Highlights of Undergraduate Research

Summaries of selected research projects presented at Ohio State’s 19th annual Denman Undergraduate Research Forum
With this booklet, the Undergraduate Research Office showcases some of the compelling work undergraduates complete each year. Working with faculty, graduate students, peers or independently, these talented and motivated students inspire the entire university community.

Each spring, several hundred undergraduates in all fields of study present their work at the annual Denman Undergraduate Research Forum, now in its 19th year. We invite you to browse these pages to see the excitement, value and diversity of the scholarly contributions from this year’s forum. This is only a brief introduction to the types of research our students are conducting; a list of all student projects from this event, along with descriptive abstracts, is available at denman.osu.edu. You can also find undergraduate research theses at Ohio State’s Knowledge Bank, kb.osu.edu.

For support of the Denman forum, we thank Richard J. and Martha D. Denman, the Honors & Scholars Center, the Office of Research, and the Office of Undergraduate Education; corporate sponsors Honda R&D Americas, Inc., Johnson & Johnson, Procter & Gamble, and the many students, faculty and staff who contribute to undergraduate research activities across the university. We are grateful to Ohio State alumna Lindsey Perry, who created the image of the lantern on the back cover; and to the URO staff, especially Samara Rafert and Jackie Lipphardt, who worked extensively with the students featured here.

Research Summaries

<table>
<thead>
<tr>
<th>Name</th>
<th>Project Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timothy Adams '14</td>
<td>Housing “help” for the poor</td>
<td>4</td>
</tr>
<tr>
<td>Robert Battista '16</td>
<td>Climate change and drinking water</td>
<td>5</td>
</tr>
<tr>
<td>Thomas Csepe '15</td>
<td>Mapping the heart</td>
<td>6</td>
</tr>
<tr>
<td>Anna Dorf '14</td>
<td>Creating better solar cells</td>
<td>7</td>
</tr>
<tr>
<td>Xinhe (Tina) He '16</td>
<td>Hacking the healthcare system</td>
<td>8</td>
</tr>
<tr>
<td>Chelsea Hinshaw '16</td>
<td>Apocalyptic environment</td>
<td>9</td>
</tr>
<tr>
<td>Regan Hitt '15</td>
<td>Tracking trauma through teeth</td>
<td>10</td>
</tr>
<tr>
<td>Johnathan Hubbard '15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erica Williams '14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samantha Witchey '14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alisha Kamboj '14</td>
<td>Childhood brain injuries</td>
<td>11</td>
</tr>
<tr>
<td>Tamar Kodish '14</td>
<td>Ethnography of disability</td>
<td>12</td>
</tr>
<tr>
<td>Ella Matweyou '14</td>
<td>Pairing yoga and dance to ease injury</td>
<td>13</td>
</tr>
<tr>
<td>Tomas Moreno-Vasquez '14</td>
<td>Gross! Do graphic images deter smoking?</td>
<td>14</td>
</tr>
<tr>
<td>Tyisha Nedd '14</td>
<td>Changing prison culture with dance</td>
<td>15</td>
</tr>
<tr>
<td>Devin Oliver '14</td>
<td>Urban branding and gay tourism in Rio</td>
<td>16</td>
</tr>
<tr>
<td>Basem Rashwan '14</td>
<td>I decide my future! (or do I?)</td>
<td>17</td>
</tr>
<tr>
<td>Aubrey Rybarczyk '14</td>
<td>Investigating language development and autism</td>
<td>18</td>
</tr>
<tr>
<td>Leela Singh '14</td>
<td>Folk performance and identity in India</td>
<td>19</td>
</tr>
<tr>
<td>Connor Slone '14</td>
<td>Not just for the bees</td>
<td>20</td>
</tr>
<tr>
<td>Kit James '14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>You Li '14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Katherine Wehde '15</td>
<td>Urban mining: reclaiming gold from electronics using sugar</td>
<td>21</td>
</tr>
<tr>
<td>Jillian Yuricich '16</td>
<td>Testing the world’s largest wind tunnel</td>
<td>22</td>
</tr>
</tbody>
</table>

