and Athena Nguyen are all rising seniors at Santa Clara University, California. Esther Bartlett is pursuing degrees in bioengineering and chemistry in order to become a doctor and perhaps specialize in oncology or emergency medicine. Emily Alonso, a communications major, holds a cinema studies emphasis in order to work in post-film production, music supervision, and music editing. Athena Nguyen will graduate with degrees in public health and political science and aspires to work in epidemiological research and influence public health policy. Misja Ilcisin graduated from Santa Clara University as a 2015 Global Social Benefit Fellow and is now Koe Koe Tech's Operations Associate.



Authors starting left clockwise: Esther Bartlett, Athena Nguyen, Emily Alfonso, Misja Ilcisin

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United Nations Department of Economic and Social Affairs Sustainable Development knowledge Platform, Sustainable Development Goal 3. https://sustainabledevelopment.un.org/sdg3 ▲

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aftershocks that followed the Gorkha Earthquake means that this was also an important factor in the coping of Nepalese people.

Additionally, being younger and having lower economic status leads to higher negative symptoms, especially in children (Le Greca and Silverman, 2012). This is significant because the people who were most impacted by the earthquake lived in the most marginalized communities. Parents themselves had difficulty coping with the trauma from the quake, and parental psychosocial functioning influences child psychosocial functioning (Le Greca and Silverman, 2012), so this is a further problem.

Writing Therapy

How can teachers who are not trained in psychological theories or therapies (or even those who may not even know what psychology is) be expected to counsel their students through such difficult times? Writing therapy is a mental-health counseling intervention that offers a promising solution for assisting these teachers in helping their students cope with the psychological effects of the earthquake. Variants of writing therapy have been used with Dutch and Afghani children and adolescents to treat a number of issues such as PTSD and other acute stress disorders (van Emmerik, Kamphuis, & Emmilkamp, 2008; Kalantari, et al., 2012). A meta-analysis of previous studies also confirmed the effectiveness of this method, especially in treating PTSD (van Emmerik, et al., 2013). Although typically used and studied in a clinical setting, writing therapy may have particular relevance in the Nepalese context; teachers may be more likely to use writing therapy as a psychological intervention because it relates to their educational setting and can be adapted to the academic content they are currently teaching in the classroom. In order to help teachers to help their students cope with the trauma following the earthquake, I developed training in writing therapy and writing instruction. Training in writing instruction was paired with the training in writing

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- Economic and social empowerment of women. For some women surveyed, embracing the new solar-powered technology as Solar Sister customers helped raise their status and respect within the community. The Miller Center survey found even greater benefits among SSEs who reported greater agency, status and control over their resources than their peers who were customers but not sellers of Solar Sister products. The researchers concluded that being an SSE not only provided direct financial benefits, it also motivated the women to develop new skills, travel and meet new people, engage in leadership roles that broadened their social networks, and helped them become more confident.

Solar-powered lanterns are a great example of how technology, combined with innovative and community-appropriate sales and distribution models, can help address serious issues in the developing world. The Solar Sister results, as captured by the Miller Center survey research team, demonstrate the power of innovation, entrepreneurship and women's economic empowerment.

Author:

Thane Kreiner is executive director of the Miller Center for Social Entrepreneurship at Santa Clara University, where he is also Howard and Alida Charney University Professor of Science and Technology for Social Benefit. He was previously founder, president, and CEO of PhyloTech Inc. (now Second Genome) as well as founder, president, and CEO of Presage Biosciences Inc. He was the startup president and CEO of iZumi Bio Inc. (now iPierian). Prior to his efforts as a "parallel entrepreneur," he spent 14 years in senior leadership roles at Affymetrix Inc. He earned a master's in business administration degree from the Stanford Graduate School of Business; a Ph.D. in neurosciences from Stanford University School of Medicine; and a bachelor's degree in chemistry from the University of Texas, Austin.

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Solar Sister, https://www.solarsister.org/ ▲

Water, Water, Everywhere, But Not a Drop to Drink: Working with Engineers Without Borders in the Amazon Rain Forest

By Chuck Corley, Digital Design Engineer, Santa Rosa, California, USA

Last summer our local engineers from the Sonoma Countẽ branch of Engineers Without Borders traveled to the Peruvian Amazon rainforest to construct a water project in the native village of Nuevo Loreto. Up to three meters of rain per year falls on this village of 105 people. But ironically, even with this much water falling from the sky, it is very difficult for them to find any safe water to drink.

The Problem:

According to the United Nations, water-related diseases are responsible for in 80% of all illnesses and deaths in the developing world. This means that people without clean drinking water become sick five times more often and die five times more often than those in developed countries with clean drinking water. Wikipedia lists 21 different diseases that are caused by water-related contamination, giardiasis, cholera, and dysentery to mention a few.

The Amazon jungle temperatures and the abundant wildlife and their excrements make it difficult for any water that has touched the ground to be clean enough for safe drinking. Waterborne microorganisms include protozoa and bacteria, many of which are intestinal parasites which can invade tissues or circulatory system through the digestive tract. Various other waterborne diseases are caused by viruses. In addition to those nasty water problems, upstream pollution caused by mining can make the river water even more polluted and dangerous for drinking.

