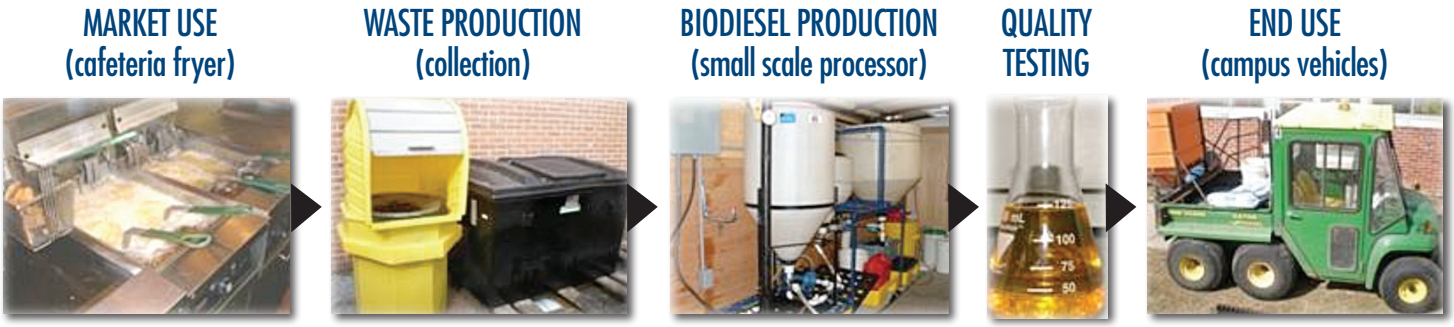
MESSIAH COLLEGE

FALL 2009 | *Department of Engineering Newsletter*

ENGINEERING NEWS

Biodiesel fuel production and methanol recovery

by Mike Zummo



Photos of current biodiesel recycling process at Messiah College by Mike Zummo '06

Researchers around the world are pursuing new forms of alternative energy to help fuel our world for the future, and Messiah College engineering students are doing their part. For the last six years, student teams from the Department of Engineering and the Collaboratory for Strategic Partnerships and Applied Research have been working to develop a process and processor systems for the production of biodiesel fuel.

Biodiesel is an environmentally friendly alternative to petroleum based diesel fuel used in diesel engines and as a fuel oil substitute. It is produced by a reaction that occurs when vegetable oils are combined with an alcohol and a catalyst. Its primary advantages are that it is an agriculturally based renewable fuel that is non-toxic and biodegradable. Biodiesel combustion produces less carbon monoxide, unburned hydrocarbons, and particulate emissions than petroleum based diesel. It is a closed carbon cycle fuel that emits no net greenhouse gasses.

The majority of the students' work has focused specifically on the conversion of waste vegetable oil into high quality biodiesel fuel. With great success, research and development teams have used the waste vegetable oil from campus dining facilities and local restaurants to produce fuel for use in diesel powered vehicles and as a heating oil substitute. In September 2008, the College was awarded a Research and Development Grant from the United States Department of Energy to promote advances in small scale biodiesel production technology. This grant will provide the biodiesel research team with the ability to pursue American Society for Testing and Materials (ASTM) certification testing for biodiesel as well as extensive process and processor research and development opportunities. Currently the team is in the final stages of installing a biodiesel research and development testing lab in the basement of Frey Hall. This lab will house equipment that allows the team to perform the following quality tests required by the ASTM specification: total and free glycerin content by gas chromatography, acid number, cloud point, flash point, and water and sediment content. Upon completion of the testing laboratory, students will begin extensive testing of samples from the biodiesel processor to establish the quality of fuel being produced. Results of such testing will enable students to develop a small scale biodiesel processor that consistently produces ASTM certified biodiesel.

Summer 2009 interns Andy Derr '10 and Stephen Bray '10 work on methanol recovery.