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In 2008, the Columbus Metropolitan Housing Authority (CMHA) announced plans to demolish public-housing community Poindexter Village. They would replace it with a mixed-income development, with the idea that living near higher-income neighbors would lift residents out of poverty. Although preservation experts found that rehabilitating the properties for affordable housing would cost less than redevelopment, CMHA moved forward with demolition in 2012, displacing approximately 1,200 residents. I sought to identify and examine the assumptions underlying the development strategy through interviews with key actors in the development coalition.

I found that many were guided by assumptions that privileged economic growth and entrepreneurialism, rather than providing employment and higher wages, as the proper strategy for ameliorating poverty. Developers were influenced by prevailing ideas of a “culture of poverty,” which blames the perceived habits and dispositions of poor individuals and families, rather than broader socioeconomic conditions of exploitation and dispossession. These assumptions influenced coalition members to reject planning strategies that may have preserved additional affordable housing and the community within Poindexter Village.

I also offered a critical history of Poindexter Village showing that contemporary practices of public housing demolition and mixed-income redevelopment have been continuous across historical periods (many scholars have demonstrated the limitations of this strategy, now an established urban planning practice nationwide). I found a 1940 master’s thesis by an Ohio State student on the Blackberry Patch, an informal community that was demolished to make way for Poindexter Village. This thesis was not only useful in providing historical context but was itself a piece of history, and I was excited and surprised to discover it.

### Housing “help” for the poor

Much of the world’s population relies on glacier-fed fresh water, and so we need to understand how climate change affects the availability and quality of drinking water from glacial sources. In Peru, the Andes’ glaciated peaks buffer seasonal variations in stream runoff. The glaciers are receding faster than ever, however, and scientists have recorded significant reductions in the water they supply to rivers. Furthermore, certain streams have been found to have adversely high acidity and potentially toxic concentrations of certain heavy metals. The toxicities of these streams will be compounded if glacial discharge continues to decrease. Yet, many such streams are used for agricultural irrigation.

To test the sources and extent of river water contamination in Peru’s glacier-fed streams, my colleagues from the geology department’s Trace Element Research Lab took surveys during three consecutive dry seasons to analyze the concentrations of various dissolved metals and isotopes along the Santa River, which drains the Cordillera Blanca glacier. I joined the sampling survey in June 2013, and, with other researchers, measured dissolved concentrations of different metals from various sample locations in the Santa River watershed. We compiled these results and compared them with those of two previous surveys, focusing on certain toxic heavy metals such as lead, cadmium and arsenic.

The most exciting part of my research was finding the Pearson correlation coefficient (which indicates the level of interdependence, meaning that as one increases in concentration, so does the other) between individual metals and finding that the strongest correlation was between nickel and cobalt. These were the most similar in both size and reactivity, supporting my hypothesis that these factors affected their relative concentrations.
For my project, I worked in the lab of Dr. Yiying Wu in the Department of Chemistry, investigating ways to create more efficient dye-sensitized solar cells by looking at alternatives to nickel oxide as a semiconductor. Right now, solar cells are characterized as n-type or p-type, depending on the type of semiconductors they use. Most are n-type, which operate at about 20 percent efficiency. P-type cells are less efficient, but theoretically, if n- and p-type cells could be combined, the resulting hybrid would be more efficient than what is in common use today. Tandem cells are the new focus for solar cell technology. Not a whole lot of people are working on this right now, especially in the semiconductor area. The key to an effective tandem cell is improving the efficiency of p-type cells, which use nickel oxide as a semiconductor. My job was to see whether the transition metals in the same row as nickel could interact the same way as nickel does, and therefore see if they can be used as more efficient alternatives to nickel oxide. Unfortunately, we found that these alternatives didn’t work as well.