Engineers Without Borders USA:

In April of 2000, a member of the Belize Ministry of Agriculture asked Dr. Bernard Amadei (professor of civil engineering at the University of Colorado Boulder) to visit and evaluate the community of San Pablo. Dr. Amadei discovered that the lacked clean water and sanitation. Because of this, instead of going to school or participating in other childhood activities, the Belizean children spent most of their time walking for miles, carrying the water their families needed for irrigation and drinking.

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therapy in order to increase teacher buy-in and effectiveness of the therapy.

While training and information are important, once the teacher closes the door to the classroom it is up to the teacher whether and how much any particular pedagogical approach might be used. In order for training to be effective and useful, the pedagogical method must have an understandable rationale, must be simple to implement, require low time commitment, have easily available materials, and be clearly related to academic content. I was confident that writing therapy satisfied all of these requirements.

Figure 1: Elementary school in Gorkha, Nepal participates in writing therapy. Photo taken by Basanta Devkota in 2016.

Writing Therapy Training in Nepal

In June of 2016, I delivered training to teacher trainers at the Ministry of Education's branch called the National Center for Educational Development. I also conducted separate training sessions at a government school in the foothills of Lalitpur and at a healthpost in Backcheck, Gorkha.

There was a high level of interest and engagement in the training at all three training sites. The training required participants to actively engage in writing therapy and to create writing assignments including prompts, ways to support background knowledge of students, ways to help students plan their writing, objective forms of grading, and motivational responses (written and verbal). These concepts and activities were new to most of the participants, yet they were able to create clear, organized assignments that were related to the curriculum already in use.

Additionally, there was much interest in creating journals for students to use in writing therapy. Participants at all sites commented that the journal was something that could be easily integrated into the existing frameworks because it does not require extended time, and the necessary resources are easily accessible. Furthermore, many participants expressed the utility of journals for helping students to cope with the psychosocial issues. This was especially true of the participants from the Gorkha training where many participants indicated that they wished to have further training on these topics for at least four to five days instead of just one. This is particularly notable because I was unable to offer the usual monetary compensation for attending training, and several participants had to walk six to seven hours one way to reach the training site.

During the training, I encountered several issues, including gender equality and adequate access to mental-health support. The idea was for the training to be an example of student-centered teaching. However, student-centered teaching works best when all students feel the freedom to express themselves, regardless of gender or other status. Though I tried to create an environment where all ideas were equally valued and heard, not all participants voiced their ideas, and this created a learning environment that was not equal for all participants. I noticed that many females in mixed-gender groups demonstrated high-quality work and ideas in their individual notes but did not share them with their male group members or the larger group in the training, even though I encouraged them to do so.

Another issue was the lack of equity in access to necessary mental-health support. While teachers and trainers in the Kathmandu Valley had familiarity with some type of psychosocial therapies, the participants from Gorkha reported no familiarity. I found this upsetting, as this is the group that is truly in most need of such therapy.

Furthermore, participants in Lalitpur shared their worries with me that several of their students were likely to have PTSD following our discussion of the topic. Luckily, I was able to refer them to a free clinic at the Kanti Children's Hospital. In contrast, I was unable to offer the same guidance to the teachers from Gorkha.

Next Steps

With the pleas for help from the teachers in Gorkha ringing in my ears, I decided to put together another project to provide further assistance in the form of a service-learning project with my students at California State University, Northridge. Our project was to expand the information from the training and create a manual that could easily be used by teachers throughout Nepal to help their students and communities cope with the psychological trauma stemming from natural disasters. My class worked closely with an English class of Dr. Iswari Pandey (no relation) to create the manual. We are currently editing the manual before delivery to the Gorkha Foundation who will translate, copy, and distribute the manual to teachers in the Gorkha district of Nepal.

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The community had the resources and desire to make the situation better, but they lacked the engineering skills needed to implement a project. When he returned from his trip, Dr. Amadei arranged a partnership with the village where eight of his University of Colorado engineering students and another civil-engineering expert designed and assisted the villagers in building a clean-water system powered by a waterfall. This was the first Engineers Without Borders project.

In 2002 Dr. Amadei formally founded Engineers Without Borders USA (EWB-USA). The organization consists of both university-student chapters and professional-engineer chapters. There are now 16,800 EWB members spread across the USA. The goal of EWB is to partner with communities in developing countries to provide the engineering resources needed for creating sustainable solutions to meet their basic human needs while building leadership experience for EWB members. A heavy emphasis is on building sustainable solutions that will last and continue to operate.

Background:

Our local professional chapter works in Peru with the NGO Amazon Promise. Much like Doctors Without Borders (with which EWB is not associated), Amazon Promise is a medical-aid organization that brings medical care to remote native villages. When they find a community that could use engineering help, they work with us as an in-country resource for setting up and executing projects in the villages.

At the village of Nuevo Loreto, we were informed that the already-bad-jungle-drinking-water situation had been become even worse. The local branch of the Yarapa River had been breached by the more polluted Ucayali River, so the polluted Ucayali River water now flowed past the village. Like the Belize community in the first EWB project, much of the children's time at this village was spent fetching water from remote sources.

Figure 1: Members of our team survey the inoperable river water treatment system that had been previously built by another charitable group.

Another charitable group had made an extremely valiant effort to help this village. They built a substantial water tower and river water treatment system that included a generator, an electric river pump, tank water settling and storage stages, and triple-stage filters to clean the river water for drinking. Unfortunately, a few months after it was installed this system could no longer operate due to filter clogging caused by the river water's high dirt and clay content, the lack of trained maintenance personnel, the high cost and scarcity of generator fuel, and the need for filter supplies and parts to operate the system.

