THE DEPARTMENT OF

Agricultural & Biological ENGINEERING

AT
PURDUE UNIVERSITY
PRESENTS:

THE 5th ANNUAL ABE-GSA GRADUATE INDUSTRIAL RESEARCH SYMPOSIUM

Thursday February 8, 2018

Agricultural and Biological Engineering Graduate Student Association - Purdue University -

#ABESymp2018

PROCEEDINGS OF THE 5TH ANNUAL ABE-GSA GRADUATE INDUSTRIAL & RESEARCH SYMPOSIUM

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College of Engineering, College of Agriculture
Purdue University

S Y M P O S I U M   O R G A N I Z E R S

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Symposium Coordinators:
Sarah Daly
Samaneh Saadat
Joseph Revuelta

Session Chairs:

Session	Student Chairs	Faculty Advisors
Machine Systems & Agricultural Systems Management	Aaron Etienne & Sneha Jha	Dr. Mark Ward
Bio-Energy	Casey Hooker & Antonio Santos	Dr. Nathan Mosier
Environmental & Natural Resources Engineering	Ahmed Hashem & Lawrence Sekaluvu	Dr. Sara McMillan
Biological and Food Process Engineering	Diana Ramirez & Jonathan mills	Dr. Martin Okos

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The symposium organizers would like to thank the Purdue Graduate Student Government & the College of Agriculture for their generous support of this event.

We are grateful to the following companies and government entities for their participation in the event:

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We would like to thank the following local businesses for donating gift cards for poster competition prizes:

S Y M P O S I U M   S C H E D U L E

9:00 – 9:30 am	**Registration & presentation set-up – *KRCH Atrium***	
9:30 – 10:40 am	**Machine Systems/Agricultural Systems Management Session – *KRCH 260***	**Bio-Energy Session – *KRCH 270***
	S. Woo: Modeling Noise Sources in positive displacement machines **A. Masjedi:** Accurate phenotyping using UAV-based Remote Sensing Data and Crop Model Simulation **A. Alexander:** An Electro-Hydraulic Traction Control System for Heavy Duty Off-Road Vehicles **A. Hearst:** Progeny Drone Inc.	**R. Red Corn:** Evaluating the potential of Glycogen Accumulating Organisms to Recycle Waste Carbon **C. Hooker:** Anaerobic gut fungi efficiently degrade renewable plant biomass with variable lignin composition for biofuel production **D. Orrego:** Enzyme Catalyzed Disassembly of Corn Kernels **E. Brace:** A molecular modeling approach to using high-oleic soybean oil to sweeten sour natural gas
10:40 – 10:50 am	***Break***	
10:50 – 12:00 pm	**Environmental & Natural Resources Engineering Session – *KRCH 270***	**Biological Engineering & Food Processing Session – *KRCH 260***
	S. Mehan: Estimation and Correction of bias of long-term simulated climate data from Global Circulation Models (GCMs). **J .Chen:** Assessment of Simulated Precipitation from Updated CLIGEN Database: Impacts on Urban Runoff. **A. Johnson:** Effects of floodplain restoration in agricultural watersheds on phosphorus dynamics. **R. Scarlett:** Using entropy generation as an environmental sustainability metric to assess Phosphorus recovery technologies.	**C. Jange:** Effect of Surface Composition on Powder Flow Properties **M. Wickramathilaka:** Investigating bioconjugation techniques to construct spontaneously assembling DNA-enzyme macromolecules. **V. Pathak:** Effect of starch-based hydrogel as seed coating on early growth of corn. **J. Bonilla:** Study of the distribution, function and interactions of Gliadins, High Molecular Weight Glutenins and Low Molecular Glutenins in Durum Semolina.
12:00 – 12:10 pm	***Break***	
12:10 – 1:20 pm	**Plenary Speaker & Lunch – *CoRec Feature Gym*** **Dr. Thieme, Chief Experience Officer at Community Health Network, Indianapolis**	
1:20 – 1:30 pm	***Break***	
1:30 – 2:30 pm	**Networking Session – *CoRec Feature Gym***	
2:30 – 4:30 pm	**Poster Session – *KRCH Atrium***	
4:30-4:45 pm	***Break***	
4:45-5:30 pm	**Pitch your thesis competition – *KRCH Atrium***	
	G. Vunnava: Using entropy generation as an environmental sustainability metric to assess Phosphorus recovery technologies. **M. Wickramathilakai:** Does distance matter?	**E. Brace:** A molecular modeling approach to using high-oleic soybean oil to sweeten sour natural gas

	A. Johnson: Effects of floodplain restoration in agricultural watersheds on phosphorus dynamics **J. Bonilla:** Study of the distribution, function and interactions of Gliadins, High Molecular Weight Glutenins and Low Molecular Glutenins in Durum Semolina, Soft wheat and Hard Wheat doughs using developed Antibodies-Quantum Dots complexes as imaging tools	**S. Mehan:** Would Sam Jr. have sufficient Water in 2050 or later? **S. Jung Ha:** The power of mass spectrometry imaging in brain cancer **V. Pathak:** Effect of starch-based hydrogel as seed coating on early growth of corn **A. Santos:** Glucose conversion from lignocellulose independent of initial solids loadings
5:30 – 6:00 pm	***Break***	
6:00 – 8:00 pm	**Keynote Speaker & Dinner– *St. Thomas Aquinas Church*** **Dr. Searcy, Senior Professor & Department Head** **Biological & Agricultural Engineering – *Texas A&M University*** **President of ASABE 2018**	

KRCH – Krach Leadership Center, 1198 Third Street
CoRec – France A. Córdova Recreational Sports Center, 355 N. Martin Jischke Dr.
St. Thomas Aquinas (STA) – 535 W State Street

SYMPOSIUM GUEST SPEAKERS

Plenary Speaker:

Dr. Steve Searcy received his MS degree in Agricultural Mechanization from the University of Missouri in 1976. He then went on to earn his Ph.D. at Oklahoma State University in 1980. From there, he became a professor at Texas A&M University, where he has remained since. During his time at Texas A&M, Dr. Searcy has been selected as an ASABE fellow, and is currently serving as the president. He has also received numerous outstanding paper awards and was named a Big 12 Faculty Fellow in 1997. Dr. Searcy's research focuses on the development and application of intelligent machine systems for agriculture, focusing on harvest, storage, and transport logistics.

Plenary Speaker:

Dr. Ron Thieme has over 30 years of success in creating teams, leading organizations, and providing business results. He has served as company CEO, President, CIO, and Co-Founder with extensive experience in creating and implementing strategy and building organizations. Ron is a successful entrepreneur who created a value proposition; built a company; and rallied support from employees, funding agencies, and clients. He has considerable experience working within and consulting to businesses of all sizes, and is actively involved in healthcare and life sciences leadership and governance. Dr. Thieme currently serves as Chief Experience Officer at Community Health Network in Indianapolis, where he is responsible for providing a market-leading experience for 15,000 caregivers and 500,000 patients through 3,000,000 annual customer touchpoints. Prior to that he was President and CEO of AIT Laboratories, a national provider of clinical tests that has achieved numerous accolades for its business success and company culture. Dr. Thieme has served as a business and technology consultant, advising firms in the life sciences, financial, and logistics sectors. He co-founded, managed, and ultimately sold Cambient, a successful business and technology consulting company. Dr. Thieme received B.S., M.S., and Ph.D. degrees from Purdue University

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* giving a presentation during the category sessions.

Research Area Key

ASH = Agricultural Safety and Health
BIOE = Bioenergy
BE = Biological Engineering
ENR = Environmental and Natural Resources
FP = Fluid Power
FOOD = Food Process Engineering and/or Food Safety
MACH = Machine Systems

1 Accurate phenotyping using UAV-based Remote Sensing Data and Crop Model Simulation

Ali Masjedi, ENR

Advisor: M. Crawford

Recent advances in remote sensing technology and algorithms provide significant opportunities for advancing applications in agriculture. Accurate phenotyping with unmanned aerial vehicles is one application that has received recent attention as plant breeders seek to automate the expensive and time consuming traditional manual acquisition of measurements of plant characteristics. This study focuses on the prediction of sorghum biomass utilizing high resolution remote sensing data.

Two methods are investigated for biomass prediction. The first uses nonlinear regression models to predict biomass directly from remote sensing data, utilizes different features from RGB images, Light Detection And Ranging (LiDAR) point clouds, and hyperspectral data. The second method incorporates the biophysical sorghum crop model, APSIM, first, using remote sensing data to parameterize the crop model, and then estimating the biomass. With the second method, environmental factors (such as weather, soil, water) are included in the prediction process. The advantage of the second method is that it is possible to estimate the crop model parameters early in the season, and use them to estimate biomass at the end of the season.

The data processing, visualization, analysis, and prediction methods, and results are demonstrated in two agricultural test fields at the Agronomy Center for Research and Education at Purdue University (ACRE).

2 The effect of floodplain creation on soil processes in agricultural channels

Celena Alford, ENR

Advisor: S. McMillan

In the agricultural Midwest, subsurface drainage allows excess water, rich in nutrients, to drain into agricultural channels which, in turn, flow into rivers and streams that transport excess nutrients downstream. During periods of high flow, greater loads of nitrogen and phosphorus are exported, contributing to eutrophication of lakes and coastal zones. The construction of an inset floodplain within agricultural channels has been proposed as an achievable, inexpensive, and cost effective solution to reduce nutrient loss from these systems. The two-stage channel enhances sedimentation of particulate nutrients and sediment, provides stable conditions for vegetation to establish, increases rates of microbial activity in floodplain sediments, and promotes denitrification. Understanding the nutrient dynamics involved in this floodplain function can help to improve current inset floodplain design for optimal denitrification. We collected sediments from the floodplains of two-stage channels and naturally forming floodplain benches in conventional channels to determine the effect of floodplain creation on soil processes that affect water quality. We measured the following rates seasonally: potential denitrification rates using bottle assays; net denitrification and respiration measurements using microcosm incubations; and nitrate, ammonium, and phosphate concentrations using flow-through cores. The preliminary data based on spring, summer, and fall sampling suggests mixed results. Higher respiration rates and organic matter percentages were measured in the inset floodplains for all seasons, but denitrification did not vary by season. However, most data suggested that results were site specific, suggesting that inset floodplain design should be customized based on the characteristics of individual sites.

