Western Kentucky University

the leading edge

Issue 16, 3rd & 4th Quarter — January 2008 through June 2008

IN THIS ISSUE:

CWRS helped direct Kentucky's FIRST LEGO League State Competition on January 19, 2008

FIRST LEGO League is an international program for children ages 9-14 that combines a hands-on, interactive robotics program with a sports-like atmosphere. Teams consist of up to 10 players with the focus on such things as team building, problem solving, creativity, and analytical thinking. Each September, a new Challenge is unveiled to FLL International teams across the world. Over the course of 8 weeks, students strategize, design, build, program, test and refine a fully autonomous robot capable of completing the various missions of the FLL International "Robot Game" using LEGO MINDSTORMS™ technology. They also search the web, talk to scientists, visit the library and develop compelling presentations based on the FLL International "Research Assignment", which relates to a problem or opportunity facing the world today. The theme of this program was "Power Puzzle".

The KY State FLL Championship brought 46 teams to WKU on January 19th with 258 students in attendance, included FLL – 9-14 year olds and JFLL (Junior FIRST LEGO League) – 6-9 years olds. Approximately 100 volunteers assisted on the day of the tournament. Additionally an estimated 1500 spectators attended the event.

The team scores were determined using 4 parts of competition; teamwork, robot performance, robot design and a research presentation. Each year FLL focuses on a theme that all parts of the competition revolve around. This year teams researched and competed around the area of alternative energy. Teams developed research projects that included conducting an energy audit of a building in their area. Robots were also designed and programmed by the teams to complete tasks autonomously on a competition table in a 2 ½ minute time frame. The winning team (Cyborgs from Mount Washington) went on to the World Festival in Atlanta, GA in April. They then competed against teams from 34 countries and 66 other state championships and won the "Against all Odds" award. Additionally two teams from Owensboro went on to compete in an open Championship in Minnesota in May with one team also winning an award.

Grant Imahara the electronics and radio-control specialist from MythBusters was the guest speaker. MythBusters is a TV program that takes a light-hearted look at modern misconceptions and the bizarre claims of Urban Legends. However this series doesn't just retell the stories… it puts them to the test. Grant is a former animatronics engineer and model maker for George Lucas' Industrial Light & Magic, where he worked on such movies as The Lost World: Jurassic Park, Star Wars: Episode 1 - The Phantom Menace, Terminator 3: Rise of the Machines, A.I.: Artificial Intelligence and The Matrix Reloaded. Grant also operated R2-D2 and developed a custom circuit to cycle the Energizer Bunny's arm beats and ears at a constant rate. He is also the author of the book, *Kickin' Bot: An Illustrated Guide to Building Combat Robots*. His own machine, Deadblow, is a BattleBots champion that continues to strike terror into the hearts of fellow competitors. Everyone enjoyed his speech and participation at the competition, including the four hour autograph session.

Donations were received from Toyota Motor Manufacturing of North America; API and Cyber Defense Lab; WKU Departments of Geography/Geology, Physics, Chemistry, Engineering, and Biology; Sam Evans Dean of Ed & Behavioral Science; Electronic Warfare Associates; Bowling Green Visitors Bureau; Microsensors Systems; Hank Wohltjen; and the Carol Martin Gatton Academy of Mathematics and Science in Kentucky. Publicity was donated by Insight Communication and WNKY. Progeny, Best Buy, API, and Electronic Warfare Associates also donated money to the winning team to fund their trip to the World Festival in Atlanta, Georgia. Design of the t-shirts was donated and t-shirts were provided to volunteers. WKU students, Rebecca Humphrey and K. Paige Davenport, worked with Karla Andrew of the **Center for Water Resource Studies**, who directed this competition.

The 2008 FIRST LEGO League's theme is "Climate Connections". Students will be encouraged to find the links between science, people, resources and communities, as well as learn about past climates and explore our current and future climatic conditions. Each team will try to understand the difference between weather and climate and how climate impacts their community and lives. The next state wide competition will be held in mid January, 2009. Many volunteers are required for a program of this magnitude. Contact John Inman at john.inman@wku.edu if you are interested in being a part of this fun and educational program.

~Submitted by Karla Andrew, Center for Water Resource Studies

Pictured: Grant Imahara, from Mythbusters was the guest speaker for the Lego League State Competition

API Also Sponsors Kentucky's First LEGO League

C.Y.B.O.R.G.S TEAM

Applied Physics Institute helped to support the 2008 Kentucky FIRST LEGO League Robotics Tournament (http://www.kyfll.org/). The competition was held on January 19, 2008 at WKU's Diddle Arena.

This year's theme was Power Puzzle – Alternative Energy. Teams were to build a Lego Mindstorms robot and program them to complete certain tasks concerning the theme. Each team is made up of 4 to 10 children between the ages of 9 to 14 years old.

Both Dr. Barzilov and Novikov were judges at the competition, and Dr. Womble was asked to present the Best Programming Award for the tournament.

