The University of Iowa

EDITOR: JENNA STOLTZFUS

AIChE Fall 2015

Advisor's Corner

By: Prof. David Murhammer, Professor and AIChE Student Chapter Advisor

Greetings to Hawkeye Chemical Engineers!! This Fall 2015 issue of our AIChE Student Chapter Newsletter begins with an article about the 2015 AIChE Annual Student Conference held in Salt Lake City, UT. Our student chapter won numerous awards at this meeting, including 2nd place in the ChemE Jeopardy competition. While our team came up just short of a 3rd consecutive national championship, they had a very strong performance in losing to an excellent team from the University of Maryland (at least we lost to another Big Ten team!). Over the last four years the University of Iowa ChemE Jeopardy team has finished 1st twice (2013 and 2014) and 2nd twice (2012 and 2015)! Other awards included the Outstanding Student Chapter Award (22nd out of the last 23 years) and the top Safety in Design award.

This issue also contains two articles about undergraduate research, an article about a summer internship, an article about a co-op experience, four student papers about the applications of Chemical Engineering that were written for Professor Julie Jessop's Process Calculations course, an article about how yoga can be used to relieve stress to help in becoming a successful chemical engineering student, and an article about the Halloween Day Camp in which young children were exposed to science with a Halloween theme. Finally, this issue contains Chemical Engineering Funnies about student life in the Seamans Center.

University of Iowa American Institute of Chemical Engineers

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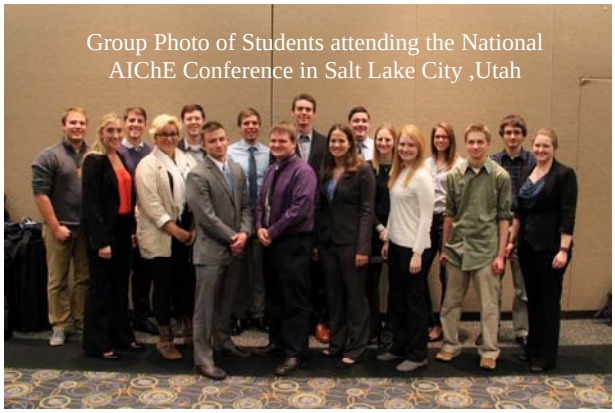
AIChE

THE UNIVERSITY OF IOWA

Fall 2015 AIChE National Student Conference

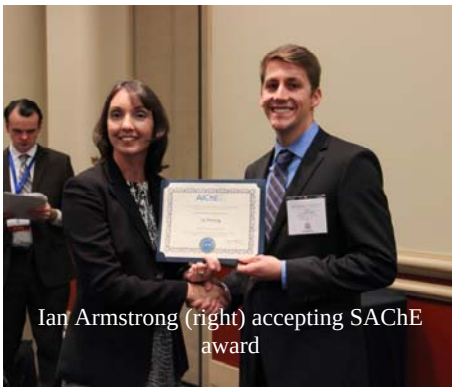
By: Matthew Johnson

Seventeen students attended the AICHE National Conference in Salt Lake City this fall. At the conference students attended a number of workshops on topics such as CSTRs, particle flow technology and interviewing skills. A career and graduate school fair was also taken advantage of by some students. Chem-E-Car coordinator Nate Shires in particular took advantage of the Chem-E-Car competition to record posters and run statistics on the cars competing in the National Competition in order to best plan a path forward for our Chem-E-Car team at the coming regional competition.



Group Photo of Students attending the National AIChE Conference in Salt Lake City ,Utah

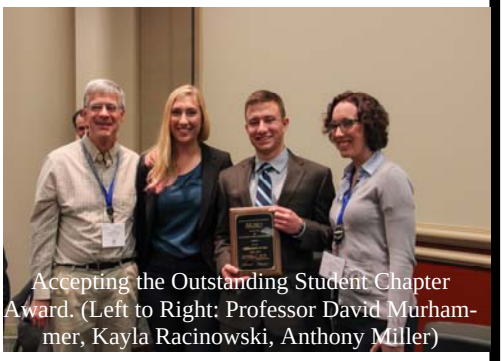
Many students: Scott Tentinger, Kathryn Classon, Jenna Stoltzfus, Graham Young, Marlis Owen and Monica Hemingway presented posters at the poster competition in various different areas of research. As usual Iowa also received an outstanding chapter award and graduate student Ian Armstrong accepted an award on behalf of Catherine Suchanek, Austin Hangartner, and himself for Safety in Chemical Engineering Education (SAChE) for the design competition



Ian Armstrong (right) accepting SAChE award

Lastly, our Chem-E-Jeopardy team: Zach Behrendt, Daniel Davies, Matt Johnson and Nathan Schuchert attempted to defend our national title in Chem-E-Jeopardy. Our team easily defeated the University of Texas and Arizona State teams in the first round going into final jeopardy with triple the score of any other team. The finals against Georgia Tech and Maryland started similarly with Iowa ending single jeopardy once again with about triple the score of any other team. However, as double jeopardy progressed, Maryland began to slowly chip away at that lead. After Iowa bet too conservatively on both daily doubles the competition became neck and neck going into the last category: fictional dog breeds. Unfortunately, this topic hadn't been covered in the Iowa chemical engineering classes yet and Maryland came out on top. Iowa bet everything on the final jeopardy question, but despite leading with triple the score of any opponent in single jeopardy, getting every single daily double, and getting every single daily double and final jeopardy correct, Maryland came out on top leaving Iowa in 2nd place. Iowa preformed particularly well in the following categories: Process Control, Biochemical Engineering, Math and Safety, and particularly Bad Categories: Fictional Dog Breeds.

While in the city of Salt Lake, the students took advantage of exploring a new city that had much to offer. Trying new local restaurants, site seeing the temple within the city, and taking advantage of local fitness gurus. Students also met many other students from other universities, including The Universities of Maine and Toledo. This experience was a great networking, learning, and social experience that was enjoyed by all who attended.



Accepting the Outstanding Student Chapter Award. (Left to Right: Professor David Murhammer, Kayla Racinowski, Anthony Miller)

Research as an Undergraduate Chemical Engineer

By: Austin McKee

My name is Austin McKee. I grew up in central Illinois in the small town of Congerville. I attended high school in Eureka, IL, home of Eureka College, where Ronald Reagan was an alumni. I am a 3rd year student at the University of Iowa and have been enrolled in the Chemical Engineering program and Honors Program from day 1. During my 2nd year here at the University, I reached out to the Dean of Engineering, Alec Scranton, to see if he knew of any professors doing research in energy related fields. He told me of a professor that was new to the university, Professor Syed Mubeen. I spoke with Professor Mubeen and our 30 minute meeting turned into a 1.5 hour long meeting where we discussed the projects he wanted to begin and what I wanted to find in research. I began doing research for Professor Mubeen in January of 2015.