3 Integrated Use of the Chamber Method and Open Path Methods to Determine N2O Emissions from Agricultural Soils

Cheng-Hsien Lin, ENR

Advisor: C.T.Johnston & R. H. Grant

Nitrous oxide (N_2O), one of strong greenhouse gases (GHGs) with the global warming potential (GWP) value of 300, emitted from agricultural soils is mainly from the use of inorganic nitrogen fertilizer (e.g., anhydrous ammonia). The fluxes of GHGs emitted from soils are continuous and dynamics, and the soil heterogeneities result in the episodic gas emissions. The chamber methods are subject to the inherent limitations that substantially lead to the uncertainties in the estimations of GHG emissions, such as the small footprint (~ 0.6 m^2) and the wild sampling interval (~ once a week). Open-path techniques combined with the inverse dispersion method is capable of acquiring the "real-time" data at a relatively high temporal resolution (minutes) and provides the gas emissions with a great spatial representative (> 100 m^2). In this study, we determined N_2O emissions from the continuous maize fields with different field managements (i.e. Chisel plow vs. No-till, and Full (200 kg NH_3-N/ha) vs. Split (100+100 kg NH_3-N/ha) N applications in the Fall and Spring) using the chamber measurement and the open-path method. The results showed that the open-path method can detect the diurnal fluctuations of N_2O emissions which were corresponding to the diurnal changes of soil temperature and wind speed, and the chamber method over underestimated N_2O emissions compared to the open-path method during the daytime because of the lack of considerations of turbulence effect on gas emissions. Also, the full application led to the higher N_2O emissions compared with the split application.

4 Comparing soil hydrology schemes in watershed-scale

Garett Pignotti, ENR

Advisor: I.Chaubey & M.Crawford

Soil water is a critical component of ecohydrologic systems, involved in hydrologic, biogeochemical, and plant growth cycles. Given the complexity of these interactions and limited observational constraints, mathematical representation of soil water processes is challenging and subsequently has varying iterations. Two general approaches of capturing soil water dynamics are implemented in various land surface, hydrologic, and ecohydrologic models: 1) numerical solutions to the Richards equation over a continuous soil profile and 2) a reservoir cascade approach over specified layer depths. While the reservoir cascade approach provides a straightforward, computationally simple method, specification of individual layer depths plays a significant role in soil water dynamics and can strongly influence simulations. Moreover, calibration may mask this effect, as soil physical parameters are often targeted. To understand and limit the effects of layer depth definition on soil water behavior in models, two objectives were considered using the Soil and Water Assessment Tool: 1) test alternative soil water schemes that both modify and replace the default approach and 2) evaluate the potential of calibration to compensate for and mask deficiencies in these schemes. Accuracy of each modified approach was compared to observed soil moisture measurements in an experimental watershed. Differences in secondary variables were qualitatively evaluated. Results highlight the relative merit and limitations of each approach and the role of calibration. Overall, enhanced soil water schemes provide an opportunity for improved model realizations, whereby decision support systems can operate with increased confidence.

5 Regression models to estimate transient storage parameters in streams

Femeena Pandara Valappil, ENR
Advisor: I. Chaubey

Solute transport models are widely used to assess transient storage in streams. Traditional method of calibrating transient storage parameters involves fitting breakthrough curves using measured tracer test data. However, these calibrated values do not consider spatial and temporal variability of stream characteristics and it is therefore challenging to generalize these models. In this study, we examine the effectiveness of regression models to predict transient storage parameters such as dispersion coefficient (D), transient storage area (As) and storage exchange coefficient (α). Published data from several tracer tests were used to develop parsimonious models that relate storage parameters with easily available stream variables such as discharge, velocity, flow width and flow depth. Correlation tests indicated moderate correlation of dispersion coefficient with velocity ($r=0.58$, $p<0.001$), depth ($r=0.37$, $p<0.001$) and width ($r=0.38$, $p<0.001$); and high correlation of storage area with the ratio of discharge to depth ($r=0.85$, $p<0.001$). Exchange coefficient showed insignificant correlations indicating that it is influenced by other geomorphological factors. The developed models were validated using literature data as well as experimental data from Hubbard Brook Experimental Forest and Kielstau Catchment. In terms of performance indicators, these models demonstrated reasonable confidence and showed better approximation of parameter values and breakthrough curves compared to other existing methods ($R2$ between modelled and observed curves were ≥0.75 for 97% of experimental cases with new equations). In addition to presenting a simple parameter estimation method, these equations will be especially useful in approximating storage parameters when tracer test data is not available for precise calibration.

6 Using entropy generation as an environmental sustainability metric to assess Phosphorus recovery technologies.

Gargeya Vunnava, ENR
Advisor: S.Singh

Thermodynamic metrics and methods continue being very useful for assessing the environmental sustainability of a technology. The current study focuses one particular thermodynamic metric that is being looked at with newfound interest lately: entropy generation. An entropy generation analysis exploits the entropy generation part of the Gouy-Stodola theorem and paves further a way for full entropy generation minimization for the technology under study. To demonstrate the use of the metric, an entropy generation analysis (EGA) was performed on a Phosphorus (P) recovery technology as a case study. The P recovery technology modeled in the study works as a side stream process in a domestic wastewater treatment plant and has two major operations: anaerobic digestion and ion exchange. EGA was performed by assuming a black box model for the technology and thermodynamic data was calculated from anaerobic digestion reaction biochemistry, ASPEN Plus flow analysis and batch ion exchange experiments.

7 Model Development of Environmental Ventilation Control System in Gestation Barns

Iris Feng, ENR
Advisor: A. Heber

The Livestock production methods in the US have been changing in recent years. The swine industry grew fast since the 1990s, as the pig population increased, the number of pig operations decreased at the same time. There is a growing interest in developing mechanism models to estimate NH_3 emission from various animal facilities. Since swine houses are complicated biological, chemical and physical combined systems, it is particularly useful to develop process-based mechanistic models to estimate NH_3 emissions without direct measurements and monitoring. Many models related to NH_3 release from liquid manure including animal houses, field applications, outdoor lagoons, or constructed manure stores have been published.This research will introduce a mechanistic model built on heat balance and other principals to predict ventilation rate, inside temperature and relative humidity of gestation sow barns.

8 Characterization of Al-coated steel slags in flow-through experiments: an approach to evaluate the potential efficacy of P sorption materials in P removal structures

Isis Chagas, ENR
Advisor: L. Bowling

Excessive phosphorus (P) in surface waters is one of the key drivers of eutrophication. P removal structures are an emerging technology developed to reduce excessive dissolved P in runoff and drainage water, preventing or mitigating P delivery to water systems. One of the determining factors for the success of these structures is the type of P sorption material (PSM) being used. Steel slag, a residue of the steel industry, is an example of PSM proven to be efficient in sequestering dissolved P from water. However, its P sorption capacity can substantially vary, mostly because different steel-making processes generate this PSM. Aluminum-coating is a technology aiming to improve the P sorptive qualities of steel slag. In this study, we characterized eighteen different slag samples from different plants and steel-making processes. We conducted flow-through experiments, a dynamic sorption technique, on coated and uncoated slag samples to evaluate differences in P removal efficiency and the effects of Al-coating. A solution of $Al_2(SO_4)_3$ at two concentrations (94.5 or 66.2 g L-1) was used to coat the slag samples. After 48 hours in contact with the solution, flow-through experiments were performed with an incoming P concentration of 0.5 mg L-1. Hydraulic residence time was 9.85 minutes or 0.28 minutes, determined in a preliminary characterization of the steel slag samples. This study will provide essential information about (I) the intrinsic differences in steel slag composition, (II) their effects in P-sequestering ability in flowing waters and (III) the potential to improve this ability through the Al-coating technique.

9 Assessing social and biophysical drivers of water quality improvement practices across rural-to-urban-landscapes

Jennifer Domenech, ENR
Advisor: Z. Ma & S. McMillan

Effective control of nonpoint source (NPS) pollution is critical for both long-term health of freshwater ecosystems and the socioeconomic welfare of human communities. Previous research has focused on water quality management through implementation of best management practices to reduce NPS pollution from agricultural and urban land uses. However, there is a critical need to incorporate individual residents' willingness to adopt conservation practices to more accurately quantify the water quality improvement potential at the watershed scale. Our study integrates water hydrological models with human dimensions data from a survey to assess the biophysical potential and social acceptance of conservation practices to improve water quality. We focus on the East Branch–Little Calumet River watershed and the Trail Creek watershed in Northwest Indiana. Our preliminary modeling results show that current N, P, sediment, and E. coli loading from the two watersheds to Lake Michigan are unevenly distributed across five resident groups (urban residential, suburban residential, rural residential, small agricultural, medium/large agricultural). The two agricultural groups and the suburban residential group exhibit higher loads of all simulated pollutants. Resident willingness to adopt conservation practices that reduce pollution loading also varies across groups. Results will allow us to project different groups' willingness to adopt conservation practices onto the watershed and to calculate the resulting reduction of pollution loading to Lake Michigan. Our results can be used to help watershed managers and planners to better identify, prioritize and implement conservation practices with the highest water quality improvement potential and social acceptance.

10 Evaluating the effectiveness of green infrastructure on hydrology and water quality at a CSO community

Jingqiu CHen, ENR
Advisor: B.Engel & M. Gitau

Green infrastructure (GI) including best management practices (BMPs) and low impact development practices (LIDs) are increasingly being used as stormwater management approaches to mitigate the adverse impacts of urbanization on hydrology and water quality. Assessment of the effectiveness of GI in urban communities that have undergone combined sewer overflows (CSOs) is needed to support urban planners and decision makers at various stages of development or redevelopment projects. The Long-Term Hydrologic Impact Assessment-Low Impact Development 2.1 (L-THIA-LID 2.1) model was approved valid and can be applied to various locations to identify most cost-effective GI practices at watershed scale. This study describes enhancements of the L-THIA-LID 2.1 model regarding pavements separation and cost calculation and evaluated the GI effectiveness on hydrology and water quality for 15 scenarios. The various levels and combinations of GI practices reduced runoff volume by 0.5 to 22.3%, total nitrogen by 1.9 to 25.8%, total phosphorus by 2.2 to 25.4%, and total suspended solids by 2.3 to 29% compared with no GI implementation. Cost-effectiveness was also calculated and discussed in this study. The results indicate that GI implementation in CSO communities could potentially provide benefits on runoff volume and pollutant loads reductions.