Along with funding for the competition API sponsored a team called Creative Young Builders of Robotic Gadgets (C.Y.B.O.R.G.S) who are based out of Mount Washington, Ky. The C.Y.B.O.R.G.S won first place in the 2008 Kentucky tournament and continued on to the World FIRST Robotics Championship.

"I think that it is refreshing that young generations are interested in learning about robots and the technology behind them." stated Dr. Womble. "The C.Y.B.O.R.G.S are a great team and we are proud to support them and the tournament."

~API Sponsors LEGO League Release
-Thank you letter to Dr. Womble from C.Y.B.O.R.G.S team
Submitted by Katie Moore

April 21, 2008

Cyber Defense Lab / API
Att. Dr. Phillip C. Womble
Western Kentucky University
1906 College Heights Blvd #11077
Bowling Green, KY 42171-1077

Dear Mr. Womble,

Just wanted to let you know how much we appreciated your support C.Y.B.O..R.G.S. last week during the World FIRST Robotics Championship. It was truly a momentous experience.

Eighty-two teams competed, more than a third international, in the FIRST (FLL) Competition. The team from Singapore won the actual championship, but we truly feel we represented Kentucky very well. The three days of competition was busy and filled with activity. The team did a great job in the competition and came away with the "Against all odds" award. The award is given to the team that overcomes obstacles to compete at its best and leaves a great impression on the judges. Attached is the brochure that list the Cyber Defense Lab / API as a sponsor.

Just some highlights of the competition. One surprise was George H. W. Bush attended the program and gave a speech Friday before competition started. During one of the table matches, The NASA network televised many segments of the competition and one of our family members taped a close up of our team during the individual table competition. The experience was unforgettable!

This was our first experience with this level of competition and we learned a tremendous amount. Not only, did we learn a lot about ourselves, we realized just how the international competition is growing.

Again, we appreciate your generosity, and hope we represented you and the rest of KY well during our visit.

Sincerely

Stephen Rhodes
Austin Echsner
Grant Holloway
Cody Stemle
David Echsner – Coach
Becky Rhodes, Coach

C.Y.B.O.R.G.S
2008 Kentucky State Champion FLL Robotics Team

API Students Attend Symposium and Director, Dr. Phillip Womble Receives Faculty Award

API STUDENTS ATTEND SPIC SYMPOSIUM

Two students from Applied Physics Institute, Chris Davenport and James Lodmell, traveled to Orlando, Florida, on Mar. 16-20 for the SPIE Defense and Security Symposium (http://spie.org/defense-security.xml), which the defense industry's leading meeting. Two professors from API, Dr. Barzilov and Dr. Womble, accompanied the students, along with an API applications engineer, Lindsey Hopper.

They were given the chance to attend presentations from other students and also from top experts such as, The Honorable Jay Cohen of the Science and Technology for the U.S. Department of Homeland Security and Dr. Delores M. Etter from the U.S. Navel Academy.

Different fields of science and engineering were represented at the conference. Scientists and students from many national and international schools also attended the symposium including, MIT, Texas A&M, University of Kentucky, Michigan State University, University of Ottawa(Canada), Sabanci University (Turkey), Beihang University (China), and University of Canberra (Australia).

Davenport and Lodmell represented Applied Physics Institute for the session of Robotic and Mobile Sensor Technologies and Systems. They wrote a paper to show the research results that they have accomplished at API and also gave a presentation which helped to explain their work on semi-autonomous ground vehicles for defusing IED's.

"The conference was a great networking experience for Chris and James because of the national attention it receives," Hopper said.

Dr. Phillip Womble Receives Faculty Award for Research and Creativity

Dr. Phillip Womble was awarded the 2008 Research and Creativity Faculty Award for the Ogden College of Science and Engineering. This is Dr. Womble's first time to receive an award from Ogden College.

WKU Associate Professor of the Physics and Astronomy Department, Dr. Richard Gelderman along with other colleagues from the Physics and Astronomy Department are responsible for nominating Dr. Womble for this award of high-achievement.

This award can only be given to one professor for each college and is usually evaluated on the number of publications within the past five years along with their amount of current research and creative works.

Dr. Womble is currently the director of Applied Physics Institute (API) and is also the director of the Cyber Defense Lab. He has written over 70 publications which have been presented to both national and international audiences. 22 of his writings have been published within the past five years.

He has continued his dedication by mentoring over 37 students. By making certain that each of his students is consistently involved in research projects he gives them an opportunity to learn from his research along with gaining their own knowledge.

"Dr. Womble truly cares about each one of his students. He is willing to go to any lengths in order to help you with a project," said Chris Davenport, a current student research assistant at API. "He is dedicated to seeing you achieve."

Dr. Womble plans to continue at the same level that got him nominated for a long time. "I feel extremely honored and even more honored that my nomination came from my colleagues. I guess the best thing to do is to 'keep on keeping on.'" Dr. Womble said.