Figure 2: Three-stage filtering section from the inoperable river-water filtering system. The hose runs down to the river for pumping the river water up to the settling tanks.

These hard-working villagers didn't give up. But even when they managed to raise additional funds for fuel and filter supplies, during the return trip the boat carrying their supplies sank on the Amazon River, taking down with it their filter supplies and parts. The villagers again persisted and raised money for more replacement supplies, but the parts that eventually arrived didn't work. The remote jungle location had defeated the normal engineering solution that would have worked in a less severe environment.

Our local EWB group developed a completely different engineering approach for the village, a rainwater catchment drinking-water system. It takes advantage of the fact that the Amazon forest climate has year round rainstorms. In order to implement the system two teams would need to travel to Peru.

Behind The Scenes: Trip Prep

One big concern for our team on this trip was the same as the one for the people living in the village—finding enough clean water to drink. Insuring the safety for the team members participating on our Peru projects was also of high concern. We brought bottled water to drink while on the trip, and we hired a local doctor to travel with the team for the entire length of the project. As an extra precaution, the doctor carried anti-venom medicine for the unlikely possibility a team member would be injured by a snake. We say "unlikely" since team members almost always wear rubber boots to reduce the chances of unfavorable snake encounters. Before leaving on the trip, team members received their necessary immunizations for the region and readied their supply of daily anti-malaria medicines. Clothing was treated with insect-repellent Permethrin, and for exposed skin areas, insect repellent with DEET would be applied. Every possible precaution was taken. After all, this was a group of very careful engineers. Safety was our middle name.

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Figure 2: Writing Therapy Training in Gorkha, Nepal. Photo taken by Devendra Pandey, June, 2016.

Future Questions:

There are still two important questions left to address. First, what exactly is the incidence of long-term mental-health challenges facing children in rural Nepal? Second, how effective is the use of writing therapy in addressing those challenges? I will be addressing these questions with research I have planned to conduct during an upcoming trip to Gorkha, Nepal.

Author:

Jo Anne S. Pandey first went to Nepal in 1992 with a study-abroad program through Pitzer College. After graduating from Pitzer College with a B.A. in psychology and anthropology, she went on to the University of Hawaii's at Manoa for her M.Ed. in educational psychology with a thesis about differences in attributions of Hawaiian and Nepalese children. Jo Anne received her Ph.D. in psychological studies in education from the University of California, Los Angeles (UCLA) in 2003. Upon returning to Los Angeles, Jo Anne has been active in the Nepalese community there. She was one of the founders and the first president of Friends of Nepal, Los Angeles. She currently is teaching at California State University, Northridge in the Child and Adolescent Studies department and is conducting research on the effectiveness of using writing therapy in Nepal as well as researching the effects that visits by authors of children's books have on the motivation of elementary students to read, write, and revise.

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Our Project:

Our rainwater catchment system used the village schoolhouse's roof as a rainwater collector by adding gutters and plumbing to the existing metal roof. The initial water coming off the roof could possibly be contaminated by birds or other animals that had been on the roof, so it was diverted away from the storage tanks by a simple passive "first flush" system. We determined the amount of water necessary to divert and flush to the point the water would become acceptably clean based on studying rainwater harvesting research from the University of Texas.

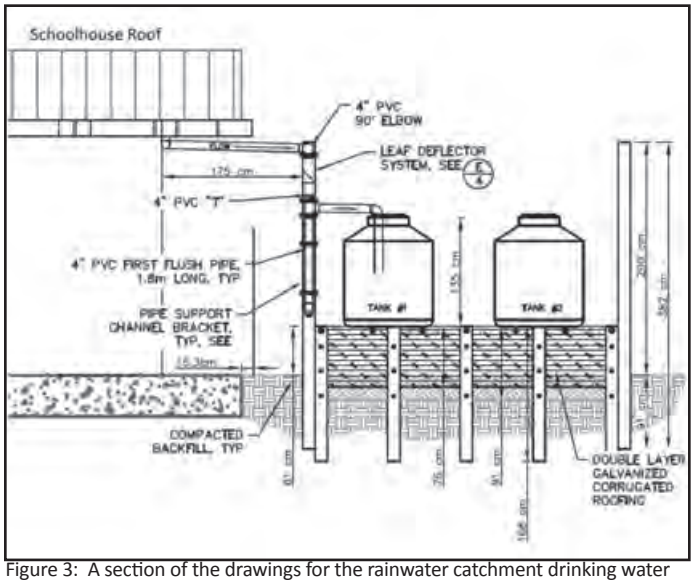

Figure 3: A section of the drawings for the rainwater catchment drinking water system.