For the first couple of months, we; myself and Kevin Ngyuen (the undergraduates) our Ph.D. student, Alan; and our post doc, Wei; spent time setting up the lab because it was new. This involved setting up the equipment that had been brought and bought by Professor Mubeen and moving around the equipment that had been stored in the room over the last few years. The next part of my time there was spent helping Alan as he began his graduate project. He was working on creating a method of doing desalination of water through the use of solar cells. This meant helping him run the computer program and testing different calibrations/initial tests. Around March 2015, Professor Mubeen approached the undergraduates in the lab, with a project involving Supercritical CO_2. This/ These project(s) consist of synthesis of many different types of materials ranging from Methane to nanoparticles and rods in Supercritical CO_2. We all decided to start working on this project under the supervision of Professor Mubeen and Professor Aurand. This project began to undergo maintenance, of which I was am in charge, and would be continued later in the year. At the end of spring semester, Professor Mubeen asked for everyone to present ideas for projects. Monica, Scott, and I all started working on a project based in nuclear engineering because we presented ideas in the nuclear field. Together we worked on immobilizing scintillators onto glass slides and covering them with stable semiconductors for use in converting water into hydrogen via gamma/X-ray radiation. This project made great progress over the summer and has been put on hold while the gas chromatographer is calibrated to our specifications. I now work on the supercritical reactor, fixing it up, making all lines made of metal, and adapting it to our uses along with creating samples for Alan and Wei to use in their respective experiments. Another role I have held in the lab from the beginning is being in charge of our weekly meetings. I run the meetings, compile all of the presentations, schedule our location, and am in charge of making sure things get done.

I love working in this lab for a few reasons. The first reason is that it conducts research in fields ranging from desalination to scintillation, converting high energy radiation to low energy radiation, to nanowire growth to supercritical synthesis. The large amount of diversity in the projects allows for the job to never be boring. I can work on one project until a road block is encountered, usually ordering parts, and then move to another project until we are able to work through the road block. The next reason I love working in the lab is the amount of freedom that is given to the undergraduates and other members of the lab group. We are allowed to work on whatever projects we want and whatever interests us. I also like that Professor Mubeen makes himself available to listen to our ideas for the projects and give advice on what he thinks is best. The final reason I love working in the lab, I could give more, is the amazing environment that is present every day at work. The graduate student and post doc find time to help us undergraduates understand what they are doing and allow for us to help them.

My experience in the lab has taught me the value of getting to know your coworkers

Research as an Undergraduate Chemical Engineer (continued)

better and has taught me how to take charge of a situation. I have taken on responsibilities in our group that are usually given to graduate students such as ordering parts for the lab and setting up and running the weekly meetings. I have come to better understand the amount of work that must go into research and all of the safety procedures required. I now better understand the impact I can have on the world by solving the world's energy, water and food needs through energy research. I also understand the work required to receive funding much better now.

Silk Ink: A Pathway to the Termination of Organ Donor Lists

By: Elizabeth Zimmerman

Currently there are more than 123,000 people waiting for organ transplants. Every year more than 6,500 people die waiting for these organs ("Facts and Myths" 2015). Fortunately, due to new technology, scientists are getting closer to fixing this important problem. Chemical engineers have played an integral role in using their knowledge of chemistry, biochemistry, material science, and applied math to discover how to use 3-D printers to print organs. This promising technology could provide assurance that no person waits on an organ transplant list, and has the potential to lead to far-reaching improvements in medicine.

Scientists, engineers, and doctors have been making prosthetics for body parts such as knees or joints for many years, but more recently they have been looking to perfect making more complicated structures such as bones or even whole organs. For example, researchers at Princeton University and John Hopkins have created prototypes of simple organs like ears using chemicals that are biocompatible and will eventually facilitate the growth of real cells (Ledford 2015). There are multiple ways to create these simple body parts. One way is to put cells into a modified inkjet printer, and use a biocompatible scaffolding or mold to create the desired body part. Another method, similar to the one employed at Princeton and John Hopkins, involves a gel. This method uses a laser with different light frequencies to polymerize the gel and position the cells to create the desired body part (Mironov 2007). While these methods usually work to create simple body parts, they may lack the structure and function of real organs, and have many challenges during the process of creation.

There are a multitude of problems that prohibit scientists from printing complex organs. Many of the processes to create the organ kill the cells and or damage the body part, rendering it useless and wasting valuable research money. When using the cell ink technique mentioned above, only certain cells may be able to be subjected to a printer and even then it is very hard to correctly orient the cells to achieve the desired structure and function. The gel technique offers a means to correctly orient and position the cells using the laser, but it is often very expensive, still quite complicated to perform and occasionally ineffective (Mirnov 2007). Ideally, scientists would synthesize ink that was made of the cells, which would be naturally found in the real organ counterpart of the one they were attempting to create. In an effort to solve the issue of orientation, cells were taken out of the inks and alternative inks were formulated. These alternate inks are made of thermoplastics, silicones, collagen and gelatin or alginate, but because of their artificial composition, have severe limitations in their usage. These inks generally require a cross-linking method in order to fully form them, such as a pH or temperature change. These changes can damage the cells and other biological components rendering the cells useless or dead ("Silk Bio-ink Could Help Advance Tissue Engineering with 3-D Printers" 2015).

Recent developments by engineer David L. Kaplan and his team may have promising results for 3-D printing ink problem ("Department of Biomedical Engineering" 2015). Kaplan's ink is

Silk Ink: A Pathway to the Termination of Organ Donor Lists (continued)

made of silk proteins and glycerol. In addition to this ink being biocompatible, it also does not require the processing methods used to cross-link the other inks. This revolutionary ink terminates problem of orientation, and does no harm to the growing cells. This ink would also be able to contain additives that the other inks could not, which will be useful in keeping infection rates down and controlling stem cells growing in the body parts. Although Kaplan's ink is only one step in increasing efficiency and precision in 3-D complex organ printing and ultimately working toward a world without the organ donor list, it is a milestone and will lead to more multifaceted and effective organs ("Silk Bio-ink Could Help Advance Tissue Engineering with 3-D Printers" 2015).

Solving complex problems, such as synthesizing the perfect 3-D organ printing ink, takes an in-depth knowledge in biotechnology, biomedical engineering, and most importantly, chemical engineering. Using knowledge of material science and thermodynamics, a chemical engineer could help to ensure that the right material is being used in order to fit all the constraints set by the needs of growing stem cells in 3-D printed organs. If this material does not exist they could design a more suitable compound. At the heart of this issue is problem solving and thinking in new ways, something that is necessary when approaching a task as daunting as attempting to print working organs.

While scientists may not be able to assembly line create beating hearts or functioning kidneys; science is getting closer and closer to making the organ transfer list a thing of the past. A few short years ago 3-D printing was limited to simple biological structures such as plastic implants. Now tissue engineering can be used to create things as complex as ears, and hopefully soon much more complicated organs. Using chemical engineering's knowledge of materials and chemistry, synthesizing ink for organs has become reality. Tissue engineering and 3-D organ printing has come a long way since their beginning and still have a lot of unknown hurdles to get past. Chemical engineering has been vital to the process of refining and sharpening 3-D organ printing, and moving toward a world where 6,500 people per year do not die waiting for organs.