11 Detection of hydrologic trends in the Wabash River Basin

Johann Vera, ENR
Advisor: B.Engel

Trends detection in hydrologic variables, water quality, and other natural time series has received great use to assess the potential impact of climatic change and variability on hydrologic time series in various parts of the world. Climatic variability is reflected in hydrologic data and can adversely affect trend test results. Trends and variability in the hydrological regime will be analyzed for the Wabash River Basin in Indiana. There are 20 USGS gauging stations inside the Wabash basin with more than 50 years of continuous streamflow records that will be evaluated. Trends will be computed for selected streamflow statistics to include maximum, medium and minima, and average change rate for streamflow, precipitation annual series, Phosphorus and Nitrate concentration by using Linear Regression and the Mann-Kendall test, which is widely used to detect trends in hydrologic data. The series will be analyzed for trends, identifying changes in the streamflow regime, to determine any statistically significant changes in mean and maximum flow and evaluate the role of local land use change relative to local climate change, assessing the correlation among Nitrate and Phosphorus concentrations and watershed features, to analyze trends among precipitation, and streamflow and how they are correlated with watershed attributes. It is expected that, changes in flood frequencies and increases in runoff due to increased precipitation or other factors such as agricultural, land use change and industrial developments that affect hydrological variables. This will help decision makers with better planning decisions in the Wabash River Basin with potential application for similar watersheds."

12 Stochastic Generation of Storms Using High-resolution Precipitation Records

Josept Revuelta, ENR
Advisor: B. Engel & D. Flanagan

Sophisticated field and watershed scale models for runoff, erosion control, environmental, and global-change investigations require detailed continuous temporal and spatial inputs of precipitation to drive the hydrologic processes. For accurate estimates of these processes, the resolution of the input data must allow the representation of the variability of precipitation as it represents a major source of variability in the model outputs. Currently, the use of stochastic weather generators is wide spread to generate continuous series of meteorological data at gauged and ungauged locations. These weather simulators are designed to replicate the statistical properties of real weather data at monthly or daily time resolutions. However, daily values of precipitation do not represent the variability of storm parameters within a day, which is assumed to significantly influence the predictions of environmental or agricultural models where processes are sensitive to sub-daily values. This research proposes a parsimonious stochastic storm generator based on 15-min time resolution and correlated non-normal Monte Carlo-based numerical simulation. The model considers correlated non-normal random rainstorm characteristics such as time between storms, duration, and amount of precipitation, as well as the storm intensity structure. The accuracy of the model was verified by comparing the generated rainfall with rainfall data from five randomly selected 15-min weather stations in Indiana. Current results have shown that the proposed storm generator can capture the essential statistical features of rainstorms as well the patterns followed by their intensities, preserving the first four moments of monthly storms events, good annual extreme event correspondence, and the correlation structure within each storm. Finally, as the proposed model depends on statistical properties at a site, this may allow the use of the synthetic storms in ungauged locations provided relevant information from a previously done regional analysis is available.

13 Compiling Physical Input-Output Tables from Process Simulations to Measure Environmental Impacts

Liz Wachs, ENR
Advisor: S. Singh

Environmental impacts from agro-industrial production can be assessed based on the measured flows of materials through these processes. In the case of nitrogen, losses at each production stage enter soils, waterways and the atmosphere, in some cases causing major environmental and health problems. While material flow analysis (MFA) can be used to track the flows between production stages, when large-scale problems such as the dead zone in the Gulf of Mexico must be estimated, a systems level approach must be taken. Typically input-output (IO) analysis, which captures the interactions within the whole economy, is used for this type of analysis. Since IO tables are generally compiled in currency units, however, the IO model can provide a skewed representation of the economic structure, leading to biased results for environmental impact analysis. Hence, we propose the use of physical input-output tables (PIOTs) for systems level MFA. PIOTs have lagged in development due to the complexity of information and high costs required. To address this challenge, a methodology for compiling PIOTs using process simulation models in Aspen Plus is proposed. Case study results are compared with an empirical nitrogen PIOT for Illinois, showing high accuracy. The method developed here can reduce costs while providing physically based information on material flows through industry. The resulting PIOT model reflects the true physical structure of the economy including information on industry trends, allowing it to provide a robust basis for projection, if needed. Areas for future work and for synthesis with other frameworks are highlighted.

14 Influence of stormwater control measures on water quality in small, nested suburban watersheds

Rachel Scarlett, ENR
Advisor: S. McMillan

Urban streams are ecologically deteriorated due to increases in impervious area, discharge and pollutant loads from modified drainage networks, stream straightening, and stream burial. The resulting degradation of water quality in urban areas has immense impacts on aquatic life and eutrophication of receiving waters. Although urban stream syndrome suggests that urbanized watersheds function as dominant transporters of nutrients to the watershed outlet, there is evidence that urban watersheds can also be assimilative ecosystems that process and cycle nutrients. Water retention structures in the terrestrial landscape, specifically stormwater control measures (SCMs), are engineered analogs of natural nutrient processing hotspots (i.e. riparian zones, wetlands, hyporheic zones), which function as facilitators of nutrient uptake, assimilation, and transformation. SCM inlet-outlet studies have widely reported reductions in nutrient loads; however at the watershed scale, where multiple confounding influences impact nutrient behavior, SCM mitigation is not consistently linked to improvements in water quality. To assess cumulative impacts of SCMs, storm discharge and water chemistry were monitored at high temporal resolution along a longitudinal gradient of SCM treatment in a small suburban watershed in Charlotte, NC. Results show that the cumulative impact of SCMs can decrease in-stream concentrations of soluble reactive phosphorus, dissolved organic nitrogen, and ammonia to that of the reference stream, however SCMs have no cumulative impact on major cations and sulfate concentrations, which increase with urbanization. Additionally, water storage availability plays a significant role in nutrient flushing behavior; controls on solute transport change dependent on antecedent conditions and precipitation depth.

15 Long-Term Hydrologic Impacts of Controlled Drainage Using DRAINMOD

Samaneh Saadat, ENR
Advisor: J.Frankenberger & L.Bowling

Controlled drainage is a management strategy designed to mitigate water quality issues caused by subsurface drainage but it may increase surface ponding and runoff. To improve controlled drainage system management, a long-term and broader study is needed that goes beyond the experimental studies. Therefore, the goal of this study was to parameterize the DRAINMOD field-scale, hydrologic model for the Davis Purdue Agricultural Center located in Eastern Indiana and to predict the subsurface drain flow and surface runoff and ponding at this research site. The Green-Ampt equation was used to characterize the infiltration, and digital elevation models (DEMs) were used to estimate the maximum depressional storage as the surface ponding parameter inputs to DRAINMOD. Hydraulic conductivity was estimated using the Hooghoudt equation and the measured drain flow and water table depths. Other model inputs were either estimated or taken from the measurements. The DRAINMOD model was calibrated and validated by comparing model predictions of subsurface drainage and water table depths with field observations from 2012 to 2016. Simulations based on the DRAINMOD model can increase understanding of the environmental and hydrological effects over a broader temporal and spatial scale than is possible using field-scale data and this is useful for developing management recommendations for water resources at field and watershed scales.

16 Estimation and Correction of bias of long-term simulated climate data from Global Circulation Models (GCMs)

Sushant Mehan, ENR

Advisor: M.Gitau

Global circulation models are often used in simulating long-term climate data for use in hydrologic studies. However, some bias (difference between simulated values and observed data) has been observed especially while simulating precipitation events. The bias is especially evident with respect to simulating dry and wet days. This is because GCMs tend to underestimate large precipitation events with the associated precipitation amounts being distributed to some dry days, thus, leading to a larger number of wet days each with some amount of rainfall. The accuracy of precipitation simulations impacts the accuracy of other simulated components such as flow and water quality. It is, thus, very important to correct the bias associated with precipitation before it is used for any modeling applications. This study aims to correct the bias specifically associated with precipitation events with a focus on the Western Lake Erie Basin (WLEB). Analytical, statistical, and extreme event analyses for three different stations (Adrian, MI; Norwalk, OH; and Fort Wayne, IN) in the WLEB were carried out to quantify the bias. Findings indicated that GCMs overestimated the wet sequences and underestimated dry day probabilities. The number of wet sequences simulated by nine GCMs each from two different open sources were 310-678 (Fort Wayne, IN); 318-600 (Adrian, MI); and 346-638 (Norwalk, OH) compared with 166, 150, and 180, respectively. Further work involves developing reliable climate dataset for WLEB for use in the hydrologic and water resources modeling.

17 Glucose conversion from lignocellulose independent of initial solids loadings

Antonio Santos, BIOE

Advisor: M. Ladisch

Pelletized corn stover was pretreated at 190 °C for 20 min in liquid hot water at initial solids loadings of 360 g/L. The biomass was washed and transferred to a 1 L reactor agitated with a marine impeller at 290 rpm for enzymatic hydrolysis at pH 4.8 and 50°C for 72 hours with Cellic CTEC2 at 3 mg protein/g solids. At initial solids concentrations of 10, 100 and 200 g/L, the extent of hydrolysis was found to be independent of solids concentration, giving 50% conversion of cellulose to glucose for all solids loadings. In contrast, hydrolysis at the same conditions in 250 mL shake flasks gave lower conversions at the higher solids loadings: 40% at 200 g/L vs 51% at 100 g/L. These data show that mixing is an important factor in maintaining the extent of hydrolysis as solids loadings increase and that a combination of static liquid hot water pretreatment at high solids loadings using densified biomass, followed by enzyme hydrolysis in a reactor agitated with a marine impeller, enables significant conversion of the cellulose in pretreated and washed corn stover. The benefit of mixing at high loadings includes improved conversion of cellulose to glucose and higher volumetric productivity.