Once the first water is sufficiently flushed, it is treated by running the incoming water over chunks of chlorine tablets before flowing

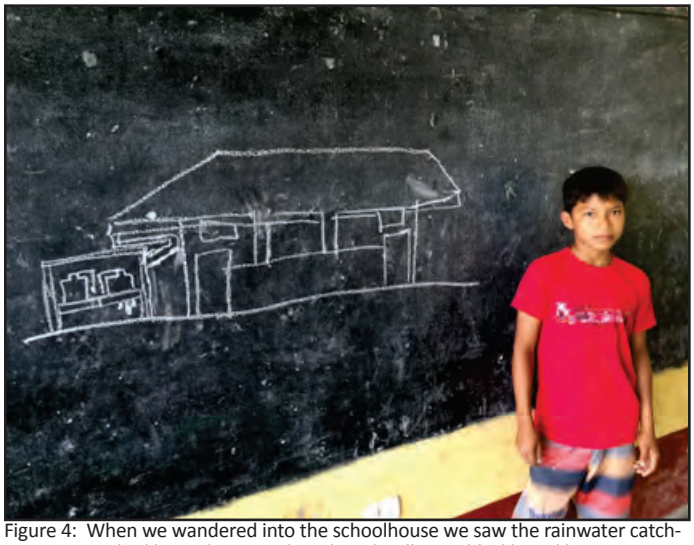

Figure 4: When we wandered into the schoolhouse we saw the rainwater catchment system had been diagramed on the schoolhouse blackboard by Roy, one of the students. Roy often pitched in to help us build the water system when school was not in session. From his drawing skills we suspected he could be a future engineer if the proper educational opportunities were made available to him.

Figure 5: A child takes a drink as finishing touches are made to the water system. The activated carbon filter used for removing chlorine from the water is the blue canister in the center.

into storage tanks. Before the water from the tanks flows into villager drinking water containers, the chlorine (and its chlorine taste) is removed by passing through a single activated carbon filter.

For regions that have sufficient year-round rain, this type of system has many benefits, foremost among them is reliability. It is also much less expensive to build and very inexpensive to operate since the system runs completely on gravity, that is there are no pumps or moving parts and thus no expensive generator or fuel to have to buy. Since the fairly clean rainwater hasn't touched the ground, less filtering and chemicals are needed. In Peru, chlorine is available and is inexpensive compared to other chemicals. The main cost of operating a system like this is about $10 yearly for the chlorine and about $125 for the carbon filter (which must be replaced every 12 to 17 months). The villagers collect a monthly usage fee to support the replacement of these chemicals and parts. We are currently working on finding ways to reduce these operating expenses even further.

This was our second construction trip, and the third system of this type our group has built in the Amazon rainforest of Peru. For the Nuevo Loreto system described here, we used rammed-earth construction techniques to reduce the construction and transportation costs. A motion-lapse video of the construction of the Nuevo Loreto system is available on our YouTube channel: tinyurl.com/ewbsonoma-youtube

Conclusions:

It was very rewarding to assist with a project that had significant health and wellness benefits for the adults and children of the village. In this region there is far more demand for our help than we can supply. A clone copy of our system has now appeared in another village. We want to encourage this kind of copying so

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Figure 6: Sonoma County EWB Team #2 and some of the villagers who participated in the construction. The members of the village water committee who've just completed system maintenance and support training hold their training certificates.

that more villages in the area can make use of our design, as there are many more villages needing help in this area than we will be able to assist. We are now starting to work on developing additional documentation and training materials so that other villages in this area can construct their own rainwater catchment systems with less direct assistance from our group. In the future we hope to further multiply our effectiveness this way. EWB is an admirable organization; I encourage others to consider becoming involved with a nearby chapter or contributing towards your local chapter or the national organization itself.

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ADDENDUM GNPN JOURNAL SECOND EDITION, JULY 2017

SCUCube, A Low-Cost, Disaster-Dedicated Amateur Radio Satellite

Authors: Matthew Condino, Andrew Drape, Isaac McQuillen

SCUCube Team: Matthew Condino, Andrew Drape, Evan Eberhardt, Cooper McDonnell, Brayton McKnight, Isaac McQuillen, James Olwell, Laura Tschudy

Academic Advisors: Christopher Kitts, Michael Taylor

Amateur Radio in Disaster Scenarios

Disaster relief communications is an area of vital and timely importance. Communications networks must be readily available when disaster strikes so that responders, families, and relief coordinators can work effectively to mitigate damages, loss of life, and any other fallouts that result. Traditional forms of communication are often unreliable during these scenarios and it cannot be assumed that these networks will be available while coordinating relief efforts. Such forms of communication include ground-based radio networks, landlines, and cellular phones. Ground-based applications are directly vulnerable from a physical infrastructure perspective and could easily fall prey to high winds, rising water levels, and earthquake events. Cellular communication often becomes flooded with high usage in disaster areas and thus cannot not provide a reliable, strong link between the different groups and entities involved in disaster relief efforts. Satellite-based communications offer a good alternative to more traditional forms of communication, but often come with a higher price tag; on the order of hundreds of dollars for common satellite phones. The SCUCube satellite project being carried out at Santa Clara University's Robotic Systems Laboratory, which is currently nearing the end of the prototyping phase, aims to provide a low-cost, disaster-dedicated alternative to more expensive satellite communications. The satellite itself takes advantage of amateur radio communications in order to interface with an existing infrastructure, which has been established as a result of both hobbyist and professional interest in amateur (HAM) radio communications. A report to the United States Congress by the Federal Communications Commission described how amateur radio communications are "suited to disaster response in a way that many more advanced forms of communication today are not". This report noted how "the resilience and geographical dispersion of amateur radio networks played a critical role in direct disaster response during Hurricane Katrina" (H.R. Rep. No. 12-1342). This is just one, among many, testaments to the efficacy and usefulness of a communications node such as the SCUCube satellite's amateur radio payload.