Submitted by Katie Moore

"Dr. Womble truly cares about each one of his students. He is willing to go to any lengths in order to help you with a project," said Chris Davenport

Figure 1

Figure 2

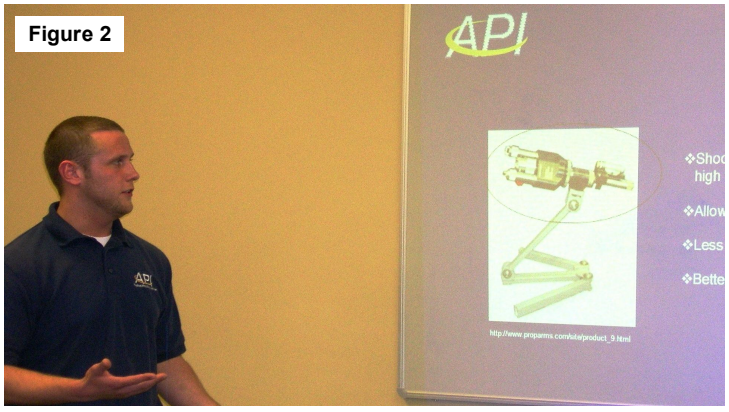


Figure 1: Dr. Phillip Womble
Figure 2: Chris Davenport, presenting at symposium.

API Student Receives Honorable Mention at WKU Research Conference, New Faculty joins API

"The event also allows the students to be honored and recognized for the dedication to their projects."

Jason Smith, an Applied Physics Institute student, received honorable mention at the 38th Annual WKU Research Conference. The conference was held on Saturday, April 12, at the Carroll Knicely Conference Center.

Smith's honored presentation titled "Modeling Results for Environmental Acoustic Pressure Obstructions" included all of his research discovered over the topic.

Other API research students gave their presentations on several different topics:

- Brian Cooper – Underwater Threat Detection Using Pulse Neutrons
- Chris Davenport – Unmanned Ground Vehicles to Defuse IED's
- Matthew Lodmell – Design of a New Control System for an Electron Neutron Generator
- Kyle Moss – Design of Electroencephalogram and Electrocardiogram Technology Including Wireless Integration for Use in Polysomnography
- Jason Musser – Correction in Doppler Broadening in Gamma Ray Spectra for Light Nuclei

This annual research conference allows Western students from multiple schools to showcase their knowledge of academic expertise. The event also allows the students to be honored and recognized for the dedication to their projects.

~WKU Research Conference Release
Submitted by
Katie Moore

Dr. Stacy Wilson Joins The Team Of API

Dr. Stacy Wilson joins Applied Physics Institute. She is Professor of Electrical Engineering at WKU and received her Ph.D. from Tennessee Technological University in 1996. Dr. Wilson is registered Professional Engineer in the Commonwealth of Kentucky.

Dr. Wilson's research interests include control systems, modeling, and system identification. She is interested in women in science issues, and served as organizer of the Girls in Science Day at WKU. Dr. Wilson is a member of Institute of Electrical and Electronics Engineers, American Society for Engineering Education, and Society of Women Engineers.

Dr. Wilson will contribute her Electrical Engineering expertise to API projects that involve WKU undergraduate students.

Dr. Stacy Wilson
WKU Release
Submitted by
Katie Moore

Figure 1

Figure 2

Figure 1: Jason Smith, an Applied Physics Institute student, received honorable mention at the 38th Annual WKU Research Conference.
Figure 2: Dr. Stacy Wilson, professor of Electrical Engineering joins API.

API Receives Homeland Security Grant to Develop Underwater Threat Detection System

API professors awarded the Homeland Security grant in the area of threat detection. The $796,736 project titled "A Compact Neutron Interrogation System for Underwater Threat Detection and Identification" has duration of two years. The principle investigator for the project is Dr. Ivan Novikov, and co-principal investigator is Dr. Alexander Barzilov.

The goal of the project is to develop a system for detection and characterization of different threats in underwater environment. The proposed system is based on active interrogation of underwater objects with fast neutrons. These neutrons will penetrate deeply into an object under scrutiny and excite nuclei of chemical elements within the object through inelastic neutron scattering and thermal neutron capture reactions. Nuclei de-excite with emission of photons with characteristic energies that act as "fingerprints" of chemical elements. The elements contained in the object can be identified by an analysis of detected photon spectra.

The system will be automatic and compact, so it can be integrated with Unmanned Underwater Vehicles (UUVs), or it can be used separately if required. The identification of chemical composition of the underwater object will be carried out within a few minutes. This will allow planning further cleanup actions such as deployment of time and costing consuming special diver team or other techniques.

Such a technology to detect and identify waterborne or underwater threats approaching waterfront facilities such as (ports, dams, locks, ports, refineries, liquefied natural gas and liquefied petroleum gas cargo and other systems) is vital for protection of the critical infrastructures.

Special effort will be made to commercialize the proposed technology and to make it available for users such as port authorities, first responders and security personnel.