Mapping the heart

The sinoatrial node (SAN) is the primary pacemaker of the heart and is responsible for normal sinus rhythm, or heart rate. Spontaneous electrical impulses in the SAN stimulate the surrounding atria, inducing the heart to contract. In order for the electrical impulse within the SAN to escape and excite the atria, the SAN and atria must be connected by what our lab group calls specialized sinoatrial conduction pathways (SACPs). These SACPs act as wires connecting the SAN, or battery of the heart, to the atria and ventricles, which together form the pump. Although scientists have studied the SAN for longer than a century, the ways its structure determines its function are still unknown and undefined. By using optical mapping, immunostaining (using antibodies to trace specific proteins) and histological analysis, we defined the three-dimensional microstructure of the human SAN. In doing this, we are the first to confirm direct functional and structural evidence of distinct SACPs in the human heart. Heart failure is one of the leading causes of morbidity and mortality in the United States, and around 20 percent of sudden cardiac deaths from arrhythmias are related to SAN dysfunction. Atrial fibrillation increases the risk of such death, and also increases the risk of stroke. By gaining a further understanding of the functional, structural and cellular aspects of these dysfunctions, we will be able to treat sinoatrial node diseases more effectively.

Anna Dorfi ’14 | Chemical Engineering

Project title: Investigation of Transition Metal Oxides as P-Type Semi-Conductors in Dye-Sensitized Solar Cells (DSSCs) | Advisers: Yiying Wu, Thomas Draskovic | Honors: Second place, Denman forum | What’s next: Anna is in Mainz, Germany, on a Fulbright research grant to develop superconducting materials for better energy conversion in electronics.

Thomas Csepe ’15 | Excercise Science

Project title: 3D Reconstruction of the Sino-Atrial Node Unravels Specialized Conduction Pathways in the Human Heart | Adviser: Vadim Fedorov | Honors: Undergraduate Education summer research fellowship; fourth author in paper published in Circulation Journal | What’s next: Tom will continue research with Dr. Fedorov, then attend medical school.

Creating better solar cells

Anna Dorfi ’14 | Chemical Engineering

Project title: Investigation of Transition Metal Oxides as P-Type Semi-Conductors in Dye-Sensitized Solar Cells (DSSCs) | Advisers: Yiying Wu, Thomas Draskovic | Honors: Second place, Denman forum | What’s next: Anna is in Mainz, Germany, on a Fulbright research grant to develop superconducting materials for better energy conversion in electronics.
Hacking the healthcare system

My project originated with the question, "Why is the US health care system so expensive and what can we do to improve its efficiency?" To find answers, I identified four issues within the current system: unnecessary technology use, a non-uniform pricing system, few preventative measures in place for patients and insufficient insurance coverage. In answer to these challenges, I propose entrepreneurial innovations, standardized pricing systems, selected preventative measures and regulated insurance coverage.

To quantify the problems as well as devise and prioritize solutions, I used linear and multiple regression models to identify room for improvement in 46 states. My research provides a platform for examining each state’s treatment efficiency by looking at the ideal linear regression relationship between its non-treatment level and the percentage premiums of a provider’s monthly income.

When resources and funds are put in the right place, everyone in the country benefits: the medical industry players will better understand pricing regulations, the government will be able to reduce its fiscal deficit and citizens will enjoy better health and more affordable medical services.

Apocalyptic environment

My project evolved from an honors class with Dr. Peter Hennen. In it, we studied religious groups that predicted the end of the world, as well as Earth First! and other radical environmentalist groups. For my study, I incorporated Emerson’s idea of transcendentalism with social-science analysis techniques to examine intersections of religious and secular end-of-world narratives.