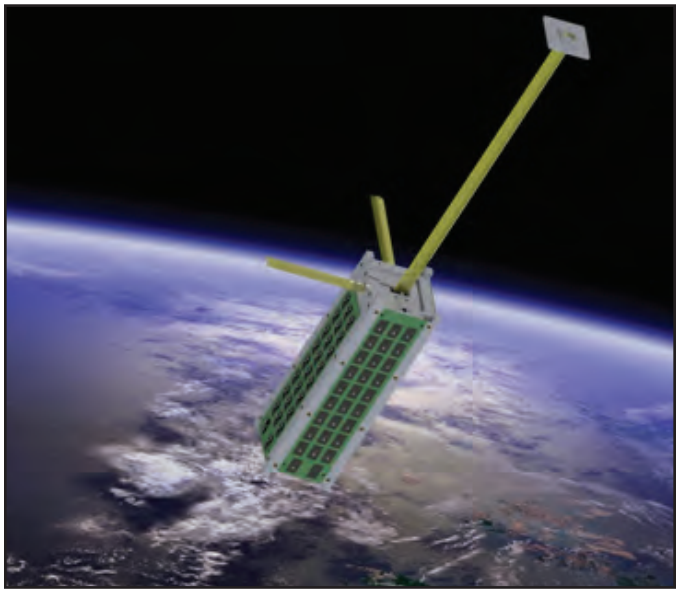


Figure 1: Render of the SCUCube Satellite in Low Earth Orbit

Existing Amateur Radio Satellites and Disaster Relief

Amateur radio satellites have historically aided in disaster relief efforts. OSCAR (Orbital Satellite Carrying Amateur Radio) satellites contain amateur radio transponders and are therefore able to be used by amateur radio operators in the event of a disaster to serve as communications nodes. Many of these satellites act as repeaters, meaning they are able to simultaneously receive a signal at one frequency and rebroadcast the signal at a second frequency. For example, the CAMSAT XW-2 satellite constellation consists for 6 satellites that each contain linear transponders that operate at 435/145 MHz as well as a dedicated AX.25 downlink radio. These satellites are used primarily as orbiting repeaters which may receive a transmission in the 435 MHz band and rebroadcast at 145 MHz (Amsat-uk.org). This allows a message to be broadcast over a much broader area, allowing amateur radio operators who normally couldn't communicate to pass messages back and forth.

The vast majority of amateur radio satellites currently in service operate as repeaters, as described previously. There are several satellites, such as LilacSat-2 that contain digipeaters and other equipment designed for packet radio applications, but the vast majority of amateur radio satellite rely upon voice communications. Because there is a lack of amateur radio satellites offering packet radio services, SCUCube could provide vital communications services with its dedicated packet radio payload.

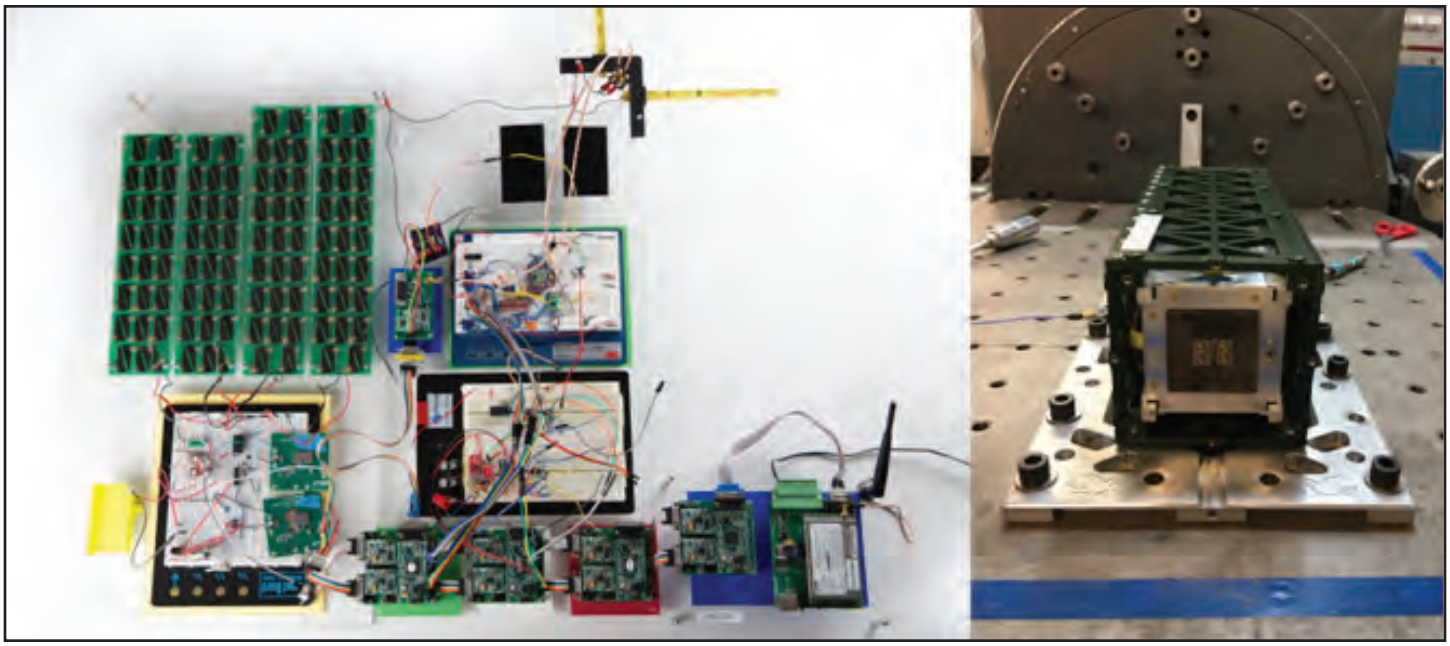


Figure 2: Left- Flat-sat configuration of the SCUCube satellite currently being tested. Right- Assembled SCUCube structure inside testing P-POD for vibration testing.

