COLLEGE OF ENGINEERING & APPLIED SCIENCE
UNIVERSITY OF WYOMING

Chemical Engineering

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Chemical Engineering Newsletter **October 2018**

Message from the Head:

Time flies when ideas materialize through timely action. Our Chemical Engineering Fall 2018 Newsletter packs a punch with plenty of positive news. I spent an invigorating summer learning and working with partners on and off campus. The meeting with talented Heads and Chairs from the western region was quite illuminating and served as one of the best training opportunities I have ever experienced. New Mexico State and The University of New Mexico were wonderful hosts in our meeting in Santa Fe, NM.

One of our industry partners, Genesis Alkali, catalyzed the kick-start of our **Process Control Engineering** program through a substantial donation. We are indebted to Genesis, particularly to Aaron Reichl (member of our Industry Advisory Board, IAB), Fred von Ahrens (VP) and Samuel Bethea (Control Engineering expert) for championing the partnership. Another partner that acted generously with time and advice, Sinclair, has given us terrific guidance and joined an advisory board for Process Control and Instrumentation along with Genesis Alkali. An article by Samuel Bethea (Genesis), sheds light on the importance of Process Control Engineering for industry. Maribeth Plocek (Sinclair), another IAB member, has been an enthusiastic supporter. Bruce Pivic, a UW alum, has been a great addition to the Advisory Board for Process Control. An IAB member and alum, Jessica Schlicting, provides a great personal account on her Process Control experience in her article. This exciting opportunity is only possible with our internal champions' participation, particularly Prof. David Bagley, Dean Michael Pishko and Craig Russow (UW Foundation). Prof. Bagley is committed to the success of the program and wrote two articles for the newsletter. The Department of Electrical and Computer Engineering is an effective partner and is onboard with Process Engineering and Instrumentation, which will serve both departments. The minor will be launched in Fall 2019. A certificate is in the works.

As announced in our Fall 2017 newsletter, Dean Pishko worked with us to secure space for the bioengineering lab. Dr. Karen Wawrousek's efforts have now paid off, and I am delighted to announce completion of the lab. We will give her a break to focus on her research program. A ribbon-cutting ceremony will be held on October 12.

Our students continue to make us proud. The Society of Women Engineers will take a record number of students (16) to the national conference. The AIChE student chapter will also take a good contingent to the annual meeting. Please, enjoy the two articles by student chapters and other great announcements. Our faculty and staff remain dedicated to our primary functions, keeping students' success as our utmost priority. Faculty publications and graduate students that completed their degrees in this cycle are also listed in this Newsletter. A worthy note is Dr. Li-Oakey's tenure and promotion to Associate Professor. We look forward to her future success as Associate Professor. Carbon Engineering continues to flourish with contributions of several faculty in Chemical Engineering. The Materials Science and Engineering program continues to grow. A new DOE Energy Frontier Research Center ($10.75MM) led by Stanford University has UW's participation ($2MM) through Profs. Saman Aryana (CHE), Teresa E. Lehmann (CHEM) and Vladimir Alvarado (CHE). A new first year seminar (freshman) title "Brewing" will start in F2019.

We envision an even more exciting new academic year and welcome interest in choosing us as your academic program. Enjoy our Newsletter!

A Personal Perspective on Industrial Process Controls

By Jessica Schlicting of Shell

I vividly remember the day my manager asked me whether I would be interested in a role in process control. At the time, I had been working as a process engineer in a refinery for a couple of years. During that time, I had had two different positions, both in process engineering, providing support to different sets of process units in the plant. Though I wasn't doing design work, I was using most of the concepts that I learned during my years of chemical engineering schooling at the University of Wyoming. Process controls was always an area that I saw as different from the traditional process engineering work that I had done, though I had worked side by side with the respective controls engineer in each of the operating departments that I worked.