Drawing on William Gamson’s frame analysis approach—a method for examining how people interpret and characterize situations—Dr. Hennen and I coded Al Gore’s *An Inconvenient Truth* documentary. From our notes, we created categories for the second phase of coding and then conducted a detailed frame analysis. We used this analysis to draw out certain religious and millennial themes. It was easy to identify the robust religious dimension of environmental movements, a topic that scholars from a variety of disciplines have explored over the last three decades.

We contend that, while latent, the spiritual elements of current Western environmental discourse are significant, and take on a millennial tone in the discourse around climate change. We further speculate that because the religious and millennial aspects of this discourse operate below the level of conscious thought, they may have unintended effects for climate change activists and their audiences. For example, we noted the film often presented Al Gore as a god-like figure; to religious Americans, this may be offensive.
Environmental stressors such as starvation, disease or a change in weather conditions can be severe enough to cause defects in young bonobos’ development. One common defect is a horizontal groove across the tooth, known as linear enamel hypoplasia (LEH). Every instance of this groove marks a time when the primate faced a period of stress.

Our undergraduate research group in the Department of Evolution, Ecology and Organismal Biology took images of canine replicas of male and female bonobos with a high-resolution camera. We examined the distance of each LEH from an anatomical landmark, the cemento-enamel junction, to determine the length of tooth formation periods and frequency of disrupted growth patterns. We asked: How do stress indicators differ between male and female bonobos, and how can scientists use this data to further conservation efforts?

Using ImageJ software, we found that the frequency of LEH was higher in males than in females. Male tooth formation took longer, and males had more sporadic rates of tooth formation, presumably indicating more vulnerability to physiological stress (as shown by higher LEH counts).

LEH expression is a powerful tool for assessing physiological stress. Examining dental structures, along with historical records of environmental changes and habitat conditions, can indicate stressors’ timing and duration. This has important implications for great-ape and other conservation efforts.

I began this research at Nationwide Children’s Hospital under the guidance of Dr. Gary Smith, director of the Center for Injury Research and Policy. Traumatic brain injuries (TBIs) caught my attention because they are a major source of morbidity and mortality in the United States. Each year, 17 million people suffer TBIs, which account for one third of injury-related deaths and thousands of long-term disability cases. In 2010, the economic burden of TBIs in the United States, including medical and indirect costs, was $76.5 billion. Ours is the first comprehensive TBI study to focus on at-home pediatric injuries nationwide, despite the fact that the highest rate of TBI-related emergency department visits occur in very young children (under five years of age) and the rate of at-home TBIs among them is increasing.

We analyzed data from the National Electronic Injury Surveillance System (NEISS) to identify causes and prevention strategies. The leading causes were falls and being struck by or against structures or objects. There was more than a 200 percent increase in the number and rate of TBIs during the study period. This may be due to increased exposure of children to home hazards, an increased risk of injury associated with specific household products or higher public awareness of TBIs’ seriousness, leading more adults to seek emergency care for children.

The NEISS is a stratified probability sample of 98 emergency departments representing more than 5,300 hospitals. Reviewing each case and gathering data on trends in demographics, injury mechanisms, diagnoses and product/activity involvement gave me an invaluable understanding of my topic.
I examined how cultural factors affect a society’s understanding and treatment of physical and developmental disabilities. By studying the interplay of culture and social services, we can begin to see how global definitions of disability differ. Societies are shifting from holding narrow views of disability rooted in the individual’s diagnosis, to also including the social and environmental factors that impede people with disabilities from community participation.

I used an anthropological approach to ask how children with disabilities are defined, perceived and treated in different cultures. I conducted ethnographic fieldwork and recorded behavioral observations at two education and therapy centers for children with disabilities in Ecuador and Israel to identify key factors in each culture that influence how disability is treated. By interviewing therapists, social workers, teachers and aides, I defined three categories of important factors: ethnic status and religious views of groups within each society; access to economic, educational and medical resources; and education and legal structures.

