



## **Twelve of the most innovative ideas to come from the University community in the past year**

By Daily Staff On September 8th, 2010

### **GLUCOSE TATTOOS**

A diabetic who needs to check his or her insulin levels currently needs to draw blood, or wear bulky equipment. But one University professor has made great strides toward making testing for glucose levels as easy as wearing a temporary tattoo.

Engineering Prof. Joerg Lahann created particles with multiple, defined compartments. These types of particles can be filled with dye so the front and back are two different colors — for example, yellow and red — and would show a different color depending on chemical levels. This way, individuals can optically distinguish between the two colors and the particles can be used as a diagnostic system to detect levels of certain molecules.

The surfaces of one of the compartments — say, the yellow compartment — contains antibodies, but the other one is unbinding. If a patient wants to test, say, glucose levels, the particles will only link to that side, and will align in such a way that only the yellow color is visible. Once the glucose levels become stable, the particles fall apart and the color becomes orange — a mix of the two.

The particles work as a “temporary diagnostic tattoo,” Lahann says. They stay in your skin for about four months before they need to be replaced. The color changing can be used to optically detect imbalances in different molecules, from water to detect dehydration to glucose levels in diabetics.

“It’s almost like a check-engine light,” Lahann said. “So it’s like, ‘hey, you’re dehydrated, drink some water.’ So, if you have a reduction in the water level ... you could essentially detect the color change and you drink and it gets better.”

Aside from using them as a diagnostic tool, there are other benefits to compartmentalizing particles. For example, it’s possible to put different drugs in different compartments and allow independent releases from different drugs. For example, there could be one drug released in 24 hours and one drug released in one week, depending on a patient's prescription.

### **SMART APPLIANCES**

Courtesy of John Marshall

What if you had the ability to come home after a long day of class and command your kitchen appliances to prepare your favorite meal? Or have your radio automatically play your favorite songs? This could one day be commonplace in households around the world with technology developed by John Marshall, assistant professor at the School of Art and Design and the Taubman College of Architecture and Urban Planning.

Marshall's creation, Tea House for Robots (THR\_33), consists of a group of three robotically designed hybrids that are a mix of common household appliances and motor vehicles, each with specific behaviors. These include TST\_003 (a toaster), RDO\_002 (a radio) and MXR\_011 (a stand mixer).

To showcase the technology, Marshall displays the three robots in a 9' x 9' x 6' Japanese-style tea house made out of layers of laser-cut synthetic paper that are sewn together. This house provides the means for humans to interact with the robots, through a program called the OMRON Smile Scan, a face detecting technology connected with the tea house in the form of "eyes."

By compiling data on facial properties from about a million people over 10 years, the program is capable of measuring the degree of someone's smile from 0% to 100%. When a person grins into a camera outside of the house, it consequently determines how wide the tea house "eyes" open.

If the person smiles largely enough to cause the tea house "eyes" to open wide, they allow a direct line of vision between themselves and the robots. This allows the robot to "see" the person, activating the robot's infrared sensors.

When the toaster robot "sees" someone, it becomes illuminated from the inside and starts its toasting cycle, extending its toasting arms forward to await slices of bread. The radio begins to play sounds, and the mixer begins to spin away from the human and begin mixing.

This revolutionary idea for interactive appliances could extend beyond the realm of Marshall's Japanese tea house. The notion of smart appliances could extend to nearly anything around the modern home, making it possible for appliances such as washing machines to run on command and immediately know what type of wash it should begin, or lights to turn on to specific preferential settings. Ultimately, it could mean a whole new way of living.

## **MULTISENSORY MARKETING**

Every Westin Hotel around the world, from New York to New Delhi, smells exactly the same.

But the hotel chain's signature scent — White Tea by Westin — not only provides a fragrant welcome, but also acts as a subconscious marketing ploy.

Marketing Prof. Aradhna Krishna's research in the burgeoning field of multisensory marketing shows that this specific type of advertising specifically targets peoples

subconscious and may be more effective than traditional forms of marketing.

“What sensory marketing does is it affects people in a more subconscious matter,” Krishna said. “For instance, I’ve done research on smell. I’ve shown that if a product has a very unique smell, than memory for other aspects of the product increases.”

Krishna has conducted numerous studies on different aspects of multisensory marketing, but, specifically, a study completed in November 2009 found that scented products help individuals better remember details about a product.

“Smell has really strong associations with memory,” Krishna said. “Among all the senses smell has a more direct connection with good memory. So, if other aspects of information get stored along with smell, than the likelihood of (retaining that information) is also higher.”