You could say that I was worried about how I might feel if I took on a process controls role- what if it was boring? What might I be doing on a day to day basis? What kind of additional training would I need to be successful? What I didn't appreciate then but found soon after I moved into the controls role that my manager ultimately offered me, was that process controls and instrumentation are the beating heart of any manufacturing facility. This technology provides the vital signs for a process unit, the key information that lets operations and engineers understand whether there are any issues that could jeopardize the unit cycle length or would allow for further optimization. Beyond the sheer necessity of control and optimization in a refinery environment, the work itself has the "cool" factor. I was able to work on what we called advanced control loops that simultaneously used multiple temperatures, flow rates, and levels across a process unit to control and optimize the unit operation. Through this work, I was able to improve operability and safety of the process unit, while also increasing revenue for the refinery. For those interested in the newest gadget or technology, process controls is the place to be. Because this space is evolving so quickly relative to any other refinery technology area and the ease/cost of implementation is usually lower than most upgrades or changes in a refinery, as a process controls engineer, I was able to try out new technologies often, which enabled me to innovate and think creatively in a different way than I had in my previous roles.

Additionally, industry needs more process controls engineers and is anticipating an even greater need for process controls engineers in the future. For one, as with most industries, there is a sizable generation of experienced workers close to retirement, reducing not only the number of people but also the available expertise. ***Continued on next page***

A Personal Perspective on Industrial Process Controls

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Because process controls and instrumentation is firmly placed in the “technology” category, this area in particular is rapidly evolving from analyzers equipped with lasers to touch screens and beyond- the landscape of this world today is very different from the one even a decade ago. Refineries and other manufacturing facilities have an ever-growing number of instruments/analyzers and control loops in use, all which process control and instrumentation engineers implement and manage. Arguably, chemical engineers are best suited to step into process controls and instrumentation engineering positions, in particular chemical engineers with a focus on process controls. Because of their deep knowledge of the process relative to their peers in other engineering disciplines, they can implement new control strategies and technologies most effectively. “Big data” seems to be the buzz word these days; with the increase of available data and more focus on margin and reliability at nearly every manufacturing site, effectively managing big data is and will be a key opportunity industry-wide. The ability to analyze the massive amounts of available data to understand previously missed codependency's and opportunities across a refinery and implement those learnings to improve site operation is invaluable. The group most clearly faced with leveraging big data analysis in any manufacturing facility is the process controls group.

From a process engineering perspective, the key technologies (hydrocracking, fluid catalytic cracking, delayed coking, and distillation) have evolved, but have not appreciably changed for decades. Process controls, however, is closely tied with new technology development, so for that reason is constantly changing; the strip charts of 30 years ago have long since been replaced with complex electronics and large process information databases. If my enthusiasm for this technology area has not come across throughout this article, then I’ll assure you that I was very happy both in the role and with the tools that it gave me in subsequent positions that I’ve held. Finally, I’ll leave you with the thoughts that I have at times and believe that industry is faced with- what will the manufacturing facilities of the future look like? Perhaps robots will be used for safety sensitive tasks, perhaps entire refineries will be run by optimizers and models and will be entirely automated, with personnel providing only maintenance support. Either way, process controls is the group best poised to forge ahead into this new frontier.

Process Control Role In Industry

By Sam Bethea of Genesis Alkali

The process control world has evolved so much over the past 40 years that it cannot be considered a sub-discipline anymore. It went from pneumatic and mechanical devices to analog electronics, then from digital electronics to software applications. With the advent of the Ethernet and wireless communications it shifted from hermetic systems to completely open systems offering thousands of features and possibilities impossible 30 years ago.

Process control systems are the brain and arms that control a process so that it behaves safely, minimizes downtime/losses, and ensures consistency in quality and throughput. Being a one dimension discipline 40 years ago, it has become a multi-faceted discipline nowadays which requires knowledge in advanced process control strategies, computer science, programming, networking, cyber-security, and wireless communications. One can't stop progress; the next step is to integrate the IIOT (Industrial Internet of Things) in process control systems.

Process control is critical to the safe and effective execution of capital projects. Corporations have an allocated capital budget in which there are competing priorities. This means to stay ahead of the competition, you must do (or choose) the right project and do the project right. The process control components of these projects help to optimize safety, productivity, yield, and total cost of ownership. A cost benefit analyses as well as risk analyses is performed to determine the best alternative. The process control engineer plays an important role in the project team. He or she provides valuable insight during the design, Process Hazard Analysis (PHA), and Pre-Startup Safety Review (PSSR). The process control narrative produced for the process provides documentation needed for operations training. It is also used as a basis of design before making future changes through the Management of Change (MOC) process.