18 Anaerobic gut fungi efficiently degrade renewable plant

Casey Hooker, BIOE

Advisor: K. Solomon

The corn kernel, abundant in starch, is utilized to produce fuel ethanol through a dry grind process. In addition to generate starch, other components such as germ, pericarp and oil, which are mixed together during the milling, cooking, hydrolysis and fermentation processes, can be separated and used prior to processing and fermentation. These components have potential to generate other value-added molecules. This could expand the use of corn and add revenue to the corn industries through diversified products and chemicals. One of these uses is production of cellulose ethanol from components that are identifiable as clearly being cellulose. To investigate an alternative source of cellulosic ethanol, we are studying conversion of pericarp, utilizing an enzyme-based process to fractionate kernels into starch, germ, fiber, and soluble proteins. In this work, the pericarp recovered from kernel fractionation was liquefied into simple sugars. These in turn were fermented to ethanol. We tested different sizes of pericarp and demonstrated the effect of particle size, mixing, and enzyme loadings for generation of sugars for the ethanol fermentation using Saccharomyces cerevisiae. Lignocellulose is an ubiquitous source of carbon that remains to be widely exploited as a platform for bioenergy production. Large compositional differences, both in plant type and cell wall structure greatly hinder the efficient hydrolysis of these feedstocks. Thus there is a critical need to identify efficient and inexpensive enzymes that robustly degrade diverse untreated renewable plant biomass. Anaerobic gut fungi isolated from the digestive tracts of ruminants and hindgut fermenters (e.g. horse, wildebeest, giraffe) express an array of carbohydrate active enzymes that readily degrade lignocellulose under mild conditions. Herein, we characterize anaerobic fungal growth on a range of untreated agricultural residues and forestry wastes. This includes the first reported analysis of gut fungal growth on poplar containing variable molar ratios of syringyl lignin, which is strongly inhibitory to wood decay fungi. We further test glucan and xylan consumption on untreated poplar by one of these isolates of anaerobic fungi, showing conversions as high as 45% and 48% respectively, which aligns with current technologies for unprocessed biomass. We also characterize these organisms by showing that the carbohydrate binding portion of the fungal secretomes respond to increasing syringyl lignin content, highlighting the importance of addressing variability in substrate composition. Lastly, we present work investigating some of these carbohydrate active enzymes, and discuss methods to alter their expressional patterns for enhanced biomass hydrolysis. Exploiting anaerobic gut fungi as a platform for diverse plant biomass hydrolysis has the potential to enhance bioenergy production from lignocellulose. Commercial hemicellulase/ cellulase enzymes were used to hydrolyze the pericarp. Mixing was found to be an important factor with an enhanced agitation giving up to 30% higher cellulose conversion in 48 h. Ethanol fermentation of pericarp hydrolysates without solids was completed in 15 h with close to metabolic yields. Experiments leading to optimal conditions are reported, and processes for production of cellulosic ethanol from pericarp are proposed.

19 US Jet Fuel Production Potential and Cost from Feedstocks with no Induced Land Use Change

Dawoon Jeong, BIOE
Advisor: W. E.Tyner

The Federal Aviation Administration estimates that nearly 30% reduction of GHG emissions in the aviation sector can be achieved with biojet fuel adoption (FAA, 2012). In addition, private airlines are interested in biojet fuel as part of a possible fuel cost hedging strategy, because jet fuel is about one-third of airline operating cost.

Despite the increasing attention, bio-jet market deployment have been hampered due to strict technology standards and uncompetitive production costs. As of now, there have been only five jet fuel pathways approved by ASTM International. With current production economics of biofuels, none of the pathways can produce bio-jet at a compatible cost with fossil based jet-fuel. Moreover, some of these pathways induced land use change (LUC). In this analysis, we will focus exclusively on pathways with no LUC emissions to increase the emission reduction potential for each gallon of renewable fuel.

The problem is that existing studies based on process-engineering cost and benefit analysis can only provide a limited analysis because they ignore market feedbacks from stakeholders and often do not include induced land use change emissions. Therefore, we examine the potential biojet production in the US through a systems dynamics model, Biomass Scenario Model. In this study, we explore various ways for the US to produce bio-jet more efficiently without food competition and LUC given the existing feedstock supply constraints, and we also estimate the total policy costs to achieve that production.

20 A molecular modeling approach to using high-oleic soybean oil to sweeten sour natural gas

Emma Brace, BIOE
Advisor: A.Engelberth

Predictive methods for sweetening natural gas using bio-based solvents provide an opportunity to add value to the soybean industry and develop an economical method for cleaning sour gas. Improvements in fracking technology have increased availability of natural gas, which is a valuable fuel source that releases less CO_2 than coal and fewer greenhouse gases than gasoline. However, natural gas often contains high concentrations of hydrogen sulfide, a corrosive compound that damages processing equipment and is harmful to humans and the environment. Soybean oil is a readily available bioresource, and the high degree of saturation in high oleic soybean oil offers several potential binding sites for sulfur. While laboratory experiments can be costly and time-consuming, predictive models that examine interactions at a molecular level can be efficient tools for solvent screening and choosing process parameters. An approach based on statistical thermodynamics known as the Conductor-like Screening Model for Real Solvents (COSMO-RS) simulated the partitioning of hydrogen sulfide between liquid soybean oil and methane gas phases. Predicted K values ranged from 0.16 – 0.20 at temperatures of 25 – 100°C; K values between 0 – 1 are indicative of near-full extraction of the hydrogen sulfide. Theoretical and experimental results are compared after mixing soybean oil with hydrogen sulfide and analyzing phase concentrations of the H_2S using chromatography. This study provides fundamental proof-of-concept for using high oleic soybean oil as a bio-based solvent in a new method for cleaning sour gas.

21 Maleic Acid and Aluminum Chloride Catalyzed Conversion of Glucose to 5-(Hydroxymethyl)furfural in Water:Dimethylsulfoxide Mixtures

Jonathan Overton, BIOE
Advisor: N. Mosier

HMF (5-(hydroxymethyl)furfural), is a promising value-added product that serves as a building-block for polymers, biofuels, and pharmaceuticals. HMF can be produced from glucose, a monosaccharide readily available in lignocellulosic biomass. Previous work has shown that maleic acid combined with aluminum chloride (MAAl) catalyzes the conversion of glucose to HMF through the isomerization of glucose to fructose, followed by dehydration of fructose to HMF in a one-pot reaction. However, conducting the reaction in an aqueous environment shifts the equilibrium of the dehydration step away from HMF production, resulting in reduced reaction kinetics and increased humin accumulation through undesired side reactions. Fructose has a higher hydrogen bonding affinity to dimethyl sulfoxide (DMSO) than water, causing fructose to associate more strongly with DMSO than water, shifting the dehydration reaction equilibrium towards increased HMF production from fructose. DMSO can further reduce side reactions and rehydration of HMF by associating with the carbonyl group of HMF. Here, we show the addition of 10% and 20% (v/v) DMSO to aqueous media to more than double the selectivity of glucose conversion to HMF at 140 °C after 30 minutes from 0.20 moles HMF per mole glucose consumed to 0.39 and 0.48 moles HMF per mole glucose consumed, respectively. Further, the rate of glucose consumption and fructose production is increased in water:DMSO mixtures relative to water alone. Using DMSO to increase the selectivity and conversion rate of glucose to HMF increases the attractiveness of the MAAl platform to produce HMF as an industrial precursor.

22 Evaluating the potential of Glycogen Accumulating Organisms to Recycle Waste Carbon

Raymond RedCorn, BIOE
Advisor: A.Engelberth

Glucose is an important feedstock in the production of biological fuels and chemicals. However, demand for glucose is largely filled through harvesting starch and cellulose based crops which must be stored to match seasonal harvest with continuous demand. In the present work, we evaluate phenotypic glycogen accumulating organisms (GAOs) for their potential to convert the carbon in municipal waste to glycogen, an analogue of starch. It is envisioned that municipal organic waste could be anaerobically degraded to produce mixed volatile fatty acids (VFAs), which are taken up anaerobically by GAOs and then converted to glycogen aerobically. A GAO culture was selected for in a trickling filter reactor through continuous six hour cycles which consisted of feeding a model acid phase digestate, followed by two hours of anaerobic conditions and four hours of aerobic conditions. Then, glycogen accumulation was optimized in the GAO culture at varied pH and temperature conditions. The optimum pH and temperature were used to evaluate the yield of glycogen per unit carbon fed. The work indicates GAOs have the potential to convert biopolymers, food waste, sewage, paper products, and other waste carbon into a stable year round supply of glucose for biological fuel and chemical production.

23 Optimization of metal recovery via lignin, a byproduct of the biorefinery

Samira Fatemi, BIOE
Advisor: A.Engelberth

The potential valorization of lignin and recovery of toxic though industrially valuable metals is studied through an environmental application. The objectives of this work are to study the adsorption characteristics to optimize removal of lead (Pb) and cadmium (Cd) from water and to investigate the potential of metal recovery through fungal-mediated degradation, called microbial combustion, of lignin which has been contaminated. Lignin was obtained from corn stover via acid hydrolysis. Metal solutions were prepared from Pb and Cd chloride salts, with concentrations ranging from 50 to 200 ppm. Batch adsorption with lignin was performed at 30°C, 40°C, and 50°C, with pH controlled at 6, 7, and 8 to select optimal conditions. The initial and final concentrations of the samples were analyzed via atomic absorption spectroscopy (AAS). Microbial combustion was performed with the white-rot fungus Pleurotus ostreatus. Growth conditions for P. ostreatus in rich medium included the presence of lignin, the presence of contaminated lignin, and the presence of Pb and Cd. Results will show the optimal temperature and pH for adsorption, as well as conditions for metal recovery via microbial combustion. After analysis with FTIR, results will show metal-lignin complexation at designated functional groups. The microbial combustion studies will result in a live/dead count via assays to determine survival rate of P. ostreatus, as well as quantifying metal accumulation within the organism. Further work will investigate interactions between organic matter in water and the lignin adsorbent, as well as separation of metals from P. ostreatus.

24 Improving Modelling in the Biomethane Potential Test

Sarah Daly, BIOE
Advisor: J. Ni

There is an increasing concern about water, soil and air pollution from animal wastes. Anaerobic Digestion (AD) is a mature and cost-effective technology that uses a mixed microbial community to convert pre-existing wasted biomass to bioenergy (methane). The Biomethane Potential Test (BMP) can predict the feasibility of a substrate for AD and is performed in batch mode at a lab scale. However, the accuracy of the BMP test to predict methane yields is low and should be improved. My objective is to develop an improved model for predicting substrate biodegradability, hydrolysis, and methane production from the BMP test to better serve large-scale digester application.

25 Potential mitigation of greenhouse gas and PM2.5 emissions using corn stover for ethanol production in China

Yang Yang, BIOE
Advisor: J. Ni

Emissions of GHG (greenhouse gases) are believed to link to climate change and emissions of PM2.5 are confirmed to related to smog. Emissions of these pollutants are causing great concern in China. Therefore, reducing GHG and PM2.5 emissions has become a critical Chinese government policy. Corn stover is a desirable raw material for producing cellulosic ethanol, and developing commercial-scale corn stover based ethanol plants could conserve fossil fuels and reduce GHG and PM2.5 emissions.
However, there are no reported studies that conducted face-to-face surveys to collect first-hand information on corn stover utilizations and then assessed the related mitigation of GHG and PM2.5 emissions across China.