References:

"Department of Biomedical E gineering." *Tufts University, School of Engineering*. Tufts University, 2015. Web. 10 Sept. 2015.

"Facts and Myths." *America Transplant Foundation*. American Transplant Foundation, 2015. Web. 09 Sept. 2015.

Ledford, Heidi. "The Printed Organs Coming to a Body near You." *Nature.com*. Nature Publishing Group, 15 Apr. 2015. Web. 09 Sept. 2015.

Mironov, Vladimir. "Organ Printing." *Organ Printing*. University of Missouri, 2007. Web. 09 Sept. 2015.

"Silk Bio-ink Could Help Advance Tissue Engineering with 3-D Printers." *American Chemical Society*. ACS, 2 Sept. 2015. Web. 09 Sept. 2015.

RTP Company Internship in Winona, Minnesota

By: Sarah Goettler

My internship at RTP Company in Winona, Minnesota started with a tour of the facility as well as introductions to the key people I would be working with. RTP Company is a global plastic-compounding company that works with a wide variety of customers. Over the next week, I received training for the main parts of my project. My project was to study the shrinkage of RTP plastic formulas after injection molding with an emphasis on correlating filler type and percentage to the amount of shrinkage. I was responsible for setting up molding parameters, experimental procedures for measurement, and a plan for testing materials. As part of my project I worked with people from different departments to determine molding parameters and testing guidelines as well as to test specific materials

RTP Company Internship in Winona, Minnesota (continued)

that the senior engineers wanted to study.

When I started the internship, I had an idea of what my project would be like, but I did not expect to learn so many skills and help with so many different steps of the process. One of the goals of my internship was to see the entire process of making the product as well as learn about tests and information that the customers want to see. That goal was achieved early in my internship. For my project goals, the main goal was to have a comprehensive list of shrinkage for each main component in each base material. Due to the limitations of the production line as well as being limited to the materials purchased by customers, a complete list would take more than a few months to finish. The project was also considered to be an ongoing project, since new materials would be produced and need to be tested as the engineers design them. Therefore, my goal was to have an outline of data sheets for two base materials, polypropylene and nylon, that could be added to in the future.

As an intern, I also helped the engineers with their work. Helping them allowed me to learn a lot more about the tests that the materials undergo. In one case, I was given a large amount of very similar materials and was told to mold samples that would undergo scratch and mar resistance testing. After molding the plaques, I found out that I would be able to finish the project and conduct the scratch and mar testing myself. I was able to discuss the results of the tests with the engineer who formulated the material and have him explain the components that might have caused the difference in results. In many cases of assisting the experienced engineers, I molded the test bars that would be sent to the testing lab to test the physical and mechanical properties. However, instead of just sending them off to the testing lab, I was able to learn how to conduct several of the tests myself. I also had the opportunity to assist with the production of some of the formulas that I ended up molding. Helping with this process allowed me to see the raw materials the company works with as well as the process of producing the product that is sold to customers.

Throughout this internship I learned the importance of many skills such as communication, organization, and leadership. Working in a large company, there are a lot of people that all work to collect the raw materials, make the product, and then ship it to the customer. Added to that is the complication of 1st, 2nd, and 3rd work shifts so the people you talk to aren't always the ones that will be completing the task. I've learned that it's very important to have clear instructions and good communication so everyone understands the entire plan. As an intern who is new to the company, I had to learn to ask the engineers for more clear communication. Since many of the engineers had worked with the company for a while, they tended not to realize when they are using terms I wasn't familiar with yet. The most important thing is to get the task completed correctly and in order to do that communication is key to understanding what needs to be accomplished.

Leadership is also very important to the company. It is important to establish good working relationships with the people even if you might not be working with them. I learned that when you need help, it is better to have multiple people willing to help you than trying to complete tasks on your own when you're running out of time. By demonstrating good leaderships skills such as determination for completing a goal, willingness to work, interest in learning, respect for everyone no matter what their position, and a good attitude even when things aren't going as planned, you are more likely to work well with many different types of people. I noticed that there were more engineers who would ask me to help them more frequently due to my willingness to help the first time they asked.

The internship experience allowed me to see how engineers work together in an industrial setting while applying experimental procedures and data organization that engineers are taught in school. I really enjoyed getting to work with so many diverse people and learn from their experiences. I learned a lot about material properties as well as about all the test-

RTP Company Internship in Winona, Minnesota (continued)

ing and research that it takes to make a material with specific properties for an application. It was fun to work with the technicians to learn more about the machines I was using as well as getting to see the production of many different plastics. This internship helped me develop a better idea of the career goals that I'm working towards and let me apply concepts that I had learned in class. I'm glad to have had such a great experience.

Chemical Engineers In Dance Marathon

By: Vincent LaPelusa and Kayla Racinowski

Dance Marathon is a student run organization that raises money for pediatric cancer families and facilities and provides emotional support to the families by hosting various events for the children and cultivating relationships between the students and families.

Students involved in Dance Marathon are encouraged to raise money in order to attend the Big Event in February. During this event students celebrate the survivors, remember those who passed and dance for hope for 24 hours without sitting or sleep. Another event that students can participate in is Dance Marathon: The Marathon where students train to run/ walk the Chicago Marathon in support of the children and to raise awareness of pediatric cancer.

There are many different roles students can play within this organization, from a dancer who raises money and attends events, to leadership committee positions like that of a moral captains who meets with dancers and helps them throughout the year.

Within this article is two perspectives on what its like to be involved in Dance Marathon. Vincent LaPelusa will share his experience as a moral captain and Kayla Racinowski will share her experience training and participating in the Chicago Marathon for Dance Marathon.

Kayla Racinowski—Dance Marathon: The Marathon

On October 11th, 2015 I was lucky enough to be one of a few hundred people running the Chicago Marathon as a charity runner for Dance Marathon. When I joined the organization a year ago I went to all the family events Dance Marathon hosts to give these kiddos a slice of relief from their battles, and I have met the most INCREDIBLE people along the way - families and dancers alike. The first event I went to was a very humbling experience, I got to see first hand the impact Dance Marathon has on these families and their tiny humans (and even the not so tiny humans). Every single family has expressed their immense gratitude for what Dance Marathon does for them whether it be because they had or have a child or sibling that is battling or has completed a battle against this terrible disease. These selfless people come out and spend time talking to students about their journey with Dance Marathon to help keep us motivated and remind us that every dollar counts. Every penny of the money donated to this organization goes towards the little things like paying for a day of parking and a meal at the cafeteria to larger items like funerals and amazing events in which ALL of their children get to come to be just like every other kid for a day.