Besides what is mentioned above, being involved in process control implies by extension that one gets to know the detailed functionality of each piece of equipment in a process and the interaction between each of them. It is an absolute necessity to understand the chemical, physical, mechanical, and the electrical principles behind the functioning of equipment in order to program it to design. Being a process control engineer means understanding several disciplines and a multitude of processes from chemical, to steel, to automobile manufacturing, to food and pharmaceutical to name a few. A specialty of this discipline is the instrumentation engineer which requires understanding hundreds of physical variable measurement principles from flow, pH, viscosity, etc.

The requirements for a good process control engineer are: passion, curiosity, logical mind set, and team work. Process control engineers are at the center of all engineering disciplines; they sit at all tables. If you like diversity, challenge and evolution; this is your place.

Life-long Learning: Process Control

By David M. Bagley, Ph.D., P.E.

Long term success in any field requires life-long learning. Life-long learning is so important that ABET requires all engineering programs to demonstrate that their graduates have the skills to continue learning. The need for life-long learning is especially true in chemical engineering where new technologies arise across the wide range of areas where we must remain capable. Chemical engineering professors are also always learning, through their research and, perhaps surprisingly, through their teaching as well. Over the last several years, I have had the privilege to learn a lot about process control, an increasingly important area for chemical engineers.

The course CHE 4090 (Process Dynamics and Control) has long been a required course in chemical engineering at the University of Wyoming. After teaching CHE 4090 (in addition to many other courses) for years, Professor Emeritus H. Gordon Harris taught it for the last time in Fall 2013 before retiring in 2014. The Department needed somebody to teach CHE 4090 in Fall 2014 so I volunteered. I had last looked at process control material when I took the course as a senior undergraduate in 1983-1984. I vaguely remembered something about PID controllers and Laplace transforms. Certainly that would be enough - what could have possibly changed in process control in the last 30 years?

In Fall 2014 a group of unsuspecting seniors had the opportunity to learn process dynamics and control along with me. Following just-in-time principles, I was about 10 minutes ahead of the students. I saw a lot of puzzled faces in class that fall but we all survived. I knew that UW had some control experts in the Department of Electrical and Computer Engineering so I decided to learn from them. Professor John O'Brien graciously let me sit in on EE 4620 (Automatic Control Systems) in Spring 2015 and his graduate control class in Fall 2015. While both courses were very interesting, the latter was truly mind-blowing for a non-electrical engineer. I was hooked – process control is fun to learn and fun to teach and this fall (2018) I am teaching CHE 4090 for the fifth time.

While learning enough about process control to teach CHE 4090, I was also able to teach CHE 4050 (Unit Operations Lab II) in Spring 2016, Spring 2017 and Spring 2018. In Spring 2016, I was fortunate to team with and learn from Professor David Bell. He had converted CHE 4050 from a traditional unit operations laboratory where students conducted a set of pre-designed experiments into a novel, highly active learning experience.

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Life-long Learning: Process Control

By David M. Bagley, Ph.D., P.E.