Krishna said the study she and her fellow researchers conducted was “painstaking.” The researchers asked about 150 college students to study a brand-name pencil, as well as an itemized list of 10 features of the pencil. Some of the pencils given to students were normal, scentless pencils while others were doused in a scented oil.

Two weeks after the initial meeting, the average student couldn’t remember any of the unscented pencil’s selling points. However, without being provided the scent again, the students remembered about three details of the scented pencils.

Krishna's research is already being implemented into the marketplace. Westin, for example, sells White Tea scented candles and oil diffusers. Additionally, Westin hands out scented pens called Aromawriters for hotel guests to take home.

“They put the signature scent of Westin Hotels in the pen, so when people go home they can smell the scent and they remember other things about Westin hotels,” Krishna said. “So, they are using this research to say, ‘Look if you give scented products for your patrons to take home they’ll remember your hotel better.’ ”

## **WELLO WATERWHEEL**

Courtesy of Josh Dick Photography

Creative thinking was the weapon of choice for Ross graduate Cynthia Koenig, who transformed an already existing concept into an innovative business and humanitarian effort.

The concept of “rolling water” in the world’s rural regions has been around for about 15 years as a method of transporting water from faraway sources, Koenig said. It greatly alleviates the strain of traditional water collection – think balancing heavy pails of water on your head – by rolling the water across terrains for more efficient water retrieval.

Two tools for rolling water have been introduced in South Africa, but these products only yielded limited success as it was impossible for many rural residents to afford them. Koenig embarked on a bold venture to make this concept of water transportation more accessible to

rural residents. Wello, the non-profit company that she founded in January 2008, focuses primarily on the much-overlooked issue of water accessibility in rural areas around the globe.

Koenig materialized her vision in the form of a WaterWheel, a durable plastic container that is pushed much like a lawnmower and capable of transporting 20 gallons of water in one trip. Traditional water gathering methods only allowed about five gallons of water to be carried at once. To put this into perspective, the United Nations Development Programme determined that humans require a minimum of five gallons of water per day to maintain reasonable health and hygiene. The WaterWheel makes this possible for a family of four.

Through Wello, Koenig was able to address the limitations of both water accessibility and water retrieval by manufacturing the WaterWheel locally. Koenig said her idea involves bringing the factory right into the rural community via onsite mobile manufacturing. The elimination of shipping costs will make her product more readily available to rural residents.

Koenig envisions that residents can use the WaterWheel not only for personal use, but to transport water and goods to sell in their own communities. Koenig adds that on-site manufacturing of the product will also create more jobs for residents.

Koenig has only recently returned from field testing the product in Rajasthan, India, looking at potential markets and usability of her product. Koenig adds that she has also developed partnerships with Indian organizations like Barefoot College and Seva Mandir to aid her venture.

## **WATER-LOVING, OIL-HATING**

As the recent fiasco in the Gulf of Mexico illustrated, it's slow work getting oil out of a large body of water. But a group of researchers at the University might have a quicker solution.

Working alongside two of his students, Material Science and Engineering Prof. Anish Tuteja has developed a method of extracting oil from water that his research team only half-jokingly refers to as a "gigantic strainer."

Tuteja's work involves a "dip-coding" process in which commercially available porous materials like cloth or polyester fabrics are covered in a thin layer of the artificial membrane that Tuteja and his researchers have been perfecting since last October.

The membrane then acts as a strainer, holding back oil while enabling water to pass through.

"It's water-loving and oil-hating at the same time," Arun Kota, one of the researchers on the project, said of the artificial membrane.

According to Tuteja, the idea of oil-water separation is completely counterintuitive.

"Take any surface in nature and if you put water through it, oil will come too," Tuteja said. Nevertheless, "the idea was there as to what we thought might work, and the proof was really to show that it works."

Tuteja's membrane involves a mixture of two elements: an oil-repellant nanoparticle and a "water-loving" plastic.

"We have to mix them in the right quantity that it can pull the water down but push the oil up," Tuteja said.

Tuteja and his researchers searched for that ideal balance through a months-long process of trial and error.

According to Kota, the membrane is now almost flawless, with recent tests extracting 99% oil from oil-water mixtures.

However, the technology has yet to be tested outside of a small laboratory setting.

As Tuteja explained, larger-scale tests can only occur once the technology gains visibility.

To that end, Tuteja and his team plan to publish the results of their research in a "high-impact journal" and have also filed a patent, Tuteja said.

Tuteja said he hopes the "dip-coding" process can be used to aid situations like the recent oil spill in the Gulf of Mexico.

As Tuteja pointed out, massive quantities of oil from the Gulf spill sank beneath the surface of the ocean and merged with the water, giving the appearance of a clean surface.