26 Effects of antibiotics in diets on ammonia and hydrogen sulfide emissions from a swine building

Chen Shi, BE
Advisor: J. Ni

Ammonia (NH_3) and hydrogen sulfide (H_2S) are two of the major pollutant gases in animal agriculture. Ammonia emission from animal feeding operation has potential negative impacts on the environment, ecosystem, and human and animal health. Hydrogen sulfide is odor-causing and toxic and has been considered as the most dangerous gas in the animal buildings.
Added amount of antibiotics in pig diet not only could prevent disease, improve feed efficiency, increase pig production, but also reduce environmental pollution such as ammonia in animal excrements.

However, lack of reliable data and continuous monitoring was an obstacle in the path of revealing the effects of antibiotic diets on NH_3 emissions during different pig growth stages from weaned to finishing. The impact of antibiotic diets on H_2S emissions from swine building is also poorly documented.

27 Chondrogenic Differentiation of Mesenchymal Stem Cells in Collagen Blend Hydrogels

Claire Kilmer, BE
Advisor: J. C. Liu & A. Panitch

Osteoarthritis is a debilitating condition that affects over 27 million people in the United States alone and is defined by degradation in articular cartilage extracellular matrix (ECM). Tissue engineering seeks to repair damaged cartilage by introducing an optimized combination of cells, scaffold, and bioactive factors that can be transplanted into a patient. Collagen type I (Col I) continues to be the most utilized type of collagen in tissue engineered scaffolds even though collagen type II (Col II), which is the most abundant type of collagen produced by chondrocytes, is the ideal environment for culturing chondrocytes. Col II has been shown to promote the secretion of ECM molecules specific to cartilage by mesenchymal stem cells but exhibits poor mechanical properties when forming a hydrogel. Our goal was to develop Col I and II blend hydrogels that harness the biological activity of Col II and the superior mechanical properties of Col I.

28 Microbial Enhanced Oil Recovery via in situ activation of native microbes with tailored nutrient formulations

Ethan Hillman, BE
Advisor: K. Solomon

Microbial processes that sour oil, corrode equipment, and degrade hydrocarbons are among some of the most costly problems to the oil and gas industry with estimated corrosion-related costs tallying nearly $2 billion worldwide each year. Yet, not all microbial processes are detrimental, and if harnessed properly can increase oil production by reducing viscosity, enhancing emulsification, and displacing immobile oil. Therefore, if these microbial communities can be appropriately manipulated the benefits of the desired outcomes can be enjoyed while avoiding the costly problems. An attractive approach to tailoring these communities is through precise control of their metabolism. By tuning the microbial metabolic inputs, a selective advantage is conferred for beneficial microbes that compete against deleterious organisms. Specifically, this allows nitrate-reducing bacteria to outcompete sulfate-reducing bacteria that form corrosive H_2S. Recently, we screened the microbial communities of five oil wells and evaluated the effectiveness of tailored nutrient profiles to control metabolism and community composition. Two wells were identified as candidates for metabolic intervention and we evaluated how the salts, phosphates, nitrates, and molybdates affect the metabolism. Pairing the metabolism (gas & acid production) with the microbial composition enables us to select the most appropriate nutrient formulation that maximizes the positive outcomes while minimizing the negative. Although work to this point was done in vitro, the optimal tailored nutrient profile designed herein will be used in a field study. This work will ultimately allow us to enhance the oil recovery process at low costs while reducing losses due to destructive microbial processes.

29 Isolation and Characterization of a novel Mycobacteriophage, Ochi17

Ikenna Okekeogbu, BE
Advisor: K. Clase

Mycobacteriophages are ubiquitous viruses that infect mycobacteria. They have been reported to have vital potential uses in the field of biotechnology and medical science with applications ranging from disease diagnosis, through phage typing, phage vaccine and phage therapy. Meanwhile, only a meager number of mycobacteriophages have been identified and characterized out of the multitudes present in the biosphere. In this study, a novel mycobacteriophage that infects Mycobacterium smegmatis was isolated directly from the soil, purified and amplified using the plaque assay to get a single clonal population. The structure and genome of the isolated phage was then characterized using Transmission Electron Microscopy and restriction enzyme digestion. The characterized mycobacteriophage has a genome size of 25kbp, capsid size of 56.67 nm and a non-contractile tail length of 200 nm. It was named Ochi17 and classified into the morphotype, Siphoviridae.

30 Developing genome engineering tools for anaerobic gut fungi

Jonathan Overton, BE
Advisor: K. Solomon

Anaerobic gut fungi isolated from ruminants and hind-gut fermenters have drawn recent interest for their ability to break down and grow on a diverse range of lignocellulosic materials. To date, culturing techniques and engineering applications using anaerobic gut fungi have focused on classical techniques, such as controlling and manipulating growth by changing nutrient supplementation and reactor configurations. Emerging techniques, such as metabolic engineering, have potential to increase the efficiency and rate of lignocellulose degradation, however, the ability to insert DNA into the nucleus of anaerobic fungi has not yet been developed. Additionally, there is a need to identify appropriate selection markers to ensure only cells with modified DNA survive. These methods have not yet been developed for anaerobic gut fungi, in part due to the challenges of maintaining anaerobic environments during benchtop handling. Here, we present an electroporation-based method for inserting DNA into the nucleus of Neocallimastix, a genus of anaerobic gut fungi. A layer of mineral oil is used to impede diffusion of oxygen into the media. Further, we show that geneticin resistance is an appropriate selection marker. In developing these tools, we have provided simple, repeatable methods for future genome engineering of anaerobic gut fungi.

31 Development of novel gene-editing tools

Kok Zhi Lee, BE
Advisor: K. Solomon

Precise gene-editing with repurposed prokaryotic immune systems has revolutionized biotechnology and medicine by enabling the modification of arbitrary DNA targets in many species for the first time. Although the most popular tool, CRISPR/Cas9, has accelerated genome engineering, it requires a sequence-specific motif adjacent to gene targets that restricts the use of this technology to specific DNA regions. Here, we develop a flexible gene-editing tool that can be targeted to any DNA sequence without regard for an adjacent sequence motif. Phylogenetic analysis of the candidate protein suggests it belongs to a previously unclassified group of prokaryotic immune systems characterized by a repA domain absent in all studied family members. This uncharacterized N-terminal repA domain within our candidate protein degrades plasmid DNA and induces DNA rearrangement in E. coli. Heterologous expression of the protein cleaves DNA randomly, but can be programmed with DNA guides in E.coli to target specified regions. We also showed that repA domain deletion mutants could be targeted with programmable DNA guides to edit the genome of E.coli with 55±16% increase in editing frequency compared to an unguided control. Collectively, our study provides insight into a more flexible tool for precise gene-editing, and identifies strategies to improve fidelity for application in basic research, biotechnology, and medicine.

32 Quantitative & Systems Approaches to Developmental and Cancer Biology

Linlin Li, BE

Advisor: D. Umulis

Bone Morphogenetic Proteins (BMPs) play a significant role in dorsal-ventral (DV) patterning of the early zebrafish embryo. BMP signaling is regulated by extracellular, intracellular, and cell membrane components. BMPs pattern the embryo during development at the same time that cells grow and divide to enclose the yolk during a process called epiboly. We developed a new three-dimensional growing finite element model to simulate the BMP patterning and epiboly process during the blastula stage. Quantitative whole mount RNA scope data of BMP2b and phosphorylated-SMAD data are collected and analyzed to precisely test the hypotheses of gradient formation in our model. We found that the growth model results in consistent spatially and temporally evolving BMP signaling dynamics within a range of biophysical parameters including a minimal rate of ligand diffusion.

33 Development of Novel ELP-Based Transcriptional Regulators for Improved Biomanufacturing

Logan Readnour, BE

Advisor: K. Solomon

The potential of using microbes to produce drugs, chemicals, and biofuels, has not been fully realized due to low production yields. Production may be enhanced by genetic circuits capable of redirecting resources toward desired products. However, this redirection of flux towards product must be balanced with resources for cellular health to sustain optimal performance. Therefore, we propose novel elastin-like polypeptide-sigma factor (ELP-SF) constructs as synthetic regulators that recognize cues of cellular health and autoregulate expression of bioproduction pathways for improved health and production. Elastin-like polypeptides (ELPs) make ideal sensors since they exhibit a sharp, inverse phase transition to indicators of cellular health such as pH and ionic strength, and external stimuli such as temperature. A library of ELP-SF constructs that transition under physiological conditions and various pH levels was created using a method known as recursive directional ligation by plasmid reconstruction (PRe-RDL). As proof of concept, expression of ELP-SF from an inducible plasmid was designed to drive the production of green fluorescent protein (GFP) from a non-native promoter. Initial designs successfully alter gene expression by 15-30% in response to temperature. We anticipate refinement of this design and combinatorial construct libraries will generate various regulators with diverse outputs that may be integrated in bioproduction pathways for improved performance.

34 Investigating bioconjugation techniques to construct spontaneously assembling DNA-Enzyme macromolecules

Malithi Wickramathilaka, BE

Advisor: B.Tao

The main objective of the study is to synthesize an enzyme macromolecule facilitated by DNA hybridization. Initially, we developed an adapted strategy from the conventional 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC) crosslinking technique, and demonstrated covalent bond formation between a model organic molecule, and a single stranded DNA (ssDNA). Matrix assisted laser desorption ionization-time of flight (MALDI-TOF) results indicated ssDNA conjugate formation. Reversed phase high-performance liquid chromatography (RP-HPLC) indicated that the conjugate yield via the conventional EDC method was 68.3±2.2%, while that of our adapted technique was 79.0±2.4% (n=10). The adapted crosslinking technique was then extended to glucose oxidase, and horseradish peroxidase enzymes. Size exclusion chromatography, and fluorescence spectroscopy are being used to confirm the existence of the final macromolecule.