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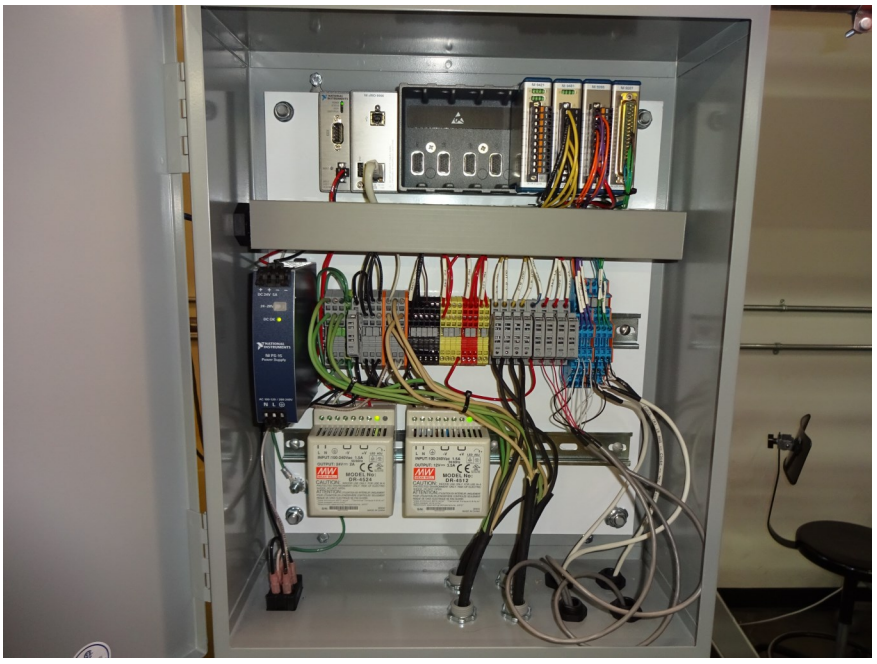


Students select an engineering problem, they design and construct the needed experimental apparatus, and then they conduct the experiments to gather the data to examine their problem. Additionally, students are required to write laboratory instructions for their apparatus so that their experiments can be evaluated for future use as pre-designed experiments in CHE 3040 (Unit Operations Lab I).

In Spring 2016, one student group in my section chose to work on developing a process control laboratory. They designed and constructed a system to measure and control the water level in three columns. We had received funding from the College of Engineering and Applied Science that allowed us to purchase three control valves and a programmable logic controller (PLC) as well as the pumps, piping and laptop to run the system. The students constructed not only the physical system but also wrote a LabView interface to operate it. For the PLC and training in LabView, we relied on terrific support provided by Marvin Perry, Senior Systems Engineer in the College's Machine Shop.

In Spring 2017, two more student groups put the process control laboratory through its paces. We learned much more about its capabilities (and limitations) and in Fall 2017, a graduate teaching assistant was able to fine-tune the system. In Spring 2018, we rolled out the new process control laboratory to CHE 4050 students who conducted this pre-designed lab in addition to their self-designed experiments. Although I am not teaching CHE 4050 in Spring 2019, I will take the feedback we received from the Spring 2018 students to further improve this system.

Since first teaching CHE 4090 in Fall 2014, I have learned a lot about process control. I hope students have learned something too! This past summer I have also had a chance to learn about the demand for process control engineers in industry, especially here in Wyoming. The demand is strong and shows no signs of diminishing. Of particular interest to me was learning that industry needs chemical engineers to help solve their process control problems, specifically because chemical engineers understand chemical processes. Furthermore, I learned that industry is having trouble finding process control engineers because many chemical engineering programs have shifted their focus to other areas. This provides an opportunity for UW and one we intend to seize. In the meantime, I will continue my life-long learning in process control as we work to develop coursework and laboratories to support a new educational opportunities in process control and instrumentation for UW students.

Process Control and Instrumentation Minor

By David M. Bagley, Ph.D., P.E.

Wyoming industry has spoken: they need engineering graduates with strong fundamental and practical training in process control and instrumentation. These engineers need to understand the processes that they are controlling, they need to keep their focus on the dynamics of these processes, and they should have hands-on experience. To address this need, the Department of Chemical Engineering at UW is leading the development of a Process Control and Instrumentation Program. A key step in the program is to develop an undergraduate minor in Process Control and Instrumentation.

The **minor in Process Control and Instrumentation** will require a minimum of 18 hours of coursework. To recognize that several engineering programs at UW already require coursework related to process control that is appropriate for the minor, up to 6 hours of coursework taken for the minor may also count as required coursework toward a student's major.

All students will take CHE 2005 (Chemical Process Analysis). This three-hour course is currently required for all chemical engineering students. Students learn to examine chemical engineering processes quantitatively, specifically applying material and energy balances to engineering processes and systems. Because the concepts in CHE 2005 are fundamental to understanding processes, non-chemical engineering students pursuing the minor must also take this course.