"On the surface the ocean looks clean, but underneath there's plumes and plumes of this oil-water mixture," Tuteja said. "Right now all they're doing is skimming the top."

But Kota said the new membrane can easily tackle such underwater mixtures.

"We have excellent separation happening," Kota said.

## **UNDERWATER TURBINES**

Courtesy of Tarun Koshy

There has been much debate over plans to install wind turbines on the shores of Lake Michigan. But what if those turbines were shoved under water? Juniors Tarun Koshy and Nicholas Williams have proposed just that. The two want to harness the currently unused power of Michigan lakes and rivers by installing large-scale underwater turbines.

Inspired by a Discovery Channel special he saw as a high school freshman, Koshy decided to research the feasibility of extracting energy from underwater currents. The increase in investment in clean energy and the fact that Michigan is full of bodies of water also convinced Koshy and Williams that underwater turbines could prove successful in Michigan.

"Michigan's known so much for its water," Koshy said. "Why not use what's right in front of us?"

Not to be confused with water turbines, underwater turbines do not require the construction of dams. They work on the same principles as wind turbines but use moving water to turn the propellers, which can generate much more power than wind turbines. Underwater currents produce up to 840 times the energy density of wind, according to Hydro Green Energy, a company that is currently developing a similar idea.

Additionally, water currents are constant, unlike the sporadic nature of wind, making them much more reliable. And they don't present an eyesore to the communities where they're installed. "People don't want wind farms anywhere close to their homes," Koshy said.

A version of the underwater turbine idea is already in production in Norway and in the Hudson River in New York. The single turbine in Norway produces enough energy to fully power 37 homes, while the New York turbine powers a supermarket and parking garage.

Despite concerns that the propellers could negatively alter ecosystems, the actual impact on wildlife has been found to be extremely low. After scientists tagged fish in the Hudson River within a 50-mile radius of the turbine, they concluded that most were smart enough to avoid the underwater turbine, according to a study funded by the New York City government.

Koshy and Williams debuted their idea at the statewide Motivate Michigan competition, in which participants proposed plans to energize Michigan's slumping economy. The pair took top honors and a \$20,000 scholarship. Motivate Michigan liked the idea so much that next year's competition will ask students to develop a business plan to implement underwater turbines in Michigan.

## **MIGRANT REMITTANCES**

Each year, developing countries around the world receive billions of dollars in remittance funds—money that migrant workers send home to their families while partaking in jobs outside their home country. This money plays a big role in the economic development of a country, but little is known about how to best utilize these funds for maximum economic growth.

Many economists even speculate that remittances could be detrimental to a country, because many of the families that receive the money from migrants begin to lose incentive to work, or that they use the money for short-term needs rather than long-term investments that would do more for the development of the country.

But according to Ford School of Public Policy Prof. Dean Yang, these remittances can actually be used more efficiently and yield greater advancements for the country if migrant workers exhibit greater control over the way the money is spent, rather than leaving it up to their families.

To test his hypothesis, Yang embarked on a field study in which different members of a group of migrant workers from El Salvador were placed under varying financial conditions. Some were offered savings accounts that allowed for greater control over how their families were using the money, others were provided a joint savings account with their families back home

to increase spending monitoring, and the last group had no financial guidance.

The results of the study proved that when migrants had more control over the money they sent home, their savings greatly increased, ultimately allowing for more long-term investment use.

“What this reveals is the first hard, scientific evidence that this idea of giving migrants more control over how remittances are used potentially can have some kind of development impact,” Yang said. “It gives migrants more control over how remittances are used, and to exercise that control so that more of that money sent home does end up getting allocated to purposes and they’re more likely to have the long run development impact.”

Yang says most migrant workers tend to want their money to be spent on more long-term investments—like schooling, healthcare and small business ventures—but that in many situations, families use the money for more short-term necessities, like groceries and household bills. Because of this, a migrant may send less money back home, ultimately bringing less money to the home country and limiting that country's economic development.

“Migrants certainly realize that even though they state a preference for the money to be used for education or small enterprise investments, they know that they can’t really control how the money is used,” Yang said. “They probably send less money home in total than if they did have the ability to control how the money was used and allocated once it arrived home.”

## **BABY CHIC**

Courtesy of Allen Kim

By his or her first birthday, an infant can grow to about three times its original size. With this drastic change, many parents find themselves shelling out hundreds for new clothes, only to have to replace them in a matter of months.

It was this knowledge that motivated Engineering senior and MPowered member Allen Kim to create bebaroo.com—a sort of Netflix-style rental website for baby clothes — with University alum Luis Calderon. The website, still in its beta phase, allows parents to rent baby clothes at up to 80 percent off the full price garment and then exchange the clothes when their child outgrows them.