35 Informing Biological Simulations with Data: Development of the Tissue Simulation Software CompuCell3D

Matthew Thompson, BE

Advisor: D. Umulis

CompuCell3D (CC3D) is an open-source virtual tissue modeling package that enables researches to perform simulated experiments to understand the mechanisms controlling biological phenomena. It is undergoing active development on several fronts, including the integration of diverse data types generated from physical experiments. These data are classified as quantitative, semi-quantitative, and qualitative. Ongoing research in data optimization techniques are used to efficiently identify uncertain model specifications and parameters that most closely align with the available experimental data. As an application of these new capabilities, a mathematical model of the developing organ of Corti within the ears of mouse embryos will be used. In this system, a set of diffusive morphogens work in concert to specify cell fate determination and tightly-controlled pattern specification. High-quality semi-quantitative imaging data of these morphogen gradients along with qualitative perturbation data is available, but the intrinsic value they contain is not yet fully tapped. This research will produce new tools broadly applicable to biologists studying a variety of systems including, for example, cancer and other diseases, development, and immunology.

36 Formulation of chitosan-based nano-carriers via ionic gelation method: A rational approach

Pablo Vega, BE

Advisor: N. Mosier

Chitosan nanoparticles have been shown to have enhanced biological properties. Ionic gelation (IG) is the method of choice to fabricate chitosan-based nanoparticles (CSNPs) because it requires no harsh conditions nor specialized equipment. The intrinsic heterogenous molecular weights and surface charges of chitosan, produced by deacetylation of natural chitin from shellfish or other organisms, makes it challenging to fine-tune the formulation procedures and ensure reproducible processing necessary for commercialization of CSNPs. The main objective of this research was to develop a way to formulate CSNPs via IG on a molar basis with consistent stability in terms of size, polydispersity (PDI) and zeta potential (ZP), using low (LMW) and medium molecular (MMW) weight chitosan. A pretreatment process was developed to normalize the amount of available NH_3^+ of chitosan, estimated as moles/gram of polymer via potentiometric titration. Our results indicate that regardless of the molecular weight, at a molar relation of 4:1 (NH_3:TPP) CSNPs precipitate as consequence of excess of TPP. Increasing the NH_3:TPP to 20:1, results in stable CNPS. The mean diameter of LMW-CS were not significantly different at NH_3:TPP of 10:1 and 20:1, with values of 233.4nm and 204.85 nm respectively. This characterization allows us to fine-tune the formulation of CSNPs to control the cross-linking process. This could enable the optimization encapsulation efficiency for bioactive cargo of interest, and more importantly, it may serve to allow scale-up of the process yielding stable, consistent nano-sized particles.

bioactive glass offers an attractive approach for inducing osteogenic differentiation leading to bone formation due to its ion release capacity. The long-term goal of this work is to develop osteomimetic and osteoinductive composite scaffolds to promote bone regeneration. In this study, a novel 3D osteomimetic composite porous scaffold was developed by sintering of composite microspheres comprised of poly(lactide-co-glycolide) (PLGA) and a novel bioactive silicate glass (BSG). This combination synergistically merged the benefits of mechanical properties of PLGA with the bioactivity of the BSG. Composite scaffolds were optimized to obtain bone-mimicking structural and mechanical properties by controlling fabrication parameters including BSG weight percentage and sintering conditions. The optimized composite scaffold exhibited compressive properties in the mid-range of trabecular bone. Furthermore, the composite scaffolds supported adhesion and growth of human MSCs during a 3-week cell culture. Interestingly, the composite scaffolds significantly increased the alkaline phosphatase activity of the cells leading to enhanced mineralization as compared to control PLGA scaffolds. These experiments supported the promise of developing next generation osteoinductive composite scaffolds for healing large bone defects.

37 Metabolomic Profiling of Glioblastoma using Multiple Reaction Monitoring (MRM) Mass Spectrometry

Soo Jung Ha, BE

Advisor: K.Clase

Glioblastoma (GBM) is the most common and aggressive form of primary brain tumor. Due to its extremely malignant and invasive nature, the mean survival period of GBM patients is only 12-15 months from diagnosis. GBM patients rely on current treatment options, including surgery, radiation and chemotherapy. Unfortunately, these treatment options fail to improve quality of patients' lives. Studies have shown that altered lipids and metabolites in GBM may play a critical role in chemo-resistance, cancer cell initiation and progression governed by oncogenic signaling pathways.

This research utilized multiple reaction monitoring (MRM) profiling mass spectrometry to investigate lipids and metabolite changes in various xenograft GBM tissues. MRM profiling takes advantage of neutral loss (NL) and precursor ion (PREC) scan mode experiments to profile diverse classes of lipids and metabolites based on the fact that the lipid chemical structure is common in 'building blocks'. In order to visualize the data, we utilized supervised statistical analysis methods (principal component analysis -PCA), univariate statistics and receiver operating characteristics (ROC) curve to show the differences of lipid and metabolite profiles and define prospective biomarkers. Our findings concluded that phosphotidylcholine (PC) and sphingomyelin (SM) were significantly differentiated between GBM10 brain tumors and control, and GBM brain tumors and flank tumors.

Understanding of metabolic reprogramming and differences between GBM10 tumors and control, orthotopic and subcutaneous tissues, and drug effect on tumors might provide knowledge on the therapeutic targets for GBM.

38 Lipid Biomarker Discovery through Glioma Lipidome Analysis by DESI and MALDI

Stephen Miloro, BE

Advisor: K. Clase & J. Rickus

Glioblastoma Multiforme (GBM) is an incurable form of brain cancer. Limitations in diagnostics, prognostics, and treatment reduce patient quality of care. Approved molecular and genomic biomarkers lack efficacy to address these clinical gaps, therefore discovery of reliable biomarkers is required to better patient outcomes. Lipids have promise as biomarkers due to their altered composition in GBM. GBM metabolic reprogramming drives lipogenesis, increasing the availability of potentially useful lipid biomarkers. The connection between lipids and metabolism has been established; lipid subtypes expressed with changes in metabolism and tumor grade has not. To characterize the GBM lipidome, we will use DESI and MALDI mass spectrometry. Coupling these techniques provides a more thorough chemical profile of lipids and metabolites from a single sample, aiding in biomarker discovery. Our goal, through these methods, is to identify reliable and novel lipid biomarkers to improve clinical gaps in GBM patient care.

39 Investigating Impact of Mycobacterial Physiology on Mycobacteriophage Life Cycles by Mass Spectrometry

Yi Li, BE
Advisor: K.Clase

Phage-bacteria interaction plays an important role in both ecology and evolution. Phages lyse bacterial cells to keep nutrient and energy flows of the environment. Arm-race between phages and bacteria drives evolution of both phages and bacteria. Current phage infection model demonstrates two typical types of phage-bacteria interaction: lytic and lysogenic cycles. However, the model emphasizes the actions of individual phage particle and bacterial cell. Several researches have unveiled that phage-bacteria interaction is behavior of both phage and bacterial communities, and a portion of bacterial cells can turn unsusceptible for phage infection. Since phage infection is initiated after the attachment of phage particles to bacterial cells, bacterial surface properties may impact phage-bacteria interaction. Mycobacterium smegmatis (M. smegmatis) has a thick lipid-rich cell envelope. Previous researches elucidated that glycopeptidolipids (GPLs) in cell envelope are involved in cell surface properties, receptors of phages and colony morphology of M. smegmatis. Therefore, GPLs may impact phage-bacteria interaction. Besides GPLs, unique lipids including monomycoloyl trehaloses (MMTs) and triacyl glycerols (TAGs) of M. smegmatis may also impact phage-bacteria interaction. As morphologies of both M. smegmatis cell and colony change with cell growth phase, composition of envelop lipids (GPLs, MMTs, TAGs etc.) and proteins may change with growth phage, which ultimately lead to alteration of phage-bacteria interaction. To explore how the mycobacterial physiology affects mycobacteriophage life cycles, the impact of bacterial lipids and proteins composition change on phage and bacterial populations need to be investigated. Five mycobacteriophages from diverse clusters were selected to infect M. smegmatis cell cultures at early exponential and stationary phases for ten hours. Populations of both phages and bacterial cells were determined over time. After four and ten hours of infection, total proteins and lipids were extracted from subsamples of phage-bacteria mixture, and further analyzed by mass spectrometry. The overall objective of this project is to figure out how phage life cycle alters when bacterial growth phase changes, and which proteins and lipids may be involved. The findings will provide a better understanding of phage-host interactions over time and contribute towards novel applications in biotechnology.

40 Toward a Sustainable Wine Scoring System (SWSS) base on LCA.

Andres Valero, FOOD
Advisor: J. Howarter & J.Sutherland

The process of buying wine is complex. Consumers classically look for attributes as taste, quality/price relation, origin, labeling style. In recent years, sustainability is having a greater influence on the buying decision. Nonetheless, when looking at the sustainable attribute of a bottle of wine, consumers face numerous obstacles due to the considerable number of eco-labeling available. On the other hand, sustainable winegrowing and winemaking practice have become accepted by large part of the wine community as a key driver to face climate change challenge and natural resources depletion while fulfilling consumer expectations. Quantifying and predict the environmental, social, and economic impact of the implementation of certain sustainable practice or sustainable program is challenging due to the lack of multivariable metrics and normalization criteria. Life cycle assessment (LCA) has proven to be the one most comprehensive assessment of multiple environmental impacts of the productive process. The main objective of this research is to develop a methodology to unify sustainability assessment for the wine industry. A Sustainable mapping is being developed in the different wine region. The mapping defines the flow of energy, water and material and their environmental impact following an LCA methodology. The different impact find will be normalize considering the ecosystem boundaries of the region under study. Finally, the normalized indicators will be aggregated considering a weight factor to generate the sustainable scoring. The unified assessment will allow defining a Sustainable Wine Scoring System (SWSS) to benchmark regions, wineries, and wine sustainable performance.

41 Effect of re-acetylation on the acid hydrolysis of chitosan under induced electric field

Dandan Li, FOOD

In comparison to traditional acid hydrolysis, the viscosity of chitosan-acid solution treated by induced electric field (IEF) reduced more rapidly. However, chitosan with different degree of deacetylation (DD) exhibits different amount of charge, different electrical conductivity, and thus may have different hydrolysis behavior under IEF. In this study, chitosans with DDs of 85.9%, 78.88%, 63.58%, and 55.51% were obtained by re-acetylating 1 mol chitosan with 0, 1.2, 1.4, and 1.6 mol acetic anhydride at 25 ºC for 4 h. The effect of DD on IEF-assisted hydrolysis was investigated by energy efficiency analysis, molecular weight determination, and rheological measurement. Energy efficiency analysis suggested that chitosan with higher DD showed higher conductivity, thus contributing to enhancing the energy efficiency of IEF system. However, molecular and rheological measurements showed opposite results, which indicated that the hydrolysis enhanced with DD decreasing. The reason was that re-acetylation showed little effect on the molecular weight and steady shear viscosity but did significantly destroy the granular and crystal structure of chitosan, making chitosan chain more susceptible to acid. The study suggested that the structural compactness played a more important role on IEF-assisted hydrolysis than charge content, which may give guide for further application of IEF in the modification of charged-polysaccharide.