A set of three new required courses is being developed for the minor. The first will be a two-hour 2000-level course that introduces students to sensors, valves, actuators and the assembly of process control components. This new course will also provide hands-on practical experience with level control, flow control, temperature control and pressure control processes. This course will consists of one hour of lecture and two hours of laboratory per week and may be taken by all engineering students who have completed Calculus II. The laboratory component will be conducted in the proposed Process Engineering Control Laboratory to be located in Engineering Hall and in the Fluid Mechanics Laboratory in the new Engineering Education and Research Building.

The second new required course will be a one-hour 3000-level course that introduces students to dynamic simulation software for controlling individual chemical engineering processes. This course requires CHE 2005 as a prerequisite. This course will consist of two hours of laboratory per week and will be located in the proposed Control Simulation Laboratory to be located in Engineering Hall.

The third new required course will be a three-hour course where students learn to put everything together. Students will be presented with process systems to control. They will learn to identify and specify the key parameters to be controlled, select appropriate sensing and transmission systems, specify appropriate final control elements, and select an appropriate controller. By the end of the semester, students will be able to accomplish these tasks for a system of linked processes. This course consists of two hours of lecture and three hours of laboratory per week and will use both the proposed Process Engineering Control Laboratory and the proposed Control Simulation Laboratory. The new 3000-level course will be a prerequisite. Additionally, students must be concurrently enrolled in either CHE 4090 or EE 4620.

For their final required course, students may choose either CHE 4090 (Process Dynamics and Control) or EE 4620 (Automatic Control Systems). These existing three-hour courses are currently required for all chemical engineering students (CHE 4090) or electrical engineering students (EE 4620). They develop the classical control theory that is needed to design controllers and formally evaluate control loop performance.

Students will complete the minor by taking at least six hours from a list of approved electives. The following three courses are already approved as electives – ES 2210 (Electric Circuit Analysis), EE 2220 (Circuits and Signals), EE 3220 (Signals And Systems) – and additional courses will be evaluated for approval. Additionally, students will be encouraged to complete an internship in Process Control Engineering. This will enable students to obtain credit for serving as interns with an approved organization that provides process control and instrumentation experience.

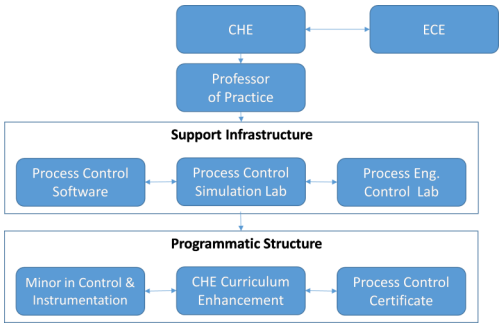
The minor in Process Control and Instrumentation has not yet been formally approved by UW. Next steps include finalizing the necessary justification for the minor and routing it through the appropriate administrative levels for approval. The goal is to accomplish this by May 2019 to allow students to begin pursuing the minor starting in Fall 2019. Feedback from all stakeholders is welcome. Please send feedback to Professor David Bagley at bagley@uwyo.edu.

Process Control and Instrumentation Program

This educational and training program will be coordinated by the Department of Chemical Engineering in partnership with the Department of Electrical and Computer Engineering, and industry.

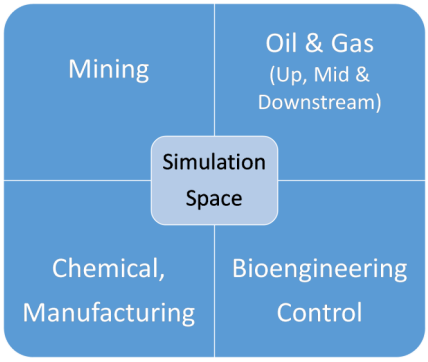
Goals of Process Control Engineering

1. To educate more industry-ready graduates with strong fundamental and practical training in process control -> enhanced employability
2. To enhance Chemical Engineering Process Control Engineering experience for undergraduate/graduate students
3. To partner with the Department of Electrical and Computer Engineering to enhance programmatic content and create joint educational opportunities
4. To create new educational (e.g. minor) and training (certification) to better serve the State of Wyoming and The Nation