Another key aspect of the project involves working with the resulting waste streams. The glycerol byproduct of the biodiesel production process contains residual methanol which makes its uses limited. Implementing a methanol recovery system allows the methanol to be removed from the glycerol, leaving a safe glycerin byproduct that has many uses and provides recycled methanol for future production of biodiesel. Over the course of the last three years, student teams have developed a functional prototype methanol

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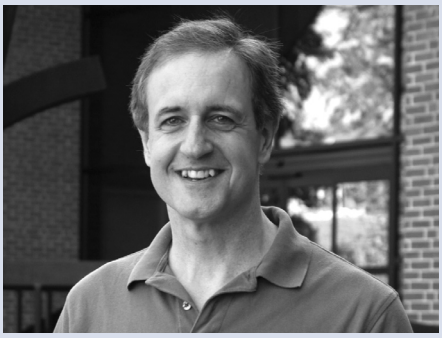
Chair's corner

On a regular basis I am asked the question, "What's going on in Messiah engineering these days?" With 12 educators and 145 students, that simple question generates a flood of images. The short answer is that "Messiah engineering is growing in exciting ways."

This fall we welcomed the first students into our two new concentrations in biomedical and environmental engineering. These students came to Messiah trusting that these new concentrations would someday be approved by ABET. In late August we learned that "someday" was *now*. ABET notified us that these new concentrations were approved as additions to our already accredited BSE degree. What an answer to prayer.



This fall we welcomed our largest class of incoming first year and transfer students in several years. That coupled with good retention has resulted in a 12% growth in the size of the department.

Our facilities are also growing. If you look behind Frey Hall, you will see a pole barn nearing completion. The additional 100 m^2 of space (shame on you if you were thinking sq. ft) will be used for storage and will provide much needed IPC project space. A brand new rapid prototyping system has also been delivered in the last week and will soon be called into service to support both course work and IPC project work.

What an exciting time to be at Messiah. "To serve the present age, my calling to fulfill; O may it all my powers engage to do my Master's will."

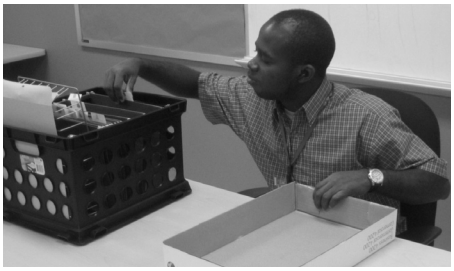
Dr. Randy Fish
Chair, Department of Engineering

Update on progress with Wireless Enabled Remote Co-presence (WERC)

by Harold Underwood

As noted in the fall 2008 issue, the prototype of an assistive technology for those with Asperger Syndrome (AS) was developed and tested during summer 2008 by a team of Messiah College students and faculty, in partnership with The SymBionyx Foundation (TSF). Further progress on the WERC project has been hosted by the communications group of the Messiah College Collaboratory and facilitated by the Integrated Projects Curriculum (IPC). A qualitative study recently conducted with the participation of high school students with AS and educational consultants indicate that a broader, more extensive study would be worthwhile. The qualitative study took place during spring 2009 at Hill Top Academy of the Capital Area Intermediate Unit (CAIU) near the Messiah College campus. The most recent phase of work on this project has benefited from funding from the PA Department of Education (PDE), through CAIU and TSF.

Responses of the five AS participants and remote coaches were very positive, overall. The AS participants unanimously agreed that the earphone and camera devices were physically comfortable to wear. In the setting of this study, they unanimously disagreed that WERCware made them feel embarrassed to wear in front of other people. Rather, most of them indicated they felt completely comfortable with WERCware, knowing they were being observed. They unanimously agreed that WERCware was easy to use, and mostly agreed that directions from the remote coach were easy to hear through the earphone, without hurting their ears. Most of them found directions from the remote coach easy to understand. Although responses seemed to be mixed as to whether WERCware got in the way after completing a simple assembly task, all the participants disagreed that it interfered with a filing task. From the study, we concluded that



Messiah College student Ade Osunsakin '10 simulating the filing task during testing at Hilltop Academy.