SCUCube Satellite

SCUCube is an amateur radio communications Cubesat designed to be a communications node during a disaster scenario. The satellite conforms to the CubeSat 3U standard, and is 10cm x 10cm x 34cm in size with a weight of 2.5 kgs. Cubesats are an increasingly popular type of satellite due to their low cost of manufacturing. In addition, the standardized size of Cubesats allows a variety of launch adapters, such as the P-POD or NanoRacks deployer, to be used to launch the satellite. This results in significantly reduced launch costs for Cubesats. The satellite is in the late prototyping phase and is currently configured as a flat-sat with all of the circuitry wired as it will be in the satellite structure. The SCUCube project is part of Santa Clara University's (SCU) School of Engineering and partially funded by SCU's Miller Center for Social Entrepreneurship's Roelandts Grant program.

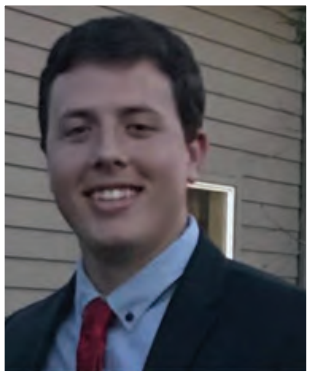
SCUCube contains many support subsystems that maintain the health of the satellite and ensure its proper functionality. The satellite contains an electronic power system that collects solar energy with body mounted solar panels and regulates this energy to provide power to the rest of the subsystems. The satellite also contains an S-Band radio for command and control of the satellite, and features decentralized command and data handling. Notably, the satellite uses a semi-passive gravity gradient stabilization technique for attitude control. An end mass is deployed from the satellite which has the effect of aligning the satellite with the local vertical such that the satellite will always point towards Earth. This technique only uses power for the initial deployment of the boom, as opposed to active control devices such as reaction wheels and magnetorquers. This reduces overall power draw within the satellite, allowing the satellite's payload may be active for a larger fraction of the time.

The payload of the satellite is an amateur radio payload that allows data messages to be sent and received. The payload currently supports the AX.25 packet protocol, a popular packet format used by HAM operators globally. The payload radio operates at 437.1 MHz with Frequency Shift Keying (FSK) modulation and uses a data rate of 9600 bits per second with a bandwidth of 1kHz. The design team chose to use packet radio since it offers very quick communications speeds in contrast to voice communication which has traditionally been used for emergency communications with amateur radio. The payload is intended for use with any ground station that is able to properly decode AX.25 packets.

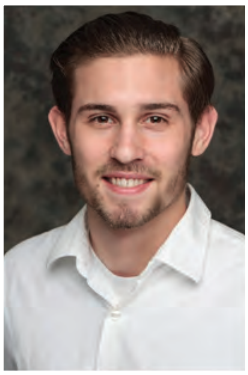
Currently, the SCUCube project is nearing the end of the prototyping phase. Final versions of circuit boards for the attitude control system, payload, and electronic power system are being tested. In addition, the structure of the satellite has been successfully vibration and shock tested, showing that the design meets specifications, as outlined by the Cubesat Standard. As part of the structural testing the satellite passed the all-important "fit test", in which the team confirmed the final size of the satellite, and that the satellite will be able to interface with a standard deployer. The team hopes to integrate all the electronics into the structure in the coming months and continue to test the system in order to validate that it will function as intended on orbit.

Though there are only plans to build and fly one SCUCube currently, there is great potential for increased ground coverage and user interaction if a constellation of satellites were to be used. Upon final validation and verification of the current design, future Santa Clara students could upgrade the satellite bus with a crosslink radio that would allow two satellites on orbit to communicate with one another. This would result in a low cost communications network in low earth orbit that would allow users in different parts of the world to communicate solely through amateur radio, which could be very beneficial in a disaster scenario.

Matthew Condino



Isaac McQuillen



Andrew Drape

Applications of SCUCube

For the HAM radio aboard the SCUCube to be effective in disaster relief situations, a small portable communication system must be available to the organizations assisting in these times of need. Although a basic HAM radio with a TNC decoder will provide full communication capabilities to these groups, future work at Santa Clara University will be devoted to developing a small, inexpensive, easy to use, portable system that can be distributed to relief organizations and NGO's. Because of the SCUCube's wide range of communication abilities, these organizations will be able to use the system in whatever manner best fits their needs. One such capability of the SCUCube is message storing and forwarding. This function can currently be used from the Santa Clara University ground station, and future work will make this available for all ground stations. This allows a message sent by one organization to be accessed by other operators all around the world. Using the SCUCube communication link, NGO's could pass messages along to other NGO's working in the same disaster region, and send messages outside of the region to global headquarters. These organizations would be able to quickly send and receive timely information that would otherwise be unavailable with traditional forms of communication. Additionally, this information will be available to satellite operators at Santa Clara University who could take said information and make it publicly available. Depending on the specific needs of each organization, the HAM radio communication payload can easily be used to optimize assistance efforts globally.