42 Rapid starch gelatinization and phenolics thermomechanical destruction during bioextruison

Enbo Xu,FOOD

The aim of this study was to investigate the influence of the bio-extrusion (simultaneous extrusion and enzymatic hydrolysis) on phenolics in kinetics when rapid starch gelatinization occurred. Rice was extruded with thermostable α-amylase (0-1‰) at different feed rate (F, 1.5-3.0 kg/h), screw speed (N, 100-200 rpm), moisture content (M, 22-38%) and barrel temperature (T, 80-100 °C). High-efficiency bioextrusion (F and N as independent variables) was carried out using RSM method as T and M were consistently stable in consideration of enzymatic activity. F, N, M and T all affected the degradation rate constants of phenolics and starch (kP and kG, respectively). The positive relationship between kP and kG was inverted due to enzyme introduced into extrusion processing. Activation energy (E) of total phenolics destruction increased from 37.49 to 70.30 kJ/mol, mainly because of the great decrease of die pressure, SME and shearing.

43 Cross-Linking on Swelling Kinetics of Maize Starch Suspensions

Gnana Prasuna Reddy Desam, FOOD

Advisor: G.Narsimhan

Pasting behavior of starch greatly influences the texture of a variety of food products. Starch consumption is believed to be linked to the occurrence of diabetes and obesity. It is important to characterize the connection between the structure, composition, and architecture of the starch granules and its pasting behavior to design modified starch of desirable rate of digestion and texture. In this research, the evolution of granule size distribution of maize starch when subjected to different heating temperatures and heating rates were characterized. The effect of extent of cross-linking of maize starch on its swelling behavior was examined by granule size distribution and RVA. The nature of cross-linking was evaluated by P31-NMR. The changes in starch architecture during swelling were characterized by cryo TEM. As expected, the swelling was more pronounced at higher temperatures, higher heating rate and lower extent of cross-linking and resulted in a shift of granule size distribution to larger sizes with a corresponding increase in average size from 11 μm to 18-26 μm based on the extent of crosslinking. Most of the swelling occurred within the first 10 min. Polymer solution theory was applied to predict the evolution of granule size distribution of starch at different heating temperatures, rates and cross-linking in terms of its molecular weight, second virial coefficient and charge and compared with experimental data.

44 Expanding the fundamental insight of particle surface characteristics and its role on powder flow.

Hector Lozano Perez, FOOD

Advisor: T. Carvajal

Flowability mastership of powders is required for reliability in the functionality during processing and in performance as products. The goal of this study is to measure powder flow using the shear cell test and with "traditional" methods such as angle of repose. The physical, chemical and surface properties of particulate are responsible for powder flow behavior, in addition, flow tendency is affected in response to stress. Relationships between particulate characteristic such a morphology with flowability and surface energy properties was evaluated by Inverse Gas Chromatography (IGC).

45 Prediction of Swelling Kinetics and Pasting Behaviors of Rice and Maize Starch

Jinsha Li, FOOD

Advisor: G.Narsimhan

Starch pasting behavior greatly influences the texture of food products such as canned soup, baby food, etc. The annual consumption of starch in the U.S. is 3 million metric tons. The overall goal of this investigation is to characterize the relationship between pasting behavior of starch and its structure and composition. In this research, evolution of granule size distribution of waxy native maize starch when subjected to heating at constant temperatures of 65 to 90°C was characterized using static laser light scattering. As expected, granule swelling was more pronounced at higher temperatures and resulted in a shift of granule size distribution to larger sizes with a corresponding increase in the average size from 12 μm to 23-26 μm. Most of the swelling occurred within the first 10 min. Pasting behavior of waxy maize and rice at different temperatures was also characterized from the measurements of G' and G" for different heating times. While G' was found to increase with temperature and decreased at larger holding times, G" was insensitive to both conditions. Polymer solution theory was applied to predict the evolution of average granule size of starch at different heating rates in terms of its molecular weight, second virial coefficient and granule elasticity and compared with experimental data. The results from this investigation will build connection between the structure, composition and architecture of the starch granules and its pasting behavior in order to arrive at a rational methodology to design modified starch of desirable rate of digestion and texture.

46 Synergistic effect of low power ultrasonication on antimicrobial activity of cecropin P1 against E. coli in food systems

Maya Fitriyanti, FOOD

Advisor: G.Narsimhan

Food safety continues to be a major issue for consumers and manufacturers. Recent studies have shown that both low frequency (20-100 kHz) ultrasonication and antimicrobial peptides (AMPs) treatment processes have a significant advantage in inactivating bacterial cells than the conventional heat treatment due to higher food texture quality of the final product. However, the effect of the combined process has not been fully investigated in complex matrices such as food.

In this study, deactivation of Escherichia coli in different concentrations of milk (5,10 and 100%) and orange juice (5,10 and 100%) were performed using three different treatments: low frequency ultrasonication (20 kHz) at different power levels, antimicrobial peptide Cecropin P1 at different concentrations, and combination of both. E. coli cells deactivation was measured by plate count method and transmission electron microscopy was performed to confirm a pore formation on the cell membranes. The results of all samples showed that the combined treatment is more efficient, reducing the cell density of E. coli up to four orders of magnitude, compared to individual treatments. However, the milk concentration results in lower synergistic effect. This is believed to be due to complexation of milk proteins with Cecropin P1 thus resulting in less availability of the latter for antimicrobial action. This dependence was not observed in orange juice samples. Fluorescence dye leakage experiment and electron micrograph confirmed a pore formation due to ultrasonication and antimicrobial action that leads to leakage of intracellular materials.

47 Effect of Frying Oil Degradation on Surface an Interfacial Properties

Shreya N Sahasrabudhe, FOOD
Advisor: B.Farkas

Frying oil degrades via exposure to heat, oxygen and water resulting in the formation of volatile and non-volatile products. According to the surfactant theory of frying, surface active substances formed during frying are responsible for changes in heat and mass transfer rates of oil, due to decrease in interfacial tension (IFT). During frying, oil at high temperature is in continuous contact with steam, making it necessary to understand the change in interfacial properties of oil in contact with saturated and superheated steam. To quantify the effect of surfactant formation in oil after frying, fresh oil (Total Polar Material, TPM=4) and used oil (TPM=12) samples, obtained from Purdue dining courts were analyzed, for the effect of frying on surface tension with air and steam. A ramé-hart goniometer was used to measure oil-air (24-200°C) and oil-steam (100-200°C) IFT of fresh and used oil, using pendant drop technique. All IFT values decreased linearly as temperature increased (R2>0.99). There was no significant difference between oil-air and oil-steam IFT from room temperature to 160°C. As the temperature increased beyond 160°C, used oil IFT (with air & steam) was significantly lower than fresh oil ($p \leq 0.05$). This effect may be attributed to increased diffusion rates of surfactants in used oil to the oil/air or oil/steam interface at higher temperatures, as predicted by Einstein-Stokes equation. Thus, the surface tension of used oil is significantly different, when measured at frying temperatures, which may be responsible for increased heat and mass transfer rates when degraded oil is used.

48 Effect of starch-based hydrogel as seed coating on early growth of corn

Vaibhav Pathak, FOOD
Advisor: K. Ambrose

Seeds depend on proximity and prolonged presence of moisture along with a good soil-seed surface contact to derive water for germination and early seedling growth. Poor soil water availability, due to dry weather and insufficient irrigation, delays early seedling growth while partial imbibition renders seeds susceptible to death. To overcome this problem, water should be made available to the seeds in a more efficient, sufficient and prolonged manner. Coating seeds with an absorbent material can potentially increase moisture retention of soils and localize water near the seed. This technology has already been commercialized but there have been very few scientific studies on its effects on plant growth. The existing studies show that the effect can vary, from positive to negative, with plant species, type of hydrogel and availability of water. The current work will be studying the effect of a biodegradable starch-based hydrogel as a seed coating on corn. Seeds will be coated with different amount of hydrogel and will be grown in soil under different irrigation treatments. The treatments will be compared for growth performance using the rate of emergence and the root and shoot biomass at several growth stages after emergence. The study is expected to show if the hydrogel coating benefits the growth of corn seeds and what combination of hydrogel treatment and irrigation levels are favorable to such effects.

49 Modifying soybean oil chemistry using High Voltage Atmospheric Cold Plasma (HVACP) treatment with hydrogen and nitrogen gas

Ximena Yepez, FOOD
Advisor: J.Kokini

Partially hydrogenated oils are considered unsafe to use as food ingredients due to their high content of trans-fatty acids (TFA). High Voltage Atmospheric Cold Plasma (HVACP) has been investigated as a novel technology to hydrogenate soybean oil without the formation of TFA. The goal of this study is to determine if HVACP can hydrogenate soybean oil at room temperature and atmospheric pressure, without a metal catalyst, using hydrogen and nitrogen gas. A 5.0 g soybean oil sample was exposed to HVACP treatment, by triplicate for times up to 1.5 h. The effect of HVACP treatment was evaluated by measuring iodine value, fatty acid composition, NMR, and nitrogen content. Optical emission spectroscopy was used to identify some of the hydrogen and nitrogen species involved in the reactions. During treatment a solid oil fraction developed on the top surface of the oil. After treatment two sample fractions were analyzed. The liquid sample which consisted of approximately 95%, and a solid sample which consisted of approximately 5% of the original sample. Results showed a decreasing iodine value with increasing treatment time. At 1.5 hours the liquid fraction decreased from an initial IV of 130 to an IV of 122, whereas the solid fraction decreased to an IV of 90. The fatty acid composition for both samples showed a significant increase in saturated fatty acids. Proton-NMR studies showed a triglyceride chemical structure. This study demonstrates that HVACP can partially hydrogenate vegetable oils without producing TFA, without requiring additional heat, high pressure, or metal catalyst.