The award was announced on May 12th, 2008 in Somerset, Kentucky by U.S. Rep. Harold Rogers, R-KY, and Undersecretary Jay Cohen, Head of the Science and Technology Directorate of U.S. Department of Homeland Security. The National Institute for Hometown Security (NIHS) will manage the grant and will assist with the commercialization.

~Homeland Security Grant for Underwater Threat Release
Submitted by
Katie Moore

May 12, 2008. Awards ceremony at The National Institute for Hometown Security. From left to right: U.S. Rep. Harold Rogers, R-KY; Dr. Keith Andrew, Head of WKU Department of Physics and Astronomy; Dr. Alexander Barzilov; Dr. Ivan Novikov, Dr. Sadiq Shah, WKU Vice-President for Research and Development; Undersecretary Jay Cohen, Head of the Science and Technology Directorate of U.S. Department of Homeland Security.

WATERS Laboratory Joins ARTP-USDA Coalition to Study Karst Groundwater Contamination

"This collaborative effort has provided field and laboratory Experience for a diverse group of graduate and undergraduate students and interns …"

It is common agricultural practice to fertilize plots with livestock manure to increase nutrient concentrations in the soil. In karst terrains here and all over the world, soluble and porous limestone bedrock lies just beneath a relatively thin and irregular layer called the *epikarst*. Despite the fact that epikarst is a minimally protective barrier between anthropogenic surface activity and subsurface karst aquifers, few details are known about transport of fecal bacteria and pathogens through the epikarst ultimately to end up in drinking water sources.

To address these questions, a team led by Geosciences graduate student Brian Ham with advisors Carl Bolster of the United States Department of Agriculture Animal Waste Management Research Station (USDA-AWMRS) and Chris Groves of the Hoffman Environmental Institute (HERI) established a field study site at a cave in Warren County. Dairy manure was applied to the surface (Fig. 1) followed by a simulated rainfall with a fluorescent dye, and the experiment was followed for over ten days during which time additional natural rain events occurred. Numerous physical, chemical, and biological parameters were measured in a cave waterfall known to receive drainage from the site (Fig. 2).

WATERS Lab Analyst Rick Fowler coordinated lab efforts to measure fecal and *E. coli* bacterial contamination in hundreds of samples taken at regular intervals during the study. In addition, a rapid DNA analytical technique develops at WATERS will be used to quantify total DNA concentration and relative abundance of specific types of bacteria as they travel from the surface through the epikarst and emerge in the cave aquifer. WATERS also provides inorganic chemistry and other analytical services to compliment the capabilities at USDA-AWMRS.

This collaborative effort has provided field and laboratory experience for a diverse group of graduate and undergraduate students and interns from WATERS, HERI, and USDA-AWMRS (Fig 3).

~Written by Rick Fowler
Reviewed and Submitted by Marsha Wallace and Jana Fattic


Figure 1

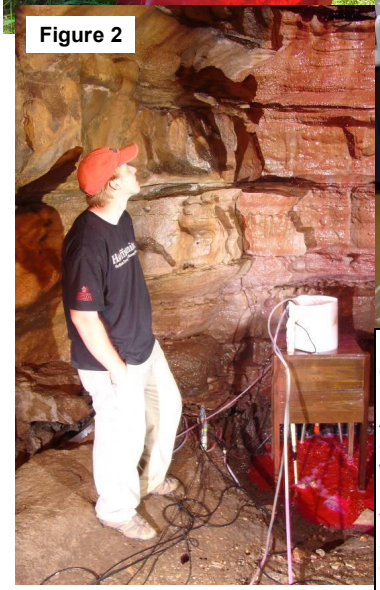


Figure 2


Figure 3

Figure 1: Brian Ham (left) and Rick Fowler (right) laying the groundwork for the epikarst dye trace study. **Figure 2:** Brian Ham monitoring the sampling station inside Crump's Cave. Artificial rainfall containing pink fluorescent dye penetrated the epikarst and delivered fecal pollution to Crump's Cave waterfall within two hours. **Figure 3:** HERI student Josh Bennett prepares some of the hundreds of samples collected during the dye trace for fecal and *E. coli* analysis. Other participating students are contributing field work, laboratory analyses, and computer expertise as part of the collaboration.

CWRS: New Associates Degree – Water and Wastewater Technician Training Institute (WTTI), CWRS leads KYWARN System

The Center for Water Resource Studies and the Bowling Green Community College of Western Kentucky University have formed a partnership to address the Water & Wastewater Operator/Technician shortage anticipated over the next few years as "Baby Boomers" retire. The Water and Wastewater Technician Training Institute (WTTI, pronounced "witty"), is a partnership with the employment sector (a growing number of water & wastewater utilities/municipalities/districts), state primacy agencies and technical assistance/trade associations to refine an industry needs driven curriculum that utilizes on-line course delivery to provide options for both traditional & non-traditional students. The program will offer two tracks: a Utilities Management Track and an Operations Track.