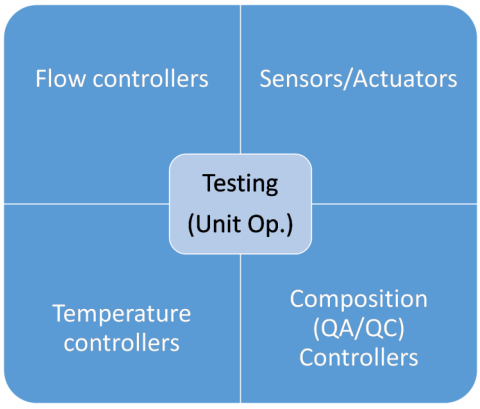
Process Control Engineering Organization

The Department of Chemical Engineering will coordinate the program. We will work closely with the Department of Electrical & Computer Engineering with the intent of creating joint educational and research opportunities to address industry needs. A Professor of Practice will coordinate the program, but faculty in CHE and ECE will be encouraged to introduce curricular enhancements.



Process Control Simulation Space

This lab will provide software and hardware for process control simulation activities. It is reconfigurable active learning and a training space. Hardware will simulate sensors and actuators responses. It will have "corner space", so control training needs for various industries can be housed, e.g. Mining, Up-, Mid- and Down-stream Oil & Gas, Chemical, Manufacturing and Bioprocesses. Instead of a traditional computer classroom, it will rely on Cloud Computing and low-cost tablets and laptops.



Process Engineering Control Laboratory

This lab serves as a safe space for physical testing of control system designs. It is a natural expansion of the Process Engineering (Unit Operations) Lab. This part of the facility will serve curriculum enhancement needs in Engineering and will augment Active Learning. It can also serve as a laboratory for applied research activities. A longer-term goal is to support a Master of Engineering in Process Control Engineering.

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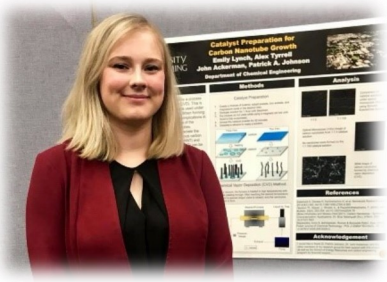
AIChE Student Chapter Update

This year AIChE has participated in many different activities and conferences. In March AIChE and SWE participated in a brew tour at the New Belgium Brewery in Fort Collins, Colorado. Members were able to learn about the brewing process from start to finish, and of age students were able to sample the different beers made by the brewery.



Twelve students from the chapter recently attended the Rocky Mountain Regional Conference 2018 at BYU in Provo, Utah. For the ChemE Jeopardy activity the team consisted of Sarah Kamphaus, Todd Muller, Alex Brown, and Kameron Jensen. The team placed second in the first round against BYU and Utah State. Seth Harris presented in the Paper Competition, and Emily Lynch presented in the Poster Competition. Lynch placed 2nd overall in the poster competition.

In April the AIChE chapter had a brew day at Altitude Chophouse in downtown Laramie. This was the second time the students participated in brewing their own beer, and this time they brewed a chocolate orange porter which was available at Altitude the second week of May. During this brew day the participants learned about the different pairings of beer, how to pour beer correctly, why there are different types of glasses for various beers, and the overall brewing process.

This year the University of Wyoming's student chapter of AIChE will be focused on the students more than ever. Along with the typical events of National and Regional conferences, industry dinner, and the brewery tours, it is planned to tour different industries around the state. Also, this year will be full of speakers on a variety of topics which includes: engineers talking on industry, professors explaining research possibilities, graduate students about furthering education, and undergraduate students on their experience as interns.

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SWE Student Chapter Update

SWE has many wonderful things planned for this year. This semester SWE will host a WOMENgineering conference on the UW campus for around fifty middle school girls. The girls will be volunteers all day and they will experience workshops from most all of the engineering departments. There was very positive feedback last year, and the girls who participated especially enjoyed the presentations. SWE is excited to be able to host this event again this year.