At the Big Event in February I had the opportunity to sign up to get more information on running the Chicago Marathon, so I did. A few short months later I went to an information meeting and within days I was signed up for the Chicago Marathon. I had friends who ran in the previous year, and since I enjoy running and I have a passion for the cause, I figured "how bad could it be?" Famous last words, as the story will tell. Training picked up in June, and honestly the whole training period wasn't too bad. Summer was a great time to train. The hardest part of training was finding time to run once the semester started, especially that 21 mile run (which is the longest run you're supposed to do before the marathon). Then came marathon weekend.

The night before the marathon, I stayed in a hotel with my family so I could trade a 3 am wake up for 5 am. At 6 am I made my way to the Congress Hotel where all the Dance Marathon runners met up so we could take a

Chemical Engineers In Dance Marathon (continued)

group picture and leave our personal items during the marathon. It still had not hit me that I was about to spend the next 4+ hours of my life constantly running until I crossed the start line. The adrenaline rush when starting the marathon is the most common cause for people to overexert themselves and thus make it impossible to finish, but for my experience, I ended up running slower than I trained just because of the sheer volume of people that were on the course. After the first 5 miles or so, the course was less dense and easier to maintain a faster pace than before.

Overall, the marathon itself was actually a lot of fun. There were people all over the course cheering you on and shouting words of encouragement. Towards the end of the marathon we ran through the various cultural neighborhoods, people were handing out food and forcing runners to engage with them with performances literally on the course. To some that may seem obnoxious, but miles 18-24 are where a majority of people hit their wall and ask themselves "why in the world did I do this?", so the distraction was actually welcomed. Once I passed mile 21 I was convinced I wasn't going to finish, my wall hit like a ton of bricks at this point. I kept pushing myself to run the farthest I had ever ran that day, and in the midst of motivating myself through mile 22 I saw a Dance Marathon family that had just lost their kiddo a few short months earlier. They saw my Dance Marathon jersey and they started screaming and yelling and I high-fived the kiddo's parents and younger siblings and I thought to myself "if these people can come out on top of one of the worst experiences anyone should ever live through, I can finish these last 4.2 miles". So I did. I continued to run, I found another Dance Marathon runner that I had never met until mile 24.2, and we continued to motivate each other until we crossed the finish line. Before the finish line, there are the hardest 400 meters of the whole race to conquer. Of the last 800 meters, the first 400 are about a 40 degree uphill incline, which is basically torture for those who have not done something as exerting as a marathon. However, the last 400 meters were completely flat, and I had never been more grateful to see a giant "FINISH" sign in my whole life.

The first thing I thought of when I crossed was all about the Dance Marathon families. They say fighting cancer is like running a marathon; it's about the endurance through the battle. Running the marathon was physically, mentally, and emotionally the hardest thing I have ever done in my whole life, but what I endured was nothing compared to what all the kiddos and their families go through in their fight against cancer. That day I learned a lot about myself from how much I could accomplish with discipline and motivation, to how much self-growth happens in 4 hours 49 minutes and 43 seconds. On the whole, I had an incredible marathon experience and I could not imagine it any other way.

Vincent LaPelusa—Moral Captain

Dance Marathon has been a huge influence on my everyday life. Ever since my first Big Event in 2014 I fell in love with the organization. The student run organization fundraises year round and provides support for families whose children have suffered or are suffering with cancer. At the end of this year of hard work and dedication of students involved a 24 hour event of no sitting, no sleeping, and no caffeine takes place to celebrate all the families. Being on Leadership and more specifically a Morale Captain has changed my life drastically. I am involved in order to spread the love of these families to everyone on campus. Further I want to spread awareness of Dance Marathon to more people and show/explain that it can make a HUGE difference in the lives of many families. By being a morale captain, I am able to inspire my group of dancers to fundraise, raise awareness and reach out to people not within Iowa city. I am also able to be more involved in the organization and dedicate more of my time. It is a wonderful organization that is doing wonders beyond belief for people each and every day.

Research on Drug Delivery for Respiratory Disease

By: Edwin Sagastume

I am a part of Dr. Fiegel's lab in the Department of Chemical and Biochemical Engineering here at the University of Iowa. Our lab's main focus is on targeted drug delivery for diseases infecting the lungs. I have been a part of the lab for over two years now and during this time I have worked on two separate projects. One of these projects involves developing, characterizing, and conducting *in vitro* and *in vivo* testing of antimicrobial aerosols. Antibiotic resistance has become more prevalent in recent years, and is particularly a problem for cystic fibrosis (CF) patients. Many of these patients become infected with *Pseudomonas aeruginosa*, a common bacterium that has a significantly high morbidity amongst people with CF or patients that are mechanically ventilated. My role in our lab involves generating dry powder aerosols containing antimicrobial peptides that are highly dispersible and aerodynamically light. Aerosols with these properties provide opportunities to treat respiratory infections more efficiently when compared to traditional aerosol formulations. This treatment's efficacy is tested on bacterial cell cultures generated from clinical isolates obtained from Dr. Starner at the UIHC. Furthermore, this treatment's effectiveness in eradicating a *Pseudemonas aeruginosa* infection in the lungs of mice is also investigated.

This project provides me with a unique opportunity to observe the pathway from initial formulation development to preclinical testing in animals. What is most unique about this project is that it allows me to communicate with professionals with a variety of backgrounds such as chemical engineering, pharmaceutics, and medicine. Speaking to doctors allows me to witness the realities of treating diseases in a hospital setting, which is difficult to envision when working from a lab setting.

Being a part of the Fiegel lab has provided me immeasurable opportunities as an undergraduate student. One of these benefits has been traveling to present my research. I have presented at a variety of conferences ranging from the size of small on campus conferences to large national conferences. I have presented a poster at two national conferences, and placed in the top six at the Society of Hispanic Professional Engineers National Conference. I have also given oral presentations at the regional AIChE conference and on-campus seminars. Like many others, I used to fear speaking to large groups, but these conferences have allowed me to develop as an engineer by providing me the opportunity to practice presenting to a variety of audiences. Along with progress in my oral communication skills, my technical writing ability has also developed significantly.

Although these are all great benefits from being involved in research, what I have enjoyed most is working together with research scientists to develop solutions to problems that currently have no answer. Working with scientists in different fields has helped me view problems from different perspectives. I have been able to see how a variety of fundamental concepts in engineering and other academic fields are applied to real world problems. This has allowed me to have a greater appreciation for what we learn in the classroom and other scientific disciplines. Being a part of the Fiegel lab and research has allowed me to develop as a student and professional.

The Future of Nanomaterials in Drug Delivery

By: Rachel Kessler

In recent years, the healthcare field has been developing at a rapid pace, resulting in a growing necessity to uncover the most effective forms of drug delivery. Chemical engineers are amongst those who have been working to discover new and more efficient ways to deliver drugs to the body effectively. According to Twibanire and Grindley (2014), "A large number of newly developed drug molecules are rejected by the pharmaceutical industry and will never benefit a patient

The Future of Nanomaterials in Drug Delivery (continued)

because of poor bioavailability caused by low water solubility and/or poor cell membrane availability." This issue has caused chemical engineers to look to new forms of drug delivery, resulting in a very promising candidate: nanomaterials. Nanomaterials are structures sizing in the nanometer range that can be engineered to have different physical properties. Two in particular are currently being developed for targeted delivery, polymeric dendrimers and fullerenes, both of which are clear contenders for effective drug delivery mechanisms.