A Challenging and Rewarding Job:

Working in the water/wastewater industry just might be one of the most important positions in the world since no one can live without water. It takes knowledgeable, conscientious people to deliver clean, potable water and to ensure that wastewater is discharged in an environmentally safe manner. People who like to work with their hands and have an interest in biology, chemistry, and/or mathematics are well–suited for the job.

WTTI Program Rewards:

Partnering utilities and municipalities are developing internship and co-operative educational opportunities to ensure work-based experiences for students in the program. In addition, the trade associations have committed to developing scholarship programs to lessen the financial burden for potential students.

For students already working in the Water/Wastewater industry, a college education allows operators to reach advanced certification levels years ahead of operators who do not pursue an education.

All educational aspects of the WTTI program will be available through an on-line environment with flexible class hours, allowing students to study on their schedule. The Utilities Management Track will require a total of 64 credit hours and the Operations Track will require 67 credit hours. Both tracks include both General Education and Business Technology core classes and will ultimately lead to an Associates Degree, in as little as 18 months. For students wishing to pursue an advanced degree, the Associates Degree will provide an excellent frame to build upon.

Additional Information:

More information about the WTTI program can be found at: http://wtti.waterky.org
More information about this Associate Degree can be accessed at the Bowling Green Community College website: http://www.bgcc.wku.edu/

~Submitted by Marsha Wallace

CWRS leads KYWARN system

KYWARN is a Water/Wastewater Agency Response Network (WARN) that allows water and wastewater systems in Kentucky to receive rapid mutual aid and assistance from other systems in KY to restore facilities damaged by natural or man-made incidents. Utilities sign the KYWARN mutual aid agreement, which then allows them to share resources with any other system in KY that has also signed the standard agreement

Tornadoes are more prevalent in Kentucky than hurricanes but following the impacts of Hurricane Katrina and then Hurricane Rita, it became apparent that even with the extraordinary efforts of utilities, water associations and the State Emergency Operations Center, the demand for resources and knowing where those resources were available overwhelmed the ability to effectively coordinate the initial response in times of disaster.

Realizing that utilities needed a different approach, Kentucky leaders in the water community and state agencies have joined together to create the KYWARN to support and promote statewide emergency preparedness, disaster response, and mutual assistance matters for public and private water and wastewater utilities. These leaders include the Center for Water Resource Studies, Kentucky Rural Water Association, the KY/TN Section of the American Water Works Association, the Kentucky Department for Environmental Protection, the Kentucky Water and Wastewater Operators' Association with the Kentucky Division of Water funding the project.

WKU student, Jacob Baxley, is working with project manager, Karla Andrew, to develop, host and maintain the KYWARN website where member utilities, towns, cities or agencies list their supplies and personnel available to help other members in times of emergency or disaster.

This project is another of the many efforts by all these members and water and wastewater leaders to continue to provide safe, clean drinking water to the members of our local communities.

~Submitted by Karla Andrew

Engineering Services Center: ASME Open Source Project Human Powered Water Purification Device

The American Society of Mechanical Engineers (ASME) awarded a grant of $30,000 to Robert Choate and Kevin Schmaltz of WKU's Engineering Services Center to host a student design project. The team was given the challenge to develop a proto-

Figure 1

Figure 1: Project team and initial prototype device
Figure 2: Testing Plan for Water Purification Prototype

type device powered by a human to purify water so that it is drinkable. The project extends the ASME student design competition held in November 2007 at the ASME International Mechanical Engineering Conference and Exposition, in Seattle WA. Five students from teams that qualified for the competition final were selected to participate in this second phase of the project, and by taking the best components of the finalists' designs, a commercially viable prototype product may be developed.

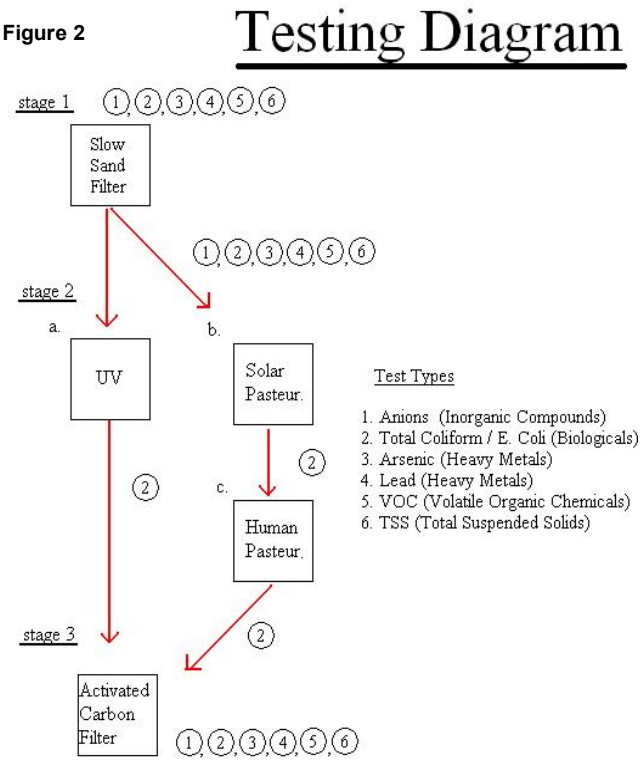
ASME selected William Hagen, University of Miami; José La Verde, Lunds University in Skane, Sweden; Javier Lopez, Simón Bolívar University in Caracas, Venezuela; Ken Ruble, New Mexico State University; and Zach Pearl, WKU, to be on the team. After months of collaborating in a virtual research environment, the five students met at Western Kentucky University in May to build an initial prototype human-powered water purification system.