My research shows that social and environmental conditions influence definitions of disability, which in turn influence treatment. For example, many Haredi Jews in Israel view disability as a challenge or blessing from a spiritual source. In Ecuador, just over a decade ago, people of indigenous descent were often automatically perceived as disabled. By understanding the impact of cultural context on the disabled, we can work toward increasing acceptance and inclusion.

Professional dancers daily push their bodies to the limit, resulting in stress and injury. I investigated how dancers can apply the yogic virtue of ahimsa, or nonviolence, directly to the dance-making process to promote physical and emotional well-being. My solo performance, “Thoughts in My Lungs,” explores how my yoga practice has shaped my identity as a performer, informed my movement choices, and altered my perceptions of my body.

First, I completed a teacher certification in Hatha yoga. I studied yogic philosophy, pedagogy, breathing techniques, meditation and anatomy. Then, I asked local choreographer and yoga teacher Colleen Leonard to create a solo for me that stemmed from my idea of a nonviolent approach to dance. We worked collaboratively to create movements, drawing from a variety of sources to build an eclectic and meditative movement vocabulary.
Many countries have attempted to control smoking by using graphic warning labels on cigarette packages. Although tobacco companies have delayed the move in court, the Family Smoking Prevention and Tobacco Control Act of 2009 mandates that the United States must do the same. Dr. Ellen Peters and I aimed to determine if the arousal levels generated by the graphic warning labels improve long-term memory for text warnings paired with the graphic labels, relative to less graphic labels or text warnings alone.

We showed participants text warnings and either highly graphic images, less-graphic images, a mix of more- and less-graphic images or text warnings alone. Half the participants answered questions about the labels immediately afterwards, and others were called back a week later. While we found no differences in recall accuracy between the groups based on how graphic the labels were, we found that those who saw only more-graphic labels or only less-graphic labels found the warnings to be more credible than those who saw a mix of more- and less-graphic images. This implies that it might not matter how graphic the warnings are, as long as each of the warnings is equally graphic.

I was drawn to my research because I wanted to help understand the avenues by which we could improve decision-making. Presenting at the Denman let me break out of the sometimes-isolating research process and explain my work to new audiences.

Changing prison culture with dance

I became interested in prison recidivism when I watched a documentary on the subject in a social work class. As a dance major, I wanted to use the arts to shift the environment and value system among inmates and create new options for people. So I started an interdisciplinary arts program at a women’s correctional institution in Columbus.

I first wanted to figure out what the women needed. I taught a creative movement class for a year to gauge interest and find out what was helpful. I saw there was a need to create a sense of ownership, because in prisons you don’t have ownership over anything. There was a lot of interest in learning cultural dances, wanting to know about the arts around the world.

Based on my observations, I brought in visual artists as well as people to teach dance forms I didn’t know. The women participated in art, dance and journaling for three months, during which we brought in different choreographers and artists. We then created a dance show.

At first, women were hesitant, but engagement grew with the program. Even women who weren’t participating wanted to know when the show was, whether they could help. People took ownership over the prescribed movements I gave, over the forms I taught. There was a sense that “this is my body and it’s valuable, I’m valuable.”
The branding of Rio de Janeiro as a modern city integrates images and narratives about its sexual openness and diversity, which are increasingly visible through celebrations like Pride and Carnival. Tourism bureaus have aimed branding campaigns toward LGBT audiences in order to attract tourists and investment. Gay tourism is a growing industry, in which leaders and businesses invest millions of dollars to promote Rio as sexually inclusive. Tourism leaders attempt to cash in on broader narratives of social progress, especially in light of recent mega-events such as the Olympic Games and the World Cup, both hosted in Brazil.

My research asks, who is left out of these campaigns, and why? I interviewed tourism officials, LGBT activists and favela residents and attended protests and meetings in order to identify the assumptions underlying Rio’s “gay-friendly” branding and tourism campaigns. I asked, to what degree do these narratives of diversity represent local LGBT realities?