WERC, continued on page 6

Mali water and disabilities study

by Zachary Crane

Cecile, who does not have use of her legs, climbs onto the concrete seat that our team installed at the pump testing site.

Our team traveled to Mali, West Africa, in January 2009 to continue our work on improving access to water and sanitation for disabled persons. Our team consisted of Professor Norman, dean of MEB; Elizabeth Sussman, education major; Sarah Jarnecki, computer engineering student; and Zachary Crane, mechanical engineering student. We stayed at the World Vision guest house at Tominian and worked mostly in the village of Mandiakuy. We also worked in villages, such as Koro, that were new to the study. We focused on three areas of water and sanitation access: pump and superstructures, latrines/sanitation, and water transportation.

The pump and superstructure team works on redesigning the surrounding well structures to improve accessibility for disabled persons. World Vision reserved a model test site in the village of Mandiakuy; at this site we were able to construct a new pump superstructure that included seats and handles for easier pumping, access ramps for tricycles and wheelchairs, and eliminated steps to make it more accessible for disabled people in the area. This new pump and surrounding structures will be used by the disabled and able-bodied persons alike for 6 months, after which we will return and collect information for further design modifications.

The latrine team works to raise awareness of personal hygiene and sanitation, and with the help of World Vision, implements those ideas by building easily accessible latrines, latrine chairs, and seats for the disabled. The latrine team has worked with various seat prototypes in the past to help both the disabled and able bodied to be able to sit while using the facilities. This raises them out of the dirt and mess and gives them some dignity. We worked on gathering data from disabled people who were currently testing our seat designs. We got a lot of feedback from them and were able to hold a handicapped conference with all the disabled people able to attend in Mandiakuy, to discuss the effects of the chairs and gain new insight into how we make these chairs. We made assortments of the chairs out of metal, wood, and wire. As new seat ideas emerge, we can gain better efficiency and design strength out of these simple materials and better meet the needs of the disabled. From the conference were able to create a one-size-fits-all seat layout for easier manufacturing. The latrine team also designs modified latrines to improve access; on this trip we worked to build a new test latrine for Marcel, a 90-year-old disabled woman, and she also received a test latrine seat to use with it. Finally, the team is also working to improve access for blind persons. Visually impaired people struggle with finding the opening of the toilet, and one of the ways we help is by installing covers or concrete seats. We also use bricks on the walls of the latrine to help guide them, and we can install a nylon rope weighted by a rock above the hole to aid them in locating the hole. The latrine team gathered valuable information and insight from its seats in Africa, how they are used, and how we can also build the latrine structures to better suit the needs of the disabled.

The water transport team helps the disabled by modifying the containers used to transport water from the well to the home so they are easier to carry and pour. In the past we have worked on many prototypes for carrying the water. Two of the most used methods for water carrying are water basins with no tops and jerry cans with closed tops and no handles on the side. Both of these are carried on the head and are extremely heavy and hard to pick up. To combat this, we worked on designing various handles, harnesses, and metal/wood cages for lifting the jerry cans. Many of the jerry can modifications are still in the prototyping stages, but we were able to get more ideas on how to improve them. Once the water is brought into the home it must be poured out of the water transport container; this is usually awkward and difficult for persons with disabilities. To alleviate this problem, we designed metal and wooden "bucket tippers" for use in the home, which allow for one hand to easily tilt the bucket or jerry can and to pour the water without spilling. All of the new prototypes are now being tested in the field.

As a team we were able to accomplish a lot, and gain invaluable feedback from the disabled and involved communities alike. It was definitely a spiritually, mentally, and physically challenging trip, but we were able to meet new people, gain better service contacts, and represent our majors and Messiah College. Most importantly, we were able to share the love of Christ and create a better understanding between our two cultures.

A woman with use of only one arm tests a jerry can tipper designed by the water transport team.

Biodiesel, continued from page 1

recovery system. In April 2009, the College was awarded a Seed Assistance Grant from the Innovation Transfer Network to provide funding for research, development, and further testing of the current methanol recovery prototype. Student researchers have been very successful in developing a safe and functional methanol recovery system which has produce 96% pure recovered methanol.