Polymeric dendrimers are highly branched synthetic molecules, which are especially promising to chemical engineers because they can encapsulate drugs and have a large loading capacity. Nonjwade *et al*. (2009) states, "Easily controllable features of dendrimers such as their size, shape, branching length, and surface functionality allow [engineers] to modify the dendrimers as per the requirements." These molecules can be designed and engineered to be highly water soluble and have many available internal cavities for drug loading (Twibanire & Gindley, 2014). Additionally, they have a high degree of branching with functional groups attached to the ends, allowing them to act like "molecular Velcro" (Nonjwade et al., 2009). These structures can deliver drugs via many different pathways—through the skin, eyes, lungs, or orally—because of their unique chemical makeup and small size. Additionally, dendrimers can be used in targeted drug therapy, like cancer treatment. Many current cancer treatments do not specifically target cancer cells, making the drugs less effective. Polymeric dendrimers, on the other hand, have very effective cell-specific targeting agents, such as folic acid (Nonjwade et al., 2009). Folic acid attaches to folate binding proteins, which are overexpressed on cancer cells. Because of this, dendrimers are promising candidates for targeting cancer cells. The many advantages of using dendrimers as a drug delivery system have driven chemical engineers to research and develop them for the pharmaceutical industry.

Fullerenes are another molecule being researched extensively as a possible mechanism for drug delivery. These hollow, soccer ball shaped carbon structures are promising candidates because of their small size and biological activity. The hydrophobic core of the fullerene can be attached to hydrophilic groups, making them water soluble and therefore capable of carrying drugs to cells. Additionally, they can also be attached to lipid-like systems, which enable the molecule to carry the drugs through cell membranes (Bakry et al., 2007). These structures can have many functional groups attached in a controlled manner to the 60 carbon base, so chemical engineers can modify a fullerene to make it particularly effective for its specific application (Montellano, 2011). Furthermore, these structures are also good candidates for cancer treatments. Nagda et al. states that the fullerenes "could be delivered into human cancer cells by hollow lipid spheres and used to induce cell death under visible light irradiation" (2010). The procedure would enable fullerenes to tag cancer cells so that they could then be killed. This application illustrates the possibility of making fullerenes an effective cancer fighting candidate. Chemical engineers are working to develop these fullerenes and derivatives like it in order to create a new mechanism for drug delivery.

With the development of new drugs there must also be a development of ways to transport those drugs into the body both safely and effectively. Chemical engineers are amongst those who are attempting to tackle this problem. Current drug delivery mechanisms have many problems, including inability to permeate a cell membrane and nonspecific targeting, both of which reduce drug efficacy. Nanomaterials like fullerenes and polymeric dendrimers are a possible solution to these problems. Small in size, easily modified for specific purposes, and able to target specific kinds of cells in the body, these nanoparticles are a clear prospect for chemical engineers to further develop for the pharmaceutical industry.

References

Bakry, R., Vallant, R. M., Najam-ul-Haq, M., Rainer, M., Szabo, Z., Huck, C. W., & Bonn, G.K. (2007). Medicinal applications of fullerenes. International

The Future of Nanomaterials in Drug Delivery (continued)

Journal of Nanomedicine, 2(4): 639–649.

Montellano, A., Da Ros, T., Bianco, A., Prato, M. (2011). Fullerene C60 as a multifunctional system for drug and gene delivery. Nanoscale, 10.

Nagda, D., Rathore, K. S., Bharkatiya, M., Sisodia, S. S., Nema, R. K. (2010). Bucky balls: A novel drug delivery system. Journal of Chemical and Pharmaceutical Research, 2(2): 240-248.

Nanjwade, B. K., Bechra, H. M., Derkar, G. K., Manvi, F. V., Nanjwade, V. K. (2009). Dendrimers: Emerging polymers for drug delivery systems. European Journal of Pharmaceutical Sciences, 38(3): 185-196.

Singh, R., & Lillard, J. W. (2009). Nanoparticle-based targeted drug delivery. Experimental and Molecular Pathology, 86 (3): 215–223.

Twibanire, J. K., Grindley, B. (2014). Polyester Dendrimers: Smart Carriers for Delivery. Polymers, 6(1); 179-213.

Co-Op Experience with Cargill

By: Megan Jones

When I was offered a co-op with Cargill, it was a tough choice as to whether accept the position or not. I had to balance the cons, such as pushing back classes and graduation, with the pros, such as getting invaluable experience. However, during the last few months with the company, I have realized that accepting the position that was offered was the right decision.

Cargill offered me the position of Production Management Engineer, and I accepted a position within Cargill Corn Milling at the Dayton, Ohio plant to learn how to apply classroom knowledge to a plant processing business environment. With the position, my principal accountabilities have multiple facets; many of which line up to the goals that were set for me by my supervisor. The first accountability includes obtaining an understanding of the plant and how the processes and equipment work within different functional areas. Additionally, my responsibilities include managing and communicating effectively with people from diverse backgrounds and working within cross-functional areas of the plant. Lastly, I am learning the importance of government safety and environmental regulation within company policies.

From this general job description, I formed a few expectations. The first, and most important, expectation that I went into the job with was that I will be challenged. From the time that I applied, I knew that this would be fundamental to my experience. Along with that, I expected that I would be given meaningful work to do. This expectation goes hand-in-hand with the expectation of being challenged. Additionally, I expected that I would meet many new people from all backgrounds and that I would be applying my learning in a hands-on fashion. The last two expectations followed directly from the job description that I was given. While I had these expectations to begin with, when I started I had no idea how fully they would be surpassed.

My supervisor assigned my 5 different goals at the beginning of my term, including: developing and implementing a capital project, learning the process flow, developing a project to install additional equipment to ensure the safety of workers, supporting operations and process improvement through smaller projects and tasks, and assisting with current projects as needed. In addition to these goals, my expectations led very well into becoming goals of themselves. The biggest personal goal of mine was to challenge myself in as many ways as I can—to challenge myself in my learning, time management, and any other unexpected areas in which I have the opportunity to exceed my own expectations.

The first of these that I accomplished was learning the process flow. I knew that I needed to teach myself a process that I would be tested on, and that was simply like studying for another test, except that it was a written test as well as a physical test—not only did I need to know the pro-

Co-Op Experience with Cargill (continued)

cess on paper, but I also needed to be able to walk down the process units in the field. From there, I set a deadline for myself and decided to study or review the process daily and proceeded to pass these tests with ease.