These campaigns are paradoxical: gay tourism and marketing may promote more positive LGBT representations, but they leave out those who don’t live up to middle-class consumption norms, perpetuating racialized, classed and gendered hierarchies. I concluded that in cities with colonial pasts, such as Rio, there are deeper legacies of racism and poverty, here repackaged through gay tourism branding.

Fatalism—the belief that life events are beyond individual control—is associated with important social and interpersonal trends. Researchers have found that fatalistic people are less likely to set money aside for the future, and are more likely to turn down life-saving surgery. Other research indicates that fatalism may represent a significant obstacle to entrepreneurship and investing in the future. On January 25, 2011, Egyptians—whose society has historically been identified as fatalistic—rose up and toppled those who had been in power for more than 30 years.

Shortly after this watershed event, I left my cold lab at Ohio State for Egypt. I wondered: Can a revolution change the way people think? Or does it simply change the regime? Can strong beliefs in divine determination and self-determination coexist? I asked 136 individuals to agree or disagree with statements formulated to identify fatalism or its absence. These were “I decide my future,” and “God decides my future and it is outside of my control.”

Five percent expressed fatalism by disagreeing with the first statement. But 46 percent agreed with the second statement. So, two contradictory statements that should have tested the same fatalism showed different results. Responses to “I decide my future” correlated with gender and age (younger people and men are less fatalistic). Responses to “God decides my future and it is outside of my control” correlated with education levels. Past studies have assumed that an individual is either fatalistic or not—he believes that outside forces control his life. What those outside forces are was deemed irrelevant. This research indicates the need for a multi-dimensional theory of fatalism.
As a future speech-language pathologist, I am interested in how children with autism develop language. When learning words, children integrate auditory information (an object’s name) and visual information (the object itself). Typically developing children are more likely to rely on auditory information when processing auditory-visual stimuli. I hypothesized that in a similar experiment, the visual-spatial strengths of children with autism would lead them to more heavily weight visual information.

I conducted this research as a member of Ohio State’s Autism and Child Language Learning Lab. To test my hypothesis, I designed an experiment to reveal whether children relied on visual or auditory information based on where they looked for a “prize” on the screen after being presented with auditory-visual stimuli. After more than a semester of programming, testing, and fine-tuning the experiment, I collected data from one typically developing pilot participant and one with autism.

Surprisingly, both children more heavily weighted visual information. However, I will be continuing this study as my master’s thesis, and I am excited to see whether a larger sample will reveal a difference in the auditory-visual processing of children with and without autism.

Folk performance and identity in India

Billed as a “tasteful and authentic symbol of ethnic village life,” Chokhi Dhani—or “Fine Village”—opened in Jaipur, India, in 1989 as a restaurant celebrating Rajasthani cuisine, and has expanded to include a resort and event park and other resorts nationwide. Its founder started the enterprise with the intention of preserving and celebrating Rajasthani folk culture in a tourist-friendly environment. The rapid transition of the Indian economy into a global presence has led to an increase in such attractions: contained, imagined spaces that celebrate a shared past. But where do the hired folk performers fit within these spaces?

Seeking a more nuanced understanding of the folk performer’s identity in the context of tourism, I interviewed roughly 40 artists. I analyzed the interviews and ethnographic field notes to paint a portrait of the state of folk performance in Jaipur and perhaps in India as a whole. While performers rely heavily on tourism to support the continuation of their crafts, the futures of their art forms vary.

I call into question the idea that folk performance had a “pure” form pre-tourism. Rather than remaining fixed, the identity of Rajasthani performers evolves with perceptions of what is authentic, placing them in a liminal space between “true” representations of the past and the present in which they practice their art.
We started with the question, how can we make cars lighter—and therefore improve fuel economy—without compromising passenger safety? This requires lightweight materials that are good at absorbing collision energy: if the force of the crash is diffused by materials rather than people, the vehicle is safer for passengers.