References:

[1] H.R. Rep. No. 12-1342 at 10039 (2012). Print.

[2] Amsat-UK. "CAMSAT XW-2 Satellites". Web. Retrieved 5/29/2017. https://amsat-uk.org/satellites/communications/camsat-xw-2/

Matthew Condino is a Mechanical Engineering Major and Mathematics Minor graduating from Santa Clara University in June 2017. Matthew was the project lead for the SCUCube mission and helped coordinate the team's efforts. He worked on both the software and the hardware for the amateur radio payload onboard the satellite as well as attitude control simulations. Matthew will be pursuing a Master's Degree in Mechanical Engineering with a focus in Robotics and Mechatronics beginning in the fall at Santa Clara University.

Andrew Drape is a Mechanical Engineering Major and Electrical Engineering Minor, graduating from Santa Clara University June 2017. Andrew was the Electronic Power System Engineer for the SCUCube mission. After graduation he will be working as a Test Engineer at Moog CSA Engineering while attending graduate school at Santa Clara University working towards a degree in Dynamics and Controls.

Isaac McQuillen and a Mechanical Engineering Major and English Minor graduating from Santa Clara University in June of 2017. During his time on the SCUCube mission Isaac served as the lead Structural Engineer, designing, machining, and testing the physical SCUCube satellite. Isaac has worked for the National Solar Observatory on a solar telescope project for the past 3 years and will continue to do so as he pursues a Master's Degree in Mechanical Engineering at Stanford University, with an emphasis in Thermofluids, next fall.

eBlackboard 'Empowering Students with Technology'

By Avideep Pradhan, Abin Pradhan, and Nabin Acharya

eBlackboard is an organization of passionate volunteers working to make a difference in the process of delivering education in developing countries like Nepal using low-cost power efficient computers. With easier access to various educational materials in the modern world, advancement of technology, low cost computers, and lower power usage devices, it is now possible to enhance the learning experience for students worldwide.

Established in Charlotte, North Carolina, eBlackboard works directly with local non-profit organizations in Nepal by providing the technology and guidance to successfully implement low-cost, power efficient computer labs in remote public schools.

We are all aware that the quality and methods of teaching in most of these schools are still very traditional and they don't have the resources or knowledge to take advantage of modern technology. The organization's primary focus is to build a technologically efficient, yet economically feasible computer labs and classrooms in remote schools and provide worldwide accessibility through internet (where ISP service is available). It is eBlackboard's intention to provide a platform for students with optimal delivery of educational content and better experience. Availability of the platform in the internet would allow people with better technical know how to teach and help unprivileged students.

What is eblackboard working on right now ?

The main player in the success of these computer labs is the Raspberry Pi, a credit card-sized computer originally designed for education, inspired by the 1981 BBC Micro and costs $35. Although it has a small footprint, it is packed with a lot of features such as built-in Wi-fi, Bluetooth, 4 USB ports, 1 HDMI, microSD card slot and a 1.2 GHz CPU backed by 1GB RAM.

This can be used as a standalone computer or a file server to keep and broadcast digital content in any form. With the availability of Wi-Fi and Ethernet, it can easily connect to any network and internet using a lightweight browser and run business applications.

Let's look at the problems in deploying technology in Nepal (or any other developing nation). Internet is not widely available in most remote villages. Even where it is available, the data plans from ISPs are prohibitively expensive for those schools which operate under tight budgets. Electrical power is not readily available, although power sources are available at random spots and times. There are very few digital educational content available based on national curriculums contexts and there is no easily accessible technology to deliver such content.

eBlackboard's solution is divided into three parts:

1. Computer Device and Display
2. WiFi Router, Server and Internet Connection
3. Interactive Educational Content

Computer Device and Display

Each computer terminal in a lab is powered by the latest Raspberry Pi card (currently it is Version 3 Model B) which is connected to a large 19" LED monitor. The network is configured to allow other display devices such as personal smartphones, tablets to join the network, where such devices are available. If students can find other random display units in the village, they can use it as it is their own device. In schools where space is a constraint, establishing a lab stand-alone projector-based computer system could also be implemented where the entire classroom is converted into a lab. In this scenario a teacher could use it as a teaching or training tool, allowing students to try out for themselves in turn. It is eBlackboard's long term goal to provide hand-held portable display devices such as digital screens to as many students as possible as their prices come down and the quality improve.

Wi-Fi Router, Server and Internet Connection

Since Raspberry Pi (RPI) cards have built-in Wi-Fi connectivity capability the computers in the labs are connected through Wi-Fi in a closed-loop network. One of the RPI devices is configured as a router and server which houses the educational content being used. The content by default is loaded in the microSD card. However, where larger content is available a portable hard-drive with larger storage capacity (1-3 TB) could be used by just connecting it to one of the four USB ports. The cost of storage has become very affordable as the price of such portable hard drives continue to fall, and eBlackboard is positioned to take advantage of that. Where internet service is available a separate low-cost router could be used to connect all the computers in a Wi-Fi network

Interactive Educational Content

The RPI server device currently hosts a locally developed educational content called E-Paath. The microSD card in the RPI device can also hold other digital contents for educational purpose. eBlackboard is also talking to USA-based organizations like CK-12 (www.ck12.org) which has a plethora of educational content online for free in the USA. Since most content is prepared with the cultural and language aspects in mind they couldn't be just imported and implemented in Nepal. This is an area where there is plenty of room for improvement and growth, both locally and internationally.