“I figured there’s got to be a smarter way for parents to clothe their kids,” Kim said.

Like Netflix users renting DVDs, Bebaroo customers choose a price plan based on the number of clothing items they want to be able to rent at once, anywhere from one to 23 items. The clothes are then delivered to their door free of charge. The parents return the clothes in a pre-paid box when they are ready for new ones. Price plans start at \$15 a month and go up to \$100 a month.

Moreover, the items parents can choose from aren’t the typical run-of-the-mill baby clothes. With brands ranging from Baby Gap and Juicy Couture to Burberry and Polo Ralph Lauren,

and with over 3,000 different items to select from, Bebaroo customers can dress their children in clothing that could otherwise be too expensive for them.

Kim said an integral part of the business is ensuring cleanliness of the clothing, an issue he realizes is extremely important to parents. Bebaroo follows a cleaning regimen established by the National Diapers Association in which all rented garments are first washed with scent-free, dye-free, all organic detergent, and then packaged in hermitically sealed bags.

While the company is currently in its pilot-stage, the website has already garnered 45,000 page hits and gained 5,000 customers who have been selected to join as a start-up customer base while Kim and his team continue to develop the business.

For his work on Bebaroo, Kim has been selected as a finalist in Entrepreneur Magazine's "Entrepreneur of 2010" award in the College Entrepreneur category.

"I'm living up to my dream," Kim said. "I always wanted to be an entrepreneur and this is something that I started for the first time and it's going great and customers are liking it. It's been an amazing, fantastic ride so far."

## **MICROCONTROLLERS**

Ambiq Micro, a startup company founded by University graduates and professors, has recently gained national attention for its work that could potentially usher in a new era in computing.

The company's co-founders — Ross graduates Scott Hanson, David Landman and Philip O'Neil and Engineering professors Dennis Sylvester and David Blaauw — have developed what they call the world's most energy-efficient microcontroller. They believe this new technology will completely transform the way users interact with computers in an everyday environment.

"Microcontrollers — or MCU's — you can think of them as a scaled down version of the microprocessors you would find inside your laptops," O'Neil said in a presentation about the new microcontrollers at Rice University. "MCUs are used in many different applications that we interact with on a daily basis, from our cell phones to our watches to our cars. And although they are becoming more pervasive over time, we believe that the next five to 10 years is where we're really going to see them become ubiquitous."

The company's founders say that, while current computing is on a one to one ratio — where users interact with computers on a personal level with a handheld device or a laptop — the future will see computing in a much more advanced scale, with microprocessors installed in items anywhere from the paint on our walls to the clothes on our backs.

As part of that future, Ambiq Micro believes there will be a need for smaller, more energy-efficient microprocessors like the company's microcontrollers.

The company's energy-efficient microcontrollers will also greatly increase the battery life of



the products in which they are used, an innovation that has not yet been seen in the market of microprocessors.

In the initial stages of research for the microcontroller, the team focused on very small chips that measured one millimeter or less, but Ambiq Micro is now focusing on more commercially profitable markets with designs that are more robust, Blaauw said.

These new microprocessors could soon provide a low-power alternative for companies, but the chip is still in the commercial prototype stage and in the testing phase of production.

Blaauw and Sylvester began the research that eventually grew into Ambiq Micro in 2003, focusing on creating an energy-efficient microcontroller that provides a new level of power reduction for various technologies, including products used in the medical field and by credit card companies. They officially founded Ambiq Micro in 2009.

The idea gained momentum, Blaauw said, in 2008 when the MIT Technology Review did a general report on the team's innovative low-power research with microprocessors.

The success of the company has only increased in the past year. The company's innovations earned first place in the Michigan Business Challenge in February, along with a prize of \$27,000 in cash grants. Ambiq Micro also won the DFJ Mercury Tech Transfer Investment Prize at the 2010 Rice Business Plan Competition, earning a total of \$54,000 in prize money and placing fifth in the competition.

Although there are other microcontrollers that are now available to consumers, Blaauw believes that Ambiq Micro could "open up new markets" by offering a technology that has never yet been seen.

## **BOMB DETECTION**

The increased threat of terrorist attacks has led to expanded, though imperfect, security measures everywhere from airports to sporting arenas. But a new development in security could provide a hidden and immediate way to detect potential suicide bombers, even in the largest crowds.

During his final semester at the University last year, recent Engineering graduate Ashwin Lalendran developed a system of wireless sensors, or units, that can detect Improvised Explosive Devices — explosives often used in suicide bombings — and transmit the data to authorities.