Aluminum is the second lightest “structural” metal after magnesium, and unlike magnesium, it is easily formed into complex shapes. Aluminum honeycomb absorbs energy extremely well. One way to judge this is to quantify how much material by mass it takes to absorb a certain amount of energy. This metric is called specific energy absorption (SEA). If we had to use as much aluminum by weight as steel to absorb the same amount of energy, the aluminum would not be an effective solution. Honeycomb has good SEA because it buckles and crushes down flat, which expends a lot of energy, therefore increasing what it can absorb.

We tested the honeycomb by striking it with a steel block at different speeds and determining how much material was required to stop the block. We also tested how honeycomb cell size and the impact angle affected its ability to absorb energy. Samples hit at small angles performed better than their counterparts that had been hit head on. This surprising result gives us a new avenue for improving energy absorption in future research.

Connor Slone ’14, Kit James ’14, You Li ’14 I Materials Science

Project title Honeycomb Materials for Improved Automobile Crashworthiness I Adviser Peter Anderson I Honors Best of Show Undergraduate Poster at the Minerals, Metals, and Materials Society (TMS) 2014 conference I What’s next Connor will pursue a master’s in materials science and engineering at Ohio State; Kit will work in GE Aviation’s Edison Program while completing his master’s; and You will study electronic materials in graduate school.

Urban mining: reclaiming gold from electronics using sugar

This project was brought to my lab by a nonprofit group, Teaching Opportunity Unity by Connecting Hearts (T.O.U.C.H.). It had recently lost its funding, and sought to become self-sustaining by opening a recycling center and reclaiming gold from electronics. The current methods for reclaiming gold use environmentally taxing chemicals such as cyanide and mercury. My particular project focuses on better ways to reclaim gold from old electronic parts. A greener process benefits the environment as well as the business, because it eliminates waste treatment costs.

The process I investigated uses a sugar complex in the shape of a ring to remove the gold from solution. The gold ions fit inside the sugar ring and connect to more sugar and more gold ions until the chain is so long and heavy that it falls out of solution as a solid. This process is not only applicable to recycling but also to mining, as a way to treat gold ore.

A researcher at Northwestern University discovered the possibilities of using sugar to extract gold in 2013, but my study differs in that I focused not only on the extraction, but the commercial viability of the process. I also introduced the idea of reclaiming gold from electronics with these methods, as the Northwestern team used gold alloy scraps.

Katherine Wehde ’15 I Chemistry

Project title An Investigation of Extracting Gold on a Small Commercial Scale I Adviser J. Clay Harris I Honors Honorable mention, 2013 Denman; first place, Ohio State Natural and Mathematical Sciences Undergraduate Research Forum; presented at the National Conference on Undergraduate Research and the American Chemical Society National Meeting on chemistry and global stewardship. I What’s next? Katherine will pursue a PhD in analytical chemistry.
The largest wind tunnel in the world, at 80 by 120 feet, is in California at NASA's Ames Research Center. By moving air at high speeds past objects, wind tunnels simulate flight aerodynamics to enable better aircraft design. In autumn 2013, I took an internship at Ames, and along with another intern and two NASA employees, was assigned the task of determining whether a Google complex under construction 1400 feet upwind from the inlet threatens the tunnel's efficacy. The fear was that the buildings could cause too much turbulent air to be drawn into the test section, which would skew test data gathered inside.

I used a 1/50th-scale model to see how the Google buildings will affect the tunnel. Inside the full-scale test section, I used large beams to block the model's inlet. The beams were moved farther and farther back until my teammates and I could no longer see turbulence readings above nominal levels. Using that data, we proved that any structures, including the Google buildings, had no effect if they were placed more than 1000 feet upwind from the inlet.

The major breakthrough came when I made the final scatter plot using all of our data. It was the final step we needed to draw our conclusions about the tunnel's fidelity. With one click, we saw that the 80 x 120 was safe from the Google complex.

The 2015 Denman Undergraduate Research Forum will be held on Wednesday, March 25, 2015
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