Messiah College engineering students are taking the principles and theories they are learning in the classroom and applying them to the development of a more sustainable biodiesel production process. As they perform this applied research and development they gain a knowledge and understanding that they can then utilize to support local entrepreneurs and institutions interested producing and using biodiesel. They can also take this knowledge to support our community partners abroad as they seek to establish sustainable sources of energy around the world.

Andy Derr '10 works on the biodiesel demonstration processor.

Messiah College engineering enters the world of "Rapid Prototyping"

Thin-walled duct

Gear tree

Flexible bellows

Advancements in computer aided design and modeling tools have dramatically streamlined the engineering design process. While these powerful tools allow us to create and analyze objects in the virtual world, there is still a need to produce actual physical prototypes for verification of form, fit, and function. Creating these detailed and dimensionally accurate prototypes is a time consuming process requiring specialized fabrication skills that student engineers do not typically possess. While instructors do spend a good deal of time teaching students these skills, new manufacturing technologies that emerge will, at the same time, expand prototyping capabilities and shorten the learning curve. Rapid prototyping is one such emerging technology that has this potential.

Rapid prototyping, the means of creating a solid object directly from a computer model, is not new; in fact the technology has been commercially available since the mid 1980s. Not until recently, however, with the advent of a new class of smaller, less costly machines, known as 3D printers, has the technology come within reach of small commercial and educational users. The combination of maturing technology, lower equipment cost, and wide acceptance of 3D printing in industry make this an ideal time to jump into the world of rapid prototyping. With the help of a generous donation from Black & Decker Corporation, the engineering department recently took delivery of its first 3D printer from Z Corporation, Burlington, Mass.

Unlike traditional manufacturing technologies that shape an object by removing material from an existing solid, 3D printers build an object from the ground up, one thin layer at a time. There are a variety of methods used for 3D printing but all start by using software to "slice up" a computer model into thin (0.001" to 0.010") cross sections. This data is then sent to the printer and printed out, one cross section at a time. The Z-310 printer that the department has ordered uses a plaster-based powder and liquid binder as the build media. To start the process, a thin layer of powder is rolled across a flat 8" x 10" build platform. A print head then traverses the build platform and dispenses binder onto the powder in the shape of the part cross section, much like printing ink on paper. In areas where the binder is dispensed, the grains of powder are fused together; all other regions on the build platform remain as loose powder. To start the sequence for the next cross section, the build platform drops one layer thickness, a new layer of powder is rolled out over the existing layer and the process is repeated using the next set of cross section data. The process continues fusing one layer on top of the next until the part is completed. Build times can take anywhere from one hour for small simple shapes to eight or more hours for large complex parts.

This 3D printing technology will enable students to create models with complex geometries that would have been extremely difficult or impossible with the department's previously existing capabilities. Even complex working assemblies can be created as one unit; the "gear tree" pictured above is one novel example of this capability. Making changes to a prototype also becomes easier with 3D printing technology. Instead of spending hours in the shop fabricating a new part, students simply alter the computer model, send it to the printer, start the print cycle and come back hours later to a finished part. Z Corporation technology also allows for the use of different building materials ranging from rigid materials suitable for use as sand casting molds to materials suitable for making the flexible bellows pictured above.

Whether it's creating a prototype motor coupling for the electric commuter vehicle, sand casting molds for the electric tricycle drive train, or helping students with complex geometry in Engineering Graphics, 3D printing technology will shorten the time to prototype and greatly enhance the overall learning experience related to practical project work by students here at Messiah College.

Department news: goings and comings

Farewell to Steve Frank

Steve Frank and Harold Underwood working on the mount of a Yagi antenna for the WiFi network in Mahadaga.

VSAT dish mounted at corner of the battery shed in Mahadaga for satellite Internet connectivity.