Lalendran worked for six months on the project — which was funded by the Air Force Research Lab at the Wright-Patterson Air Force base in Dayton, Ohio — as part of a class taught by Atmospheric, Oceanic and Spaces Sciences Prof. Nilton Renno.

"It's an innovative solution for security personnel to detect IEDs in a heavily crowded environment, such as an airport, where there is a constant flow of people," Lalendran said. "It's a form of standoff detection, for when you can't physically search every person."

Lalendran worked to create about 20 wireless units with the ability to scan for “unusual contents in metals.” The units, which would be placed about 10 feet apart from one another when in use, could then process the information in real time to detect these suspect values in metals.

The sensors are not only cost-effective, Lalendran says, but also small enough to fit in the palm of a hand, and therefore possible to hide within ordinary items like traffic cones. Officials could easily hide the units to remain undetected by would-be bombers.

The sensors could potentially play a significant role in security forces and have even been considered for use in military defense. Lalendran offered the example of placing sensors in polling stations in places like Iraq and Afghanistan to help prevent suicide bomb attacks.

“The IED problem is a really big issue,” he said. “We are losing a lot of men and women because we can’t detect IEDs, and I feel that this technology could help out with this specific issue.”

## **VEHICLE-TO-GRID**

Automobiles serve as means of transportation from point A to point B. But is that all they can be used for?

“If you could use a car for something more than just getting to work or going on a family vacation, it would be a whole different way to think about a vehicle,” Engineering professor Jeff Stein wrote in a press release.

Stein serves as project director of a team of 10 other University professors who are collaborating on a four-year mission — with funding awarded from the National Science Foundation — to reinvent the way we think about the automobile.

“We’re trying to develop mathematical-based tools that will help people be able to design the future vehicles so that they get good mileage, get good range, make good use of the electricity...and try to reduce the amount of pollution that is produced,” he said.

One of Stein’s research projects is a concept called vehicle-to-grid integration. Stein’s team is looking at tapping into a vehicle’s potential to store and feed electricity back into the grid even while the vehicle sits idle in the garage.

Right now, the electrical grid — what we plug everything from a microwave to a laptop into — operates in an “on demand” system. That is, the electricity utilities only create the exact amount of energy needed at the time they are being used. However, if there are a lot of vehicles that are sitting in garages, all with large batteries that store electrical energy, Stein believes they could temporarily store energy to be used at a later time to power other types of electricity.

Stein labels unpredictable energy, like wind and solar energy, “intermittent energy” because it occurs sporadically in large spurts. Stein thinks energy created during these spurts could be

transferred to and stored in large car batteries to be used later, rather than simply going to waste since it is not needed at that specific time. It could then be transferred to the electrical grid to power microwaves and laptops.

“The vehicles we have now provide freedom and meet the needs of individuals,” Stein said in the press release. “(Hybrid and electric vehicles) can be a completely different way of using a car, to be something that is defined as being a part of the greater good in concert with others. It has fascinating possibilities.”

## **AUTOMOBILE NETWORKING**

In an age of social networking, there are numerous ways to satisfy a Facebook or Twitter fix on the go. From laptops, to cell phones, to iPads, it’s nearly impossible not to be connected. And with the help of a team of past and present University students, social networking may soon be extended to the automobile.

The team — comprised of Engineering graduates Collin Hockey, John Ciccone and Joe Phillips and School of Information student Sangmi Park — developed Caravan Track, an in-car application that allows multiple cars to connect and share information while on the road. Caravan Track can relay information between cars, like current location, speed and fuel level to make planning within a group easier.

They created the program last spring as part of a social networking and transportation application competition offered through a University course called “Cloud Computing in the Commute.” The contest, sponsored by Ford Research and Advanced Engineering, challenged students to create the future of in-car technology.

The program also serves as an effort to decrease cell phone use while driving, as it allows drivers to communicate with one another through prewritten messages that are read aloud over other vehicles' stereos.

The idea for the application was inspired from the team’s personal experiences with group travel.

“If you've ever been on a long-distance trip involving multiple cars, you know that it's a pain to keep things organized,” Phillips said. “It involves lots of phone calls and confusion. I like to know what's going on and to be able to communicate rapidly, and this application puts almost all the required communication and information in one place.”

For winning the contest, the team got a chance to test out their invention in a Ford Fiesta during a two-week road trip from Ann Arbor to San Mateo, Calif. where they displayed their invention at Maker Faire—a science and technology-based fair that celebrates student inventions.

Ciccone said he sees this program as a step toward the future of automobile technology.

“I think we will eventually see desktop-class computer applications in vehicles, like those

created for this class,” Ciccone said. “Driving will become a more social and interactive experience.”

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