Currently, the chapter is gathering funding and planning their trip to the annual SWE National Conference. This year it will be held in late October in Minneapolis, Minnesota. Sixteen girls will be attending the conference, which is the biggest group yet. Brittany Endsley who is this year's President, had an amazing experience on last year's trip, and is excited to be able to plan the upcoming trip. This conference has many different workshops to attend. Other women engineers speak about what has made them successful in their careers and about the challenges they faced and how they overcame them. There will also be a large job fair during one day of the conference. Last year Endsley received a summer internship with Booz Allen Hamilton. The WTBC has been extremely gracious and has funded almost a third of the groups expenses for the trip. The group hopes to be able to have a couple meetings in conjunction with them this semester.

SWE is very excited to see where they are headed this semester and is hopeful to keep seeing large numbers of girls attending their meetings.

RSO Officer of the Year Award

Chemical engineering student Delaney Dent was awarded the RSO Officer of the year award at the 16th annual RSO Awards of Excellence banquet. This award is based off of the work an officer has completed for its recognized student organization (RSO). Dent was recognized for her efforts in forming the Phi Sigma Rho, which is a social sorority for women in engineering here at UW. Phi Sigma Rho was started from scratch by Dent who created all the documents, bylaws, and forms needed to make Phi Sigma Rho an official RSO. Dent also networked with the UWyo FSL office and Phi sigma RHO Nationals to facilitate the process of the sorority moving from being an interest group, to a colony, to hopefully a chapter by fall of 2018.

Dent organized the initial recruitment of four officers, and then together they recruited ladies to the sorority. In the fall of 2017 nineteen ladies were recruited, and after creating more positions and running elections in spring of 2018, five more ladies were recruited to the sorority. In the fall of 2018 thirteen more girls were inducted into the sorority. Currently the total number of ladies in Phi Sigma Rho is thirty-four.

Dent faced the difficulties of creating Phi Sigma Rho from scratch, having no Phi Rho alumni locally to advise the sorority, and the departure of their FSL adviser. This left the sorority with little guidance for a period of time here on campus, but Dent continued to lead the group of twenty plus ladies. Dent is grateful for the award as it showed that people believed in her, even though she was far from getting things right all the time.

Recent PhD and MS Graduates

Seth Bassham
MS
Summer 2018

Jose Cabrera Rodas
MS
Summer 2018

Daniel Debroy Monzon
PhD
Summer 2018

Audra DeStefano
MS
Spring 2018

William (Sandy) Duncan
MS
Spring 2018

Timothy Gunderson
MS
Spring 2018

Maryam Irani
PhD
Summer 2018

Yina Li
PhD
Summer 2018

Kelly Meyers
MS
Summer 2018

Michael Seas
MS
Spring 2018

Alexander Tyrell
MS
Summer 2018

Faculty Publications

Dr. Vladimir Alvarado

H. Yu; K. Ng*, J. Kaszuba, D. Grana, V. Alvarado, E. Campbell, (**2018**), "Experimental Investigation of the Effect of Compliant Pores on Reservoir Rocks under Hydrostatic and Triaxial Compression Stress States", *accepted,* Canadian Geotechnical Journal.

H. Wang, V. Alvarado*, E. Campbell, D. Grana and J. Kaszuba, (**2018**), "Low-Field Nuclear magnetic resonance characterization of Carbonate and Sandstone Reservoirs from Rock Spring Uplift of Wyoming", *accepted,* Journal of Geophysical Research - Solid Earth. DOI: 10.1029/2018jb015779

T.M. Reilly, M.I. Mohamed, T.E. Lehmann and V. Alvarado*, (**2018**), "Amphiphilic Phase Behavior Analysis with NMR", Vol. 268, pp. 647-657*,* Journal of Molecular Fluids. DOI: 10.1016/j.molliq.2018.07.066

M. Moradi, G. Garcia-Olvera, B. Morin, J. Oakey and V. Alvarado*, (**2018**), "Crude oil-water interfacial elasticity: an alternative enhanced-oil recovery mechanism in low-salinity waterflooding", Vol. 23, pp. 803-818, SPE Journal. DOI: 10.2118/169127-PA

X. Wang, K. van 't Veld*, P. Marcy, S. Huzurbazar, and V. Alvarado*, (**2018**), "Economic Co-optimization of Oil Recovery and CO_2 Sequestration", Vol. 222C, pp. 132-147*,* Applied Energy.