I have also successfully supported operations so far. I have helped with paperwork that is important, but still time consuming as well as helping with ensuring safety and learning procedures in shut-downs. Furthermore, I have also had the opportunity to challenge myself. I have become much more proficient at working at my own pace and being able to set reasonable deadlines for myself, as exemplified with my task of learning the process flow. The other way that I have challenged myself is taking every opportunity that I can to learn, even if it means coming into work at 3 in the morning to follow engineers around and assist with shutdown procedures. In a similar fashion, I have been able to challenge myself to take on a few different projects simultaneously to test my time management skills and through doing that, I have come to the understanding that asking questions is crucial to my learning and I need to be able to do that effectively.

The biggest goal that I have yet to achieve is developing and implementing a capital project. Other than that, I am just excited to be able to continue my current long-term projects and supporting other engineers and plant operations. Also, taking on additional smaller tasks, such as labelling process flow and equipment, that will not only aid in my learning, but also aid in the understanding of any person who walks through the plant.

My supervisor has been extremely helpful so far. We have a weekly meeting set up to discuss the projects that I am working on, projects that should be on my horizon, and any questions I may have, whether they be about my project, the plant operations, or anything else. In addition to that, I feel that I am welcome to ask anybody in the department questions that I feel they may be able to answer and that they will try to be as helpful as possible. Moreover, I have been assigned two mentors, whom I also have weekly meetings with. In these meetings I can also ask them for more insight on my projects, but also ask them about being a female engineer in industry. With all of this, the big picture is that I feel that everyone is committed to helping me learn and do the best work that I can do.

All in all, in the last two months I have learned more and been challenged in more ways than I could have ever expected. I have learned that doing engineering work takes much more attention to detail and communication skills than I thought it would. I am very thankful that I was offered and decided to accept this position, and I am more excited than ever to see what the next few months at Cargill has in store for me.

Creation and Characterization of Novel Materials for Water Purification

By: Jeremy Hutton

Since January 2014, I've researched with the Tori Forbes research group under Ashini Jayasinghe, a graduate student working towards her doctorate. Her research aims at creating novel uranyl, uranium (VI), species in the solid state at atmospheric conditions. After the discovery of uranyl IDA nanotubes and 2,6-PDC nanotubes, current syntheses aim to create similar structures. The uranyl IDA nanotubes are unique due to their ability to uptake water and hydrogen bond with water inside of the nanotubes. In order to find new structures, one varies ligands and the chemical environment the uranium crystallizes in. The methods used to induce crystallization slowly bring the solution to supersaturation by slowly evaporating the solvent or by introducing an antisolvent which reduces the solute solubility in the liquid phase. The crystals take anywhere between a few days to a couple months in order to crystallize into a solid large enough to analyze with an x-ray diffractometer. With the diffraction data, the group is able to decipher the crystal structure.

My job is to focus on the chemical synthesis and crystallization in the lab. I prepare each of

Creation and Characterization of Novel Materials for Water Purification (continued)

the crystallization mixtures, set up, and monitor the samples during crystallization, and obtain the unit cell for crystals that form. In order to prepare a crystallization mixture, I bring the solution to a point where the ligand may chelate the uranyl cation by raising the pH of the solution, which also drops the solubility of the uranium, meaning this must be done very slowly and carefully. Once I have prepared the ligand-uranyl solution, I induce crystallization by covering the solution with a perforated film to allow for slow loss of solvent, or by layering another solvent, which the species is insoluble in, on the solution which will slowly mix with the solution. Over the course of the crystallization, I check the solutions twice a week, and if there are solids that form, I check their shape and crystallinity with polarized light microscope. If a good crystal forms in any of the samples, I take a small crystal and get its unit cell information with the x-ray diffractometer, which can be used to quickly see if it is a species that has been already synthesized.

I enjoy the thrill of creating something new and the search for that creation. My research is the creation and characterization of novel materials some of which, like the uranyl IDA nanotubes, have possible applications in water purification. I find that this research also helps me with my performance in school, by using my knowledge of chemistry and material science. Experience in planning laboratory procedures and maintaining a lab notebook has helped me in both chemistry and chemical engineering lab courses. I have gained experience in navigating scientific literature in order to find what other groups are doing and producing. Working with a radioactive heavy metal like uranium has given me experience in paying serious attention to waste disposal and safety. Working with various ligands and solvents has given me experience in evaluating an MSDS and handling new materials in a safe and informed manner. Overall, I think that research has provided me an involved education on many things that I will either learn later in my education or may never learn in class.

Chemical Engineering and Controlled Drug Delivery

By: Jacquelyn Ricke

Former Surgeon General C. Everett Coop famously stated, “Drugs don’t work if people don’t take them,” and many in the science and medical community took it as a challenge to make pharmaceuticals more user-friendly (Langer & Traverso, 2015). This advancement has a monetary incentive as well, as it is estimated that $100 billion is spent annually on hospitalizations that could be avoided if people adhered to medical instructions (Langer & Traverso, 2015). One of the solutions that engineers and medical professionals turned to was controlled drug delivery, but chemical engineers have much to do before it is clinically feasible.

Controlled drug delivery is a very broad field and encompasses an immense amount of research. Decades of studies have introduced macro, micro, nano, and surface forms of delivery, designed to make drugs more efficient or easier for patients to use (Hoffman, 2008). In recent years, pharmaceutical methods such as microencapsulation have been developed, where the drug is in a capsule coated with a polymer that is taken orally. Current studies show that it can be effective for a few hours to a few days, depending on the drug (Lam & Gambari, 2014). In relation to human biology, it is known that the gastrointestinal (GI) tract can hold relatively small masses for weeks or months with no significant effects (Langer & Traverso, 2015). If these two fields were combined successfully, it may make medications easier for patients to take and therefore have a significant impact on the pharmaceutical and medical industries.

When considering the human body, many variables must be considered in order to ensure the safety of the patient. One potential liability is if a problem were to occur while the ingested capsule was in the GI tract administering the drug. There must be a way to

Chemical Engineering and Controlled Drug Delivery (continued)

remove or combat the drug without causing any harm to the patient. Other issues are transporting the drug to the GI tract and then making sure that it stays there. There needs to be a way to ensure that it will not get stopped somewhere earlier or make its way out of the system before releasing the drug. In addition, the capsule needs to be designed in such a way that the drug cannot all disperse in the body at once, as there could be very extreme consequences. It will pass through many pH levels on its path and will be in a hostile environment for a substantial length of time, making these all serious concerns (Langer & Traverso, 2015). The human body, in a sense, can be viewed as one very complex system, and the drug would be another input to it. Therefore, chemical engineers, alongside medical professionals and researchers, are studying these cases to make sure that the patient is as safe as possible.