Inspirations to eBlackboard

We looked into current challenges in technology, project implementation, creative designs and were inspired by past GNPN presentations on the following projects as they have similar themes and objectives.

- Village Tech Solutions by Skip Stritter and David Sowerwine for producing the Looma platform http://http://villagetechsolutions.org/)

- OLE Nepal for producing E-Paath and E-Pustakalaya. http://www.olenepal.org

It is interesting to note that the problems faced during the implementation of those technology-based projects in these remote villages are not even remotely considered as problems in the developed world, however, these are real problems and challenges we have to deal with to make a project successful. And these challenged can be solved, with a little bit of help from you.

How can you help?

These are some of the areas where we need your help. It could simply be through kind contributions or by helping us with improved designs in the areas listed below. Please contact any one of the eBlackboard team members listed in the contact section of this article.

Power

We have been focused mostly with schools in the outskirts of the Kathmandu valley, where power lines are available to most. Periodic power cuts are a lot less these days, but is not expected to go away entirely. A solar power backup system comprising of a high-wattage solar panel, solar battery and inverter was installed in one of the schools in 2016. It cost more than a third of the total cost of the project. A cheaper solar power backup solution would be highly desirable.

Internet Access

Internet service has become more widely available in most parts of the metropolitan areas and its surroundings in Nepal through the ISPs and telecom companies, however, the cost associated with the service is still very high. If such enterprises can bring the cost down for educational services, or donate funds that pay for the service, it would be helpful.

Educational Content

We currently rely on solutions like E-Paath, but we need more and better solutions. Students in this modern age learn interactively through visual and sound stimulations. Content has to be rich in multimedia to get the students engaged and excited on the learning modules. This calls for creative productions from multimedia software companies and the government to provide subsidy where needed.

Computer Device and Display

A Raspberry Pi Model 3 card today costs $35.00 and Raspberry Pi Zero costs $5.00, while similar products like CHIP computer sells at $9.00. A 19" LED monitor costs about $85. As the costs of the device and monitor decline we would be in a better position to save more and provide more. eBlackboard is looking into the possibility of using used monitors with lower power ratings. If anyone knows how to save on those items please contact a eBlackboard team member .

Youth & NRN Children

One of the goals of this initiative is to involve the youths of Non-Resident Nepalis in making a real-life change on the way the underprivileged students of those remote schools get educated. Even with a small contribution, either monetary or by spending time in the project implementation , they can make a difference in lowering the digital divide in those remote schools in Nepal. At the same time the youths gain invaluable experience implementing a project in a developing country.

Collection of Funds using GoFundMe

We are currently collecting funds to implement the project in four schools in remote parts of Nepal during July-September of 2017 through GoFundMe under the heading "Computer Labs for Schools in Nepal". Please click the link below and provide your support for this great cause.

https://www.gofundme.com/
computer-labs-for-schools-in-nepal

eBlackboard Team

Project Lead: Avideep Pradhan Avideep is a rising junior at ArdreyKell High School with a passion to help those in need.

He does community service in and out of school whenever he gets an opportunity.". While not volunteering he keeps busy as officer of DECA (Distributive Education Club of America) a business and marketing organization, Speech , Debate, and MIT Launch (Entrepreneurship Club started by MIT). He has finished top six in a majority of the local and national competitions for both Speech, Debate and DECA, qualifying both freshman and sophomore year to the final National competition. He enjoys being an active participant in a number of extracurricular activities and always gives his best. He enjoys Track Field and listening and playing music.

Project Coordinator: Abin Pradhan

Currently Abin is working as Vice President in Wells Fargo Co. In his twenty-four years of career span he has accumulated experience in fields such as counterparty risk management, regulatory reporting, business intelligence, telecommunications and large scale donor-funded project management. He was an active member of a Rotary Club in Kathmandu, Nepal and was instrumental in making the Rotary Centennial Everest Expedition a great success during 2005. He holds an MBA (Finance) and B.Eng (Honors) degrees from reputed universities in the USA and the UK. He came to the US as Fulbright scholar for his MBA program. In his past time he likes to go hiking, trekking, camping, listen to music and volunteer. He is married and has two sons, the young one is going to middle school and the elder is a rising junior in high school.

Project Technology Advisor: Nabin Acharya

Nabin is currently working in Nexenta Systems designing Extremely scaleable systems for really large amounts of data. Nabin has had a career in the data storage industry for the last twenty-four years where he has worked for companies like Dell, Yahoo, Brocade and many startups in the Silicon Valley .

He is always plugged-in with the latest and greatest in Technology that makes a difference. He holds a Masters in Computer Science and in his past time he likes to go hiking in the Bay Area. He lives in the Bay Area (Silicon Valley) with his wife and kids. His older kid goes to a high-school and the younger one goes to an elementary school.

With eblackboard, he provides technical advice on the infrastructure and the digital content for educational environments.

Contacts

Organization Website: http://www.eBlackboard.org

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Abin Pradhan (abin.pradhan@gmail.com)

Here are some photos of the use of eBlackboard in Schools in Nepal:

Project Lead (Avi Pradhan) :

Classroom photos for eblackboard