H. Wang and V. Alvarado*, (**2018**), "Diffusion coefficient in bulk brine and glass beads using the PFG-NMR method to characterize porous media", Vol. 49, pp. 250-259*,* Journal of Natural Gas Science and Engineering. DOI: 10.1016/j.jngse.2017.10.013

Dr. Saman Aryana

F Guo, S Aryana, Y Han and Y Jiao, A review of the synthesis and applications of polymer-nanoclay composites, Applied Sciences, v. 8, pp. 1969, 2018.

F Guo and SA Aryana, Improved sweep efficiency due to foam flooding in a heterogeneous microfluidic device, Journal of Petroleum Science and Engineering, v. 164, pp. 155 – 163, 2018.

M Koneshloo, SA Aryana and X Hu, The impact of geological uncertainty on primary production from a fluvial reservoir, Petroleum Science, v. 15, pp.270 – 288, 2018.

Z Li and S Aryana, Diffusion-based Cartogram on Spheres., Cartography and Geographic Information Science, v. 45, pp. 464–475, 2018.

S Aryana, F Furtado, V Ginting and P Torsu, On series solution for second order semilinear parabolic IBVPs, Journal of Computational and Applied Mathematics, v. 330, pp. 499 – 518, 2018.

Dr. Joseph Holles

Schmidt, L.O., and Holles, J.H., "Teaching Research Data Management: It takes a Team!", Paper #21194, Proceedings of the 2018 American Society for Engineering Education Annual Conference and Exposition, Salt Lake City UT.

Holles, J.H., and Schmidt, L.O., "Implementing a Graduate Class in Research Data Management for Science/Engineering Students", Paper #21190, Proceedings of the 2018 American Society for Engineering Education Annual Conference and Exposition, Salt Lake City UT.

Holles, J.H., and Schmidt, L.O., "Graduate Research Data Management Course Content: Teaching the Data Management Plan (DMP)", Paper #21191, Proceedings of the 2018 American Society for Engineering Education Annual Conference and Exposition, Salt Lake City UT.

Schmidt, L.O., and Holles, J.H.," "A Graduate Course in Research Data Management," Chemical Engineering Education, 52(1) (2018) 52.

Dr. David Bell

E. Beagle, Y. Wang, D. Bell, E. Belmont, Co-gasification of biochar and Powder River Basin coal in carbon dioxide, Bioresource Technology, v. 251, pp. 31-39, 2018.

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Faculty Publications

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Dr. Katie (Dongmei) Li-Oakey

Elucidation of Titanium Dioxide Nucleation and Growth on a Polydopamine-Modified Nanoporous Polyvinylidene Fluoride Substrate via Low-Temperature Atomic Layer Deposition, A. DeStefano, J. Yin, T.J. Kraus, B.A. Parkinson, and K.D. Li-Oakey, ACS Omega, 3 (2018), 10493−10502. DOI: 10.1021/acsomega.8b00864.

Reducing the Scaling Potential of Oil and Gas Produced Waters with Integrated Accelerated Precipitation Softening and Microfiltration, J.A. Brant, D. Li and J. Hegarty, J. of Water Technology and Treatment Methods, 1(4):118.

Performance evaluation of platinum-molybdenum carbide nanocatalysts with ultralow platinum loading on anode and cathode catalyst layers of proton exchange membrane fuel cells, S. Saha, J.A.C. Rodas, S. Tan and D. Li, J. of Power Sources, 378 (2018), p.742-749. DOI: 10.1016/j.jpowsour.2017.12.062.

Enhancing Oxygen Storage Capability and Catalytic Activity of Lanthanum Oxysulfide (La_2O_2S) Nanocatalysts by Sodium- and Iron/Sodium-D., Shuai Tan and **. Li**, ChemCatChem, ChemCatChem, 10 (2018), 550 –558. DOI: 10.1002/cctc.201701117R1.

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Dr. John Oakey

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