By the end of a marathon three-day session at WKU, the students had successfully implemented their prototype design, shown in Figure 1, and performed initial testing of polluted water samples created with the assistance of the WATERS Lab.

Water Quality Testing:

Test samples were analyzed following the May prototype construction efforts. Water samples were tested following the plan shown in Figure 2.

Figure 2



Water quality testing (Figure 3) quantified the effectiveness of the prototype in the removal of Biological and Volatile Organic contaminants primarily, and Inorganic contaminants and Heavy Metals secondarily. Total Suspended Solids was also tested.

The prototype was most effective in removing biological contaminants. Sand filtration removed 71% of the E.Coli and 54% of the Total Coliform found in the initial sample. Tests using the UV purifier on the prototype further reduced the biological contaminant levels, but not to the recommended contaminant levels. However pasteurization was successful in every case at removing biological contaminants to recommended levels. Tests at all pasteurization temperatures and for all durations produced acceptable water quality.

Volatile Organic Contaminant analysis was performed on 51 different parameters (substances) but unfortunately provided limited information to judge removal effectiveness. The initial samples were not sufficiently contaminated to demonstrate removal by the prototype.

Inorganic and heavy metals analysis was performed on a variety of substances. As with the VOC tests, the results yields only limited ability to judge removal effectiveness. The two heavy metals tested were arsenic and lead. In both cases the system reduced contaminant levels by ~50% (arsenic) to ~90% (lead). In the case of arsenic, acceptable contaminant levels were not reached, while the lead contamination was significant but below limits from the start.

Removal of inorganic contaminants was considered a secondary goal in the system, so the results, while not uniformly positive, are not disappointing. The inconsistent results need to be addressed if they persist in the retesting of prototype II. Proper flushing of a fabricated activated carbon filter for the second prototype will potentially remove this issue.

Tests for total suspended solids (TSS) were completely inconclusive. The level of TSS after the sand filter was higher than the incoming level. Problems with

ESC: *(Continued from page 8)*

the activated carbon filter constructed by the team made it impossible to collect a TSS sample for downstream of that filter. There are no specific requirements for TSS levels in drinking water. Reducing TSS is more for appearance than for quality as long as the levels are on the order of 50 mg/L or less. For prototype II we will test a manufactured AC filter and be more careful of the construction of the sand filter in order to determine the TSS level that our system can provide.

System Capacity Testing:

While the prototype system was never tested in a comparable fashion to the one-hour student design competition, it is possible to estimate the output of the system based on the May prototype tests. From the biological contaminant test results it is clear that pasteurization of the water at 65 C for 5 minutes will remove biological contaminants. From Figure 4 it can be estimated that the solar heating portion of the system can raise the water temperature from 25 C to 50 C in 10 minutes. From Figure 5 the friction heating system can raise 500 mL of water from 50 C to 65 C in 5 minutes, and then maintain that temperature for 5 minutes. During the 10 minute friction heating process, the solar heater will again elevate room temperature water to 50 C for the next batch.

Based on these results the system can pasteurize 5 batches of 500 mL in an hour. At this rate the system can treat 2.5 L in an hour. This can be contrasted with the maximum rates produced by the SDC competitors that were on the order of 200 mL.

This represents a 10-fold improvement in system capacity; however, the desired rate of 10 L per day would require operating the prototype for 4 hours. This seems unrealistic, but it seems reasonable to anticipate making prototype II at least twice as efficient as the initial prototype.

Plans for Prototype II:

The prototype construction and testing has guided us to the following prototype II schematic most appropriate for a water purifying system under the design criteria we selected:

The performance of the UV treating system in prototype I was only partially successful, and the complexity that this system would add (power requirements and flow control) make it less effective than the pasteurization system.

The prototype II version of the sand filtration would be similar to the initial prototype concept with the potential addition of a fabric mesh to improve TSS performance, increasing the diameter for increased capacity (or less frequent refilling) and potentially cooling the pasteurized water with the sand filter water prior to final AC filtration.

The prototype II version of the solar heating system would make use of the initial prototype concept experience, however performance with less expensive materials needs to be tested (plastic rather than copper). Modifying the flow path will also be necessary to reduce manufacturing complexity. The overall size of the initial prototype seems valid; the solar heating system should match the friction system capacity so that preheated water is available for the friction system during moderately sunny conditions.