One of the biggest challenges facing the controlled drug delivery field today is mass production. There have been several isolated cases where microcapsules and other delivery methods have been successfully developed and applied, but they have yet to be produced on a larger scale. Many issues with standardization, reproducibility, and quality control arise when controlled drug delivery is closely examined (Lam & Gambari, 2014). Chemical engineers bring a unique skillset when these issues are considered. They have the knowledge of chemical processes to understand what is happening with the system and interpret the data, while also bringing forth an understanding of mathematical modeling. They know how thermodynamics and various equipment may affect the product as it is produced on increasingly larger scales (Sherlock, 2009). This broad knowledge is what makes a successful scale-up feasible. In the end, while the advancements thus far are groundbreaking, they cannot do much good unless they are able to be produced and used by the public.

There are many potential advantages to the integration of controlled drug delivery in the medical community, so it will likely continue to be studied. Research suggests that developments such as microcapsules could be a possible form of delivery in the near future. It is clear, however, that chemical engineers will have a significant impact on the system before this happens. Mass production of an input to a system as complicated as drugs in the human body will be best addressed by chemical engineers, who are specifically trained in this matter.

References

Hoffman, A. S. (2008). The origins and evolution of "controlled" drug delivery systems. *Journal of Controlled Release*, 153-163.

Langer, G. a. (2015). Perspective: Special delivery for a gut. *Nature*.

P.L. Lam, R. G. (2014). Advanced progress of microencapsulation technologies: In vivo and in vitro models for studying oral and transdermal drug deliveries. *Journal of Controlled Release*, 25-45.

Sherlock, J.-P. (2009). Ten things chemists should know about chemical engineers. *Chemistry*

How Yoga Made Me a Successful Chemical Engineering Student

By: Abigail Haas

It's clear that throughout the four years of an undergraduate degree, a student's experience can be overwhelming. Many people will explain different ways of how they survived the brutal assignments and projects of an engineering degree; but I found that connecting to something outside of academics saved my education.

In my opinion, the most difficult aspect of being an engineering student is finding a balance between pressure and relaxation. Some of my friends and I like to call this "the steam roller" major. If you stop moving, or crack under the pressure, you'll be flatted to the ground with no hope of getting ahead again. Instead of working hard and seeing immediate reward for your effort, an engineering student will quickly learn

How Yoga Made Me a Successful Chemical Engineering Student

By: Abigail Haas

it's all about delayed gratification. Yoga helped with my mental stamina, patience, and appreciation for life's (and my major's) challenges.

I went to my first yoga class during the beginning of freshman year. At that time, it was a fun and unfamiliar way to exercise. After attending classes more regularly, I learned more about the deeper concepts of yoga that not a lot of people realize. As a result of this, a balance was found in my academic career.

Yoga is a method utilized throughout the world to become more connected with your body and mind. Each pose is held for an extended period of time in order to develop physical and mental relaxation with the position your body is in. For me, this dealt a lot more with the position my mind was in. At each class my poses became more developed and my mind became more resilient to outside strain. For the entire sixty minutes of class, my mind could not think about anything besides what I was doing- not even engineering.

When you're focusing on a posture that requires balance and strength, being stressed about an exam or a lab report is not an option. During yoga classes, I found that my mind cleared of the pressure being put on me from my academics and all I thought about was what I was doing in the moment. This feeling left gradually after the classes end, but my attitude towards the goal has changed. Nothing about an engineering degree is impossible if you have the determination to succeed.

Now, as a junior at the University of Iowa, I find that my chemical engineering schedule is manageable. Classes are still difficult, and yoga doesn't make the homework assignments any shorter. However, I have no doubt that I'm still present and succeeding as a student because of what I learned in yoga, and I plan on continuing my practice long after I graduate. What I sought out was a yoga practice to find balance in my life, and that's exactly what I found.

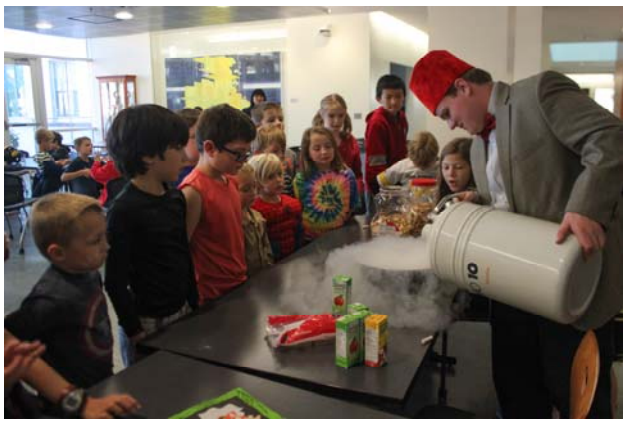
Halloween Day Camp: A Spook-tacular Success

By: Daniel Davies

The Halloween Kid's Science Day Camp was a spook-tacular success. An unprecedented 39 ghosts and ghouls showed up to haunt the engineering building and make some spooky science happen. The volunteers used mystical experiments to inspire the kids to learn more about science. Everyone was encouraged to wear their costumes and from Minecraft characters to witches to Harry Potter, we had them all.

With such an increase in number of shadowy creatures, we had to divide the experiments among two different rooms. In one room, kids explored the mysteries of non-Newtonian fluids (and studied the growth of messes) with cornstarch and water. While some of the kids enjoyed this mess, others were not so fond of it and preferred to observe. They enthusiastically froze various edible treats, most notably marshmallows, along with chocolate syrup and animal crackers, in liquid nitrogen. They had fun playing with magnetic levitation and used the magnets to make a magnetic liquid and silly putty creep through their surroundings.

In the other room the kids painted spooky glow-in-the-dark pumpkins, experiencing fluorescence first hand. They made slime and worms through polymerization reactions to gross out siblings and parents alike. This experiment seemed to be a favorite amongst the kids due to the gross factor.



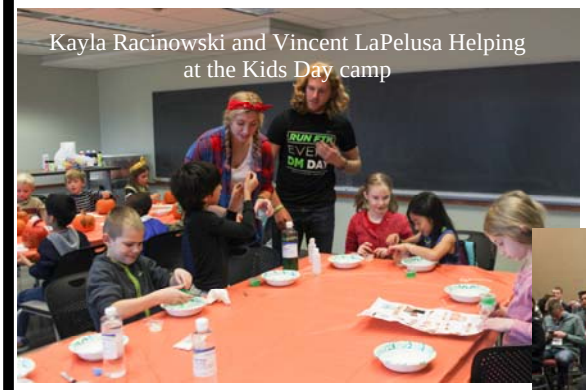
Halloween Kid's Day Camp: A Spook-tacular Success (continued)

They also investigated dry ice, making bubbles with soap and water and coins scream in the frozen carbon dioxide.

This camp is held every fall. This event is normally a great success, however this year, with increased outreach and advertisement, was the most successful fundraiser coordinated by AIChE volunteers in many years. Many students volunteered their Sunday afternoon to supervise, help conduct the experiments for the kids and clean up the gory mess that was left. With the help of the volunteers and the awesome kids that showed up to learn more about science. A fang-tastic time was had by all.