Steve Frank, our electrical and computer engineering technician since fall 2005 and Harold Underwood, associate professor of engineering, visited Burkina Faso with a short-term mission team sent by West Shore Evangelical Free (Dale and Flo Johnson's sending church), June 22 to July 8. The team set up equipment toward the goal of a Wi-Fi network and satellite Internet connection in Mahadaga, where the Walshes and Johnsons serve as SIM missionaries. After the team's return, the satellite Internet (VSAT) connection was successfully commissioned, now providing a more continuous broadband connection for those stationed in Mahadaga.

The department wished Steve farewell at the end of July as he has completed his service as a Messiah College employee. Steve has gone on to a graduate program in systems engineering at the Colorado School of Mines, where he and his wife, Krista, moved in August.

Introducing Paul Myers: our new electrical and computer engineering technician

We welcome Paul Myers who joined the department in August to fill the position of electrical and computer engineering technician. Paul comes to us as a manufacturing specialist with extensive professional experience in industrial automation, software control, customer support, and marketing. Paul has been involved in many worldwide manufacturing and control system projects during his career. During his project work, Paul has enjoyed hands-on programming of Texas Instruments, Modicon, Allen/Bradley/Rockwell, GE Fanuc, and Siemens Programmable Logic Controllers (PLCs). Paul's experience on global projects has exposed him to a variety of manufacturing processes in his consulting and marketing roles. Recently, Paul has been helping get a new Christian radio station (WPFG 91.3 FM) on the air. Paul graduated in 1976 from the Electronics Institute of Harrisburg, Pa., with an associate's degree in electronics and computer technology.

On a more personal side, Paul has been married to his wife, Donna, for 30 years. He actively participates in men's ministry and mentoring at his church, where he also sings and plays trumpet in the praise band. He maintains his "hardware" skills through his hobby of colonial woodworking, by building colonial period furniture using hand tools and methods of the 1700s. Paul is also an avid fan of Redskins football.

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ENGINEERING NEWS • FALL 2009

OUR MISSION

The mission of Messiah College is to educate men and women toward maturity of intellect, character, and Christian faith in preparation for lives of service, leadership, and reconciliation in church and society. Graduates of the engineering program will therefore be technically competent and broadly educated, prepared for interdisciplinary work in the global workplace. The character and conduct of Messiah engineering graduates will be consistent with Christian faith commitments. We accomplish this mission through engineering instruction and experiences, an education in the liberal arts tradition, and mentoring relationships with students.

WERC, continued from page 2

WERCware needs an improved, less obstructive method of attachment to the client's clothing, and that the client also needs training to keep it from interfering with tasks. Overall, with the exception of one response after the filing task, all AS participants said they liked wearing WERCware, and the experience of completing tasks from a remote coach.

A majority of the remote coach participants agreed that WERCware was easy to turn on and off from their end. However, they unanimously agreed that the headset was comfortable, and the microphone easy to use. Ability to see the whole workstation during the assembly and filing tasks proved to be a problem for some, due to limitations of the portable camera. The limited view has been partially resolved by adding the security camera view to the coach's monitor, but it also suggests that a better, wider-angle, camera lens for the portable wireless camera of WERC may improve it, an objective for future work. Overall, the remote coach participants unanimously agreed that WERCware was not only physically comfortable, but that they liked coaching student participants through tasks with it.

Messiah College Collaboratory communications group student Jason Shortall '10 posing as the coach during testing at Hilltop Academy.

These results have encouraged the WERC project team to continue its study, on a broader scale. For future work, the WERCware team anticipates the prospect of continued funding from PDE for the current academic year, and has applied for a federal grant to support a larger three year study. While the Messiah College Collaboratory facilitates the interdisciplinary cooperation and corporate partnership aspects of the project, the IPC provides a credited way for engineering students to devote a longer term effort than the traditional two-semester senior project would. In the spring 2009 semester, due to the phase of the project, WERC students collected ample portfolio material to illustrate the testing objective. This year, students hope to make significant design improvements on the portable camera. It is hoped that WERCware will help ease the transition of those with AS into the mainstream of a suitable job and more independent living.