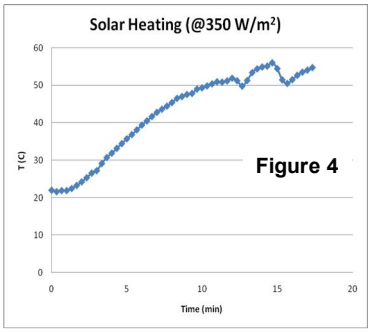
The initial prototype concept for the friction heater provided valuable confirmation of the concept. Design of the prototype II version can be based on the initial version, but it is not realistic to build a complete bicycle-like structure to support the generation of friction heat. It would also be difficult for the user to operate the initial prototype system. One of two concepts needs to be implemented for a friction heat system: incorporating with an existing bicycle, or using a different mechanical motion to impart energy to the friction pad.

The system needs to be sized to heat 1 – 2 L of water per batch. A larger diameter, but lower profile boiler vessel compared to the initial prototype seems necessary. A means of controlling the water out flow based on a set temperature needs to be implemented.

The initial prototype use of the activated carbon filter was not as successful as desired. The need to make a filter, instead of using a manufactured one proved problematic. We now have the purchased filters and will use them downstream of the pasteurization system for the prototype II testing. AC filtration adds some complexity and cost to the system, in particular the need to cool the water prior to AC filtration. This is not a major obstacle, but if the quality tests do not produce meaningful water quality improvements from the AC filter, this component of the system might be eliminated.

The faculty and staff at WKU plan to implement prototype II design, fabrication and testing during the late summer and early fall, using other WKU students as appropriate. The concepts investigated and the prototype built and tested at WKU in May will be invaluable in guiding phase II of the project. Based on the results of phase II, we will consider further development of the system.

~Submitted by
Dr. Kevin Schmaltz
Director,
Engineering Services Center



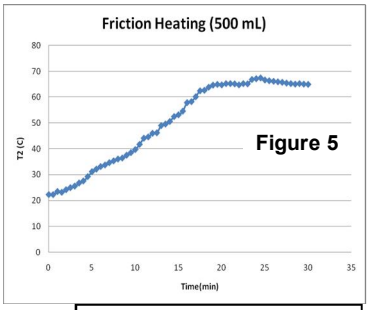


Figure 3: System Operating on May 20
Figure 4: Prototype Solar Heating
Figure 5: Prototype Friction Heating

ICSET: Coal City
China Environmental Health Project Work in Huainan

In China coal is king. China relies on coal for upwards of 70 percent of its energy and it is the biggest consumer and producer of coal in the world. Even with China building a new coal-fired power plant every three days, power demand continues to outstrip supply. While coal fuels China as the world's factory, it also releases many pollutants into the air including sulfur dioxide, nitrogen dioxide, and mercury, resulting in a profound impact on human health and the environment. Domestically, between 400,000 and 750,000 premature deaths are attributed to Chinese air pollution every year. The United States notably relies on coal for nearly 60 percent of its energy, so the opportunity for collaboration between the countries in monitoring and controlling these emissions is great.

At a 22 May 2008 China Environment Forum meeting, speakers Wei-Ping Pan of Western Kentucky University (WKU) and Mingxu Zhang of Anhui University of Science and Technology (AUST) introduced the coal component of the USAID-supported China Environmental Health Project, which aims to obtain accurate data on coal-fired pollution emissions in Huainan. Key to the success of this data collection is the strong collaborative partnership WKU has formed with (AUST) and the provincial and municipal governments. This project also includes health studies conducted in the communities surrounding the three power plants where coal emissions are being monitored. The collection of emission and health data not only helps to promote transparency on pollution emissions in China—supporting new laws on environmental information dissemination—but also potentially raises awareness among policymakers on the health dangers of coal.

Background and Inspiration for the China Environmental Health Project on Coal:

Huainan city in Anhui Province was selected as the location for the China Environmental Health Project (CEHP) coal activities because it is the energy base of eastern China—sometimes referred to as the "fuel power three gorges" because of its three, soon to be four, major power plants. Overall, SO_2 emissions have been decreasing since scrubbers were installed at all three power plants; however, with the addition of the new power plant and growth of other industries, SO_2 and other emissions will undoubtedly increase in the city. Huainan produced 11 million tons of coal in 2004 and is projected to reach 30 million tons of coal production by 2030.

The main purpose of CEHP in Huainan is to build the capacity for coal monitoring in the city and to closely examine the effects of heavy coal use and poor air quality on health. Components of this initiative include improving the monitoring system of SO_2, NO_2, PM_{10}; training and educating Chinese researchers in the latest techniques; and reducing coal-burning related health problems. Because Chinese standards have not been established for some of the pollutants (such as mercury), the project employs U.S. Environmental Protection Agency standards and sampling equipment to ensure the quality of measurement and examination.