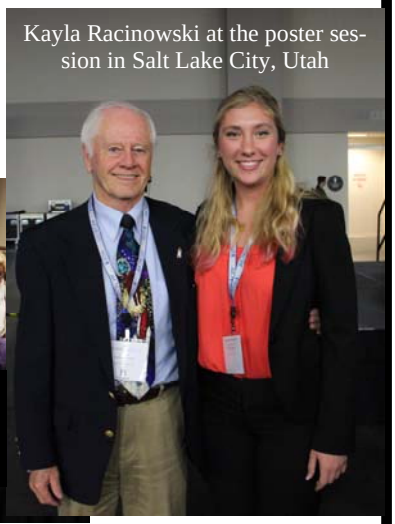
Group Photo of kids attending the Halloween Day Camp

Chemical Engineering Spotlight

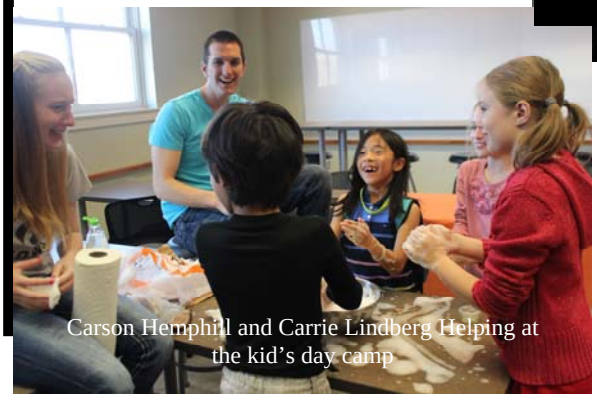


Kayla Racinowski and Vincent LaPelusa Helping at the Kids Day camp

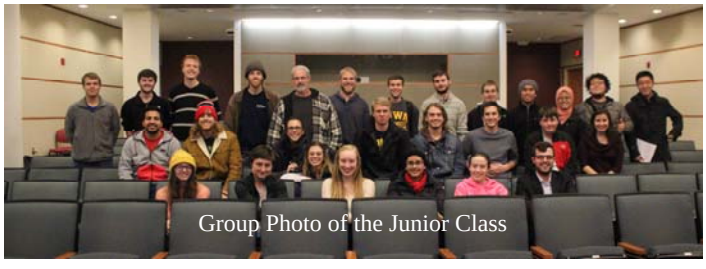
ChemE Jepardy Team: Nathan Schuchert, Zachary Berhendt, Matthew Johnson, Daniel Davies



Kayla Racinowski at the poster session in Salt Lake City, Utah



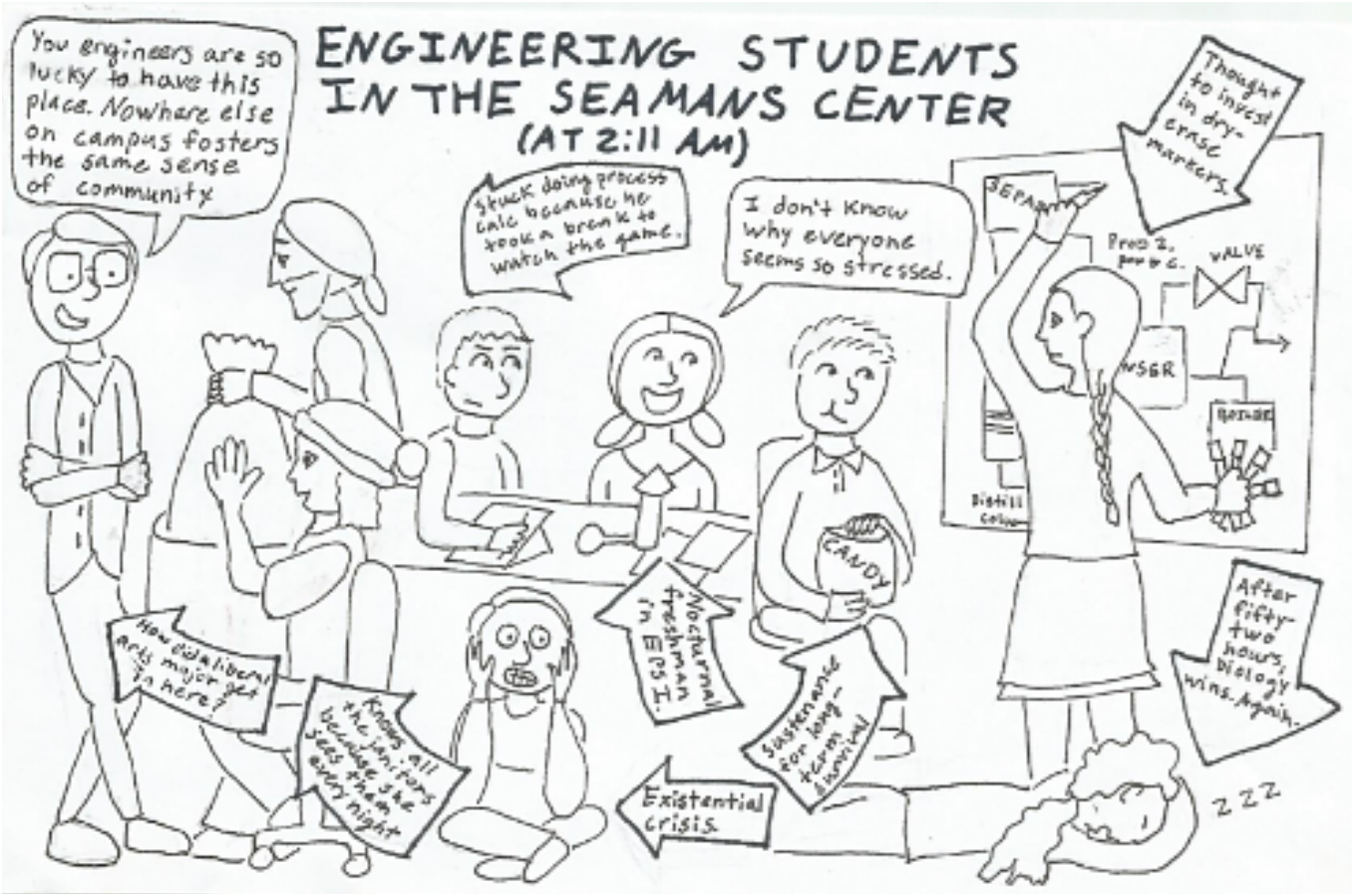
Carson Hemphill and Carrie Lindberg Helping at the kid's day camp



Group Photo of the Junior Class

Chemical Engineering Funnies

By: Corinne Andreson



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Thank you to the AIChE Officers for their hard work and contributing efforts to make our AIChE Student Chapter a successful organization.

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Your help is much appreciated!

Interested in speaking at professional seminar? If so, then contact AIChE Student Chapter President at Nathan-Schuchert@uiowa.edu or Student Chapter Advisor Prof. David Murhammer at david-murhammer@uiowa.edu for details and availability!

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