Western Kentucky University (WKU), led by Dr. Pan, has had a long-standing relationship training AUST researchers on various coal monitoring techniques. Under CEHP, WKU has been able to help install high-tech monitoring equipment and increase training activity. AUST researchers are now working with WKU counterparts to train students and collect and analyze data in collaboration with the city's monitoring station. AUST researchers set up data collection stations in 5 locations throughout the city to conduct tests every 30 minutes. They also went to different schools to test pollutants emissions and conducted a health survey of students and residents to analyze the relationship between respiratory

Chris Grove (WKU), Mingxu Zhang (President of AUST), John Pasch (USAID, project manager) and Wei-Ping Pan visited PM collection site at Huainan City, China

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diseases and coal emissions. WKU also is working with AUST to conduct experiments to capture CO2 to turn it into useful products such as Ammonia Bicarbonate fertilizer, which keeps 78 percent of its carbon in the soil after application—solving both problems with greenhouse gas emissions and the need for fertilizer.

Details of the Findings:

Professor Mingxu Zhang elaborated upon Dr. Pan's introduction of training workshops as an integral component of CEHP. Approximately 10 junior faculty, 56 graduate students, and 2,400 undergraduate students took part in training at various levels of the project including training, workshop classes and on-site sampling, the goal of which was to determine how much sulfur is produced in the solid and gas phases of coal burning. Although sulfur levels in the solid phase have been monitored over the past two years, CEHP provided equipment enables them to carry out research on sulfur in the gas phase. Professor Zhang's presentation focused on the effectiveness of scrubbers in reducing sulfur and other pollutant emissions.

The coal and fly ash samples from Tianjia'an Power plant unit 5 and unit 6 were collected during the week of September 17, 2007. The major difference between those two units is that unit 6 has installed a new wet flue gas desulfurization system (WFGD). The samples were analyzed using LECO mercury analyzer. The average mercury concentration in coal is around 0.3ppm. The average mercury concentration of US bituminous coal is around 0.1ppm. The mercury concentration in solid phases (fly ash, bottom ash, and/or gypsum) for unit 5 and unit 6 is 10% and 86%, respectively. The 90% of the mercury in coal from unit 5 was emitted into the air. However, only 14% of the mercury in coal from unit 6 was emitted into the air. This is an excellent demonstration indicating the WFGD system not only can remove SO_2, but also mercury can be removed by this air pollution control device (APCD). The Chinese government is beginning to require all power plants to install FGD systems, which keeps mercury in the solid phase and absorbed by gypsum, making it easier to utilize and capture. The new WFGD system for unit 5 will be installed by the end of year. The lower mercury emission from unit 5 should be reached next year. Our findings have been shared with the local city government to promote the significance of APCD to control the pollutants.

The PM10/TSP sampling system and PM2.5/TSP from Airmetric both have been set up and collected samples at two different locations (University and Farm location) at Huainan city. The sampling period was between December 19, 2007, and January 5, 2008. The results indicated the concentration of PM10 is higher than the Chinese second class standard (GB3095-1996: 0.15mg/m^3) in most test days at the University site. The concentration of PM2.5 followed the same pattern as the concentration of PM10. The concentration of PM2.5 at the testing site is much higher than the USEPA standard (0.065mg/m^3). The concentration of PM is also based on weather conditions, such as temperature, humidity and wind direction. The lower concentration of PM was observed in the period between December 24 and 26, 2007. This was due to the rainy days during the test periods. The rest of the testing days were sunny days. The concentration of mercury in PM samples also was tested using the LECO mercury analyzer. The concentration of mercury in PM at the University site is much higher than that in the Farm site. This may be due to the fact that the location of the University is much closer to the power and chemical plants. Several additional sampling locations are planned and they will begin collecting PM samples during 2008.

In terms China's emission standards (a scale of one to five with one being the cleanest), coal pollution in Huainan is below class one for nitrogen dioxide, above class one for sulfur dioxide, but particulate matter measuring 10 micrometers (PM10) is at a the dangerous class three due to unusually high levels of fly ash in Anhui's coal. Particulate matter not only affects air quality—visible in the black snow that falls in Huainan in the past year—but also causes asthma, lung cancer, and cardiovascular diseases. Even in rain, the levels of particulate matter in the air never fall below the U.S. standard. The effects of this heavy pollution were monitored in approximately 3,000 elementary and middle school children of an average age of 11 and 15 years old in Taiyuan and Huainan. The project also surveyed residential areas. Huainan fared better than Taiyuan—one of China's most polluted cities—in terms of disease burden, which included chronic bronchitis, asthma, constant colds and respiratory disease. Discussion at the meeting raised the suggestion that Huainan should compare its emissions to several other comparable cities to ascertain the seriousness of the city's pollution.

The general conclusions are that pollution control benefits exceed the costs; however, because the benefits will be unevenly distributed the government must be involved. Pollution control will not only save lives but also impact the local economy by reducing the days of work lost and volume of crops damaged from acid rain, which is especially significant given that much of China's scarce cropland is located at the peripheries of heavily polluted cities.

~Submitted by
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