50 Small grower drying technology for Chinese medicinal plants

Zusongying Zhao, FOOD
Advisor: K. Ileleji

With the development of a healthy society, the demand for medicinal plants has increased in recent years. China is the country with the largest consumption of medicinal plants. Chinese medicinal plants (CMP) are commonly dried for preservation, decreasing toxic side-effects, and enabling the preparation of prescriptions used in traditional Chinese medicine. However, current open air sun-drying practices by small growers lead to poor drying and quality. Our research analyzes problems associated with drying

CMP, quality requirements, and processing methods for applying simple/innovative solar drying methods for small growers.

51 Remote Hyperspectral Sensing for Weed Detection in Sorghum Field

Aaron Etienne, MS
Advisor: D. Saraswat

Currently, there lacks a practical detection method for site specific weed management (SSWM) in sorghum. Previous methods, such as physical detection and control were often costly and required a large amount of time and manpower. Earlier attempts at weed detection techniques from satellite and aerial based sensors lacked the accuracy necessary to output very high resolution images. Advances in sensor detection methods using unmanned aerial systems make it possible for the development of more accurate weed detection techniques in various growth stage sorghum fields. Sorghum is a major cash crop around the world. The ability to detect and control the development of weeds throughout the various stages of plant development is crucial to the outcome of a healthy and profitable stand. Remote-sensing based, site-specific weed management, utilizing an unmanned aerial vehicle, offers the potential to decrease weed control costs through reduction in manpower, reduction in use of herbicide, and site specific herbicide application maps.

52 Inexact nonlinear improved fuzzy chance-constrained programming model for irrigation water management under uncertainty

Chenglong Zhang, MS
Advisor: B. Engel

An inexact nonlinear mk-measure fuzzy chance-constrained programming (INMFCCP) model is developed for irrigation water allocation under uncertainty. Techniques of inexact quadratic programming (IQP), mk-measure, and fuzzy chance-constrained programming (FCCP) are integrated into a general optimization framework. The INMFCCP model can deal with not only nonlinearities in the objective function, but also uncertainties presented as discrete intervals in the objective function, variables and left-hand side constraints and fuzziness in the right-hand side constraints. Moreover, this model improves upon the conventional fuzzy chance-constrained programming by introducing a linear combination of possibility measure and necessity measure with varying preference parameters. To demonstrate its applicability, the model is then applied to a case study in the middle reaches of Heihe River Basin, northwest China. An interval regression analysis method is used to obtain interval crop water production functions in the whole growth period under uncertainty. Therefore, more flexible solutions can be generated for optimal irrigation water allocation. The variation of results can be examined by giving different confidence levels and preference parameters. Besides, it can reflect interrelationships among system benefits, preference parameters, confidence levels and the corresponding risk levels. Comparison between interval crop water production functions and deterministic ones based on the developed INMFCCP model indicates that the former is capable of reflecting more complexities and uncertainties in practical application. These results can provide more reliable scientific basis for supporting irrigation water management in arid areas.

53 Increased production efficiency and reduced environmental impact through use of intelligent and efficient autonomous agricultural vehicles

Gabe Wilfon, MS
Advisor: J.Lumkes

Autonomous and intelligent agricultural vehicle technologies have an opportunity to improve and transform conventional farming. In the years to come, the global population will require more food than ever before. Increased production efficiency is necessary to meet these demands while adhering to regulations on emissions and environmental impact. In the future autonomous agricultural vehicles will be used for various tasks such as intelligent weeding, targeted microspraying of fertilizer and pesticide, irrigation, planting, harvesting, and transportation. By modeling the function and tasks of a robotic vehicle, along with crop behavior, the production efficiency in terms of crop yield per unit resource (human capital, energy input time in field, environmental impact, water, etc.) can be calculated and compared to conventional farming techniques.

54 Digital Soil Mapping, Soil Spatial Variability, and Phenotyping

Shams Rahmani, ENR
Advisor: Dr. Darrell & G. Schulze

Soil variability is an important factor in field-based plant phenotyping because a given genotype is likely to express a slightly different phenotype on different soils in the same field. Climate, organisms, relief (topography), parent material, and time are the soil-forming factors that cause soil variation across soil landscapes. Within individual farm fields, however, most of these factors are constant and relief is usually the major factor determining soil variability. Topographic differences influence plant growth and yield through water, nutrient, and sediment movement from higher spots to lower spots in the field. Additional variability is introduced by tile drainage, and by ice-wedge polygons that formed on parts of ACRE at the end of the Wisconsin Ice Age about 15,000 to 18,000 years ago. We are using aerial photography and computer modeling to capture soil variability and develop high-resolution soil maps for ACRE. Aerial photography taken at different times shows different features and will be used to capture soil variability due to long-term differences in plant growth in the original pre-settlement vegetation, tile lines, and ice-wedge polygons, while terrain attributes calculated from high resolution LiDAR will be used for quantifying surface topographic variation.

55 A comparative study of relation between plant growth and NDVI from UAS data

Sneha Jha, MS
Advisor: D. Saraswat

The article explores the opportunities for incorporating sustainability at each phase of civil infrastructure development. These phases include needs assessment, infrastructure planning, design, construction, operation, inspection/monitoring, maintenance and repair, and infrastructure end of life. The article has discussed in detail that sustainability could be incorporated by adopting strategies like minimum reliance on non-renewable resources, maximizing benefit to the society and environment and inducing economic prosperity over the long term, at each phase of development. Moreover, decisions at all phases of infrastructure development need to adequately and explicitly account for environmental, economic, and social consequences of the system at its subsequent phases. Some of the ways for incorporating sustainability in the infrastructure development process include: taking full advantage of intensity and direction of natural elements (sun and wind); use of durable, recycled, locally available or reusable materials; using minimal or renewable natural resources for operating system components; recycling of existing materials on the project; salvage existing materials for reuse; low-maintenance landscaping; and focusing on preventative maintenance measures rather than repair measures. Specifying materials and designs that can be reused, modified and re-purposed, recycled, dismantled, sold, upgraded, or integrated with new systems could make the development process truly sustainable.

56 Port and case flow temperature prediction for axial piston machines

Lizhi Shang, Fluid Power

Advisor: M. Ivantysynova

Researchers at Purdue's Maha Fluid Power Research Center have developed models that will enable the computational design of piston machines. The core of the in-house developed program forms multi-domain models capturing the fluid-structure interaction phenomena taking place in the main lubricating interfaces (piston/cylinder, cylinder block/valve plate, and slipper/swash plate) of axial piston machines. The model allows studying the influence of a given pump or motor design on machine performance, power loss, and energy dissipation in those main lubricating interfaces. The behavior of the fluid film in these lubricating interfaces as well as the shape of the solid parts is temperature and pressure dependent. In order to solve for non-isothermal flow and to consider elasto-hydrodynamic effects, port and case temperatures are needed as a boundary condition for the model. In case of analysis and optimization of existing pumps and motors, those boundary conditions can be taken from steady-state measurements; however, when using the model to design a new unit, this information is not available. The temperature prediction model proposed in this paper fills this gap. The model can predict the outlet and case temperature for a chosen inlet temperature based on known fluid properties and calculated energy dissipation in the rotating group of an axial piston pump. The model also considers the temperature change due to fluid compression/expansion and estimated churning losses for a given axial piston machine.

57 Numerical Modelling of Gerotor Units

Matteo Pellegri, Fluid Power

Advisor: A.Vacca

This poster describes a high fidelity simulation model for GEROTOR pumps. The simulation approach is based on the coupling of different models: a geometric model used to evaluate the instantaneous volumes and flow areas inside the unit, a hybrid lumped parameter/CFD fluid dynamic model for the evaluation of the displacing action inside the unit and mechanical models for the evaluation of the internal micro-motions of the rotors axes. This poster particularly details the geometrical approach, which takes into account the actual geometry of the rotors, given CAD files as input. This model can take into account the actual location of the points of contact between the rotors as well for the actual clearances between the rotors.

58 A 21st Century Approach to Hydraulic Actuation Technology

Nathan Keller, Fluid Power

Advisor: M.Ivantysynova

In the previous century, hydraulic systems have been developed with the goal to successfully perform a specific function, while energy consumption remained an afterthought. In recent years, efforts have been made to modify the last century architectures to increase system performance. Functionality has been added to the hydraulic systems without changing the base technology. As a result, current valve-controlled hydraulic systems are experiencing an upward trend of increasing complexity. The aim of this research is to demonstrate the importance of using dynamic mathematical models to appropriately design, size and simplify hydraulic system architectures for mobile machinery. Dynamic simulation models with measured representative duty cycles are used to design and size efficient, yet simple, hydraulic system architectures for a combine harvester. The hydraulic models are developed using MATLAB/Simulink®. The hydraulic systems on a combine harvester have been chosen as examples, and the design methodology used in this work can be applied to hydraulic systems on any mobile machine. The selected hydraulic systems on a combine harvester (the propulsion, reel drive, header lift) have been designed and sized using dynamic simulation models and compared to current state-of-the-art systems. The combined power savings of the novel systems over the current systems is 11.6 kW during an average harvesting condition for the combine harvester. 11.6 kW of additional cooling power is saved as a result. This means the total power savings of the proposed systems is about 23 kW. A novel low-pressure system also showed an improvement of 7.54 kW over traditional low-pressure systems.

59 Inclusive pedagogy in designing engineering classroom in the Azraq refugee camp

Claudio Freitas, ASH

Advisor: J.DeBoer

We designed an engineering course designed to provide an opportunity for students in the Azraq refugee camp located in Jordan. We co-designed the content, assessment, and pedagogy by considering the refugee camp context, community problems, infrastructure constraints, and learning objectives. We used a variety of educational technology tools to fill diverse needs throughout the course such as, edX educational online platform, Arduino development board, computer and multimedia projector, and digital learning tools. We used students' ongoing feedback in co-design to iteratively improve the class while it was going on. We designed this course using tools validated by educational research to create an active, blended, and collaborative learning environment. Given the nature of their situation, we will focus on problem-solving, where solving problems becomes part of their daily activities. For five months, students learned technical competencies related to mathematical fundaments, electronics, and programming. They also learned engineering design process by exploring needs and problems in their community, and how to develop solution addressed to those needs. After that, they had to develop a final project where they should create a final project by using the project based approach in this activity.

In this paper, we will describe our experience by designing and implementing an engineering course in the Azraq refugee camp. By doing that, we intend to contribute to the existing literature about engineering education in fragile contexts. Also, we will share our experience by teaching engineering thinking in a culturally diverse environment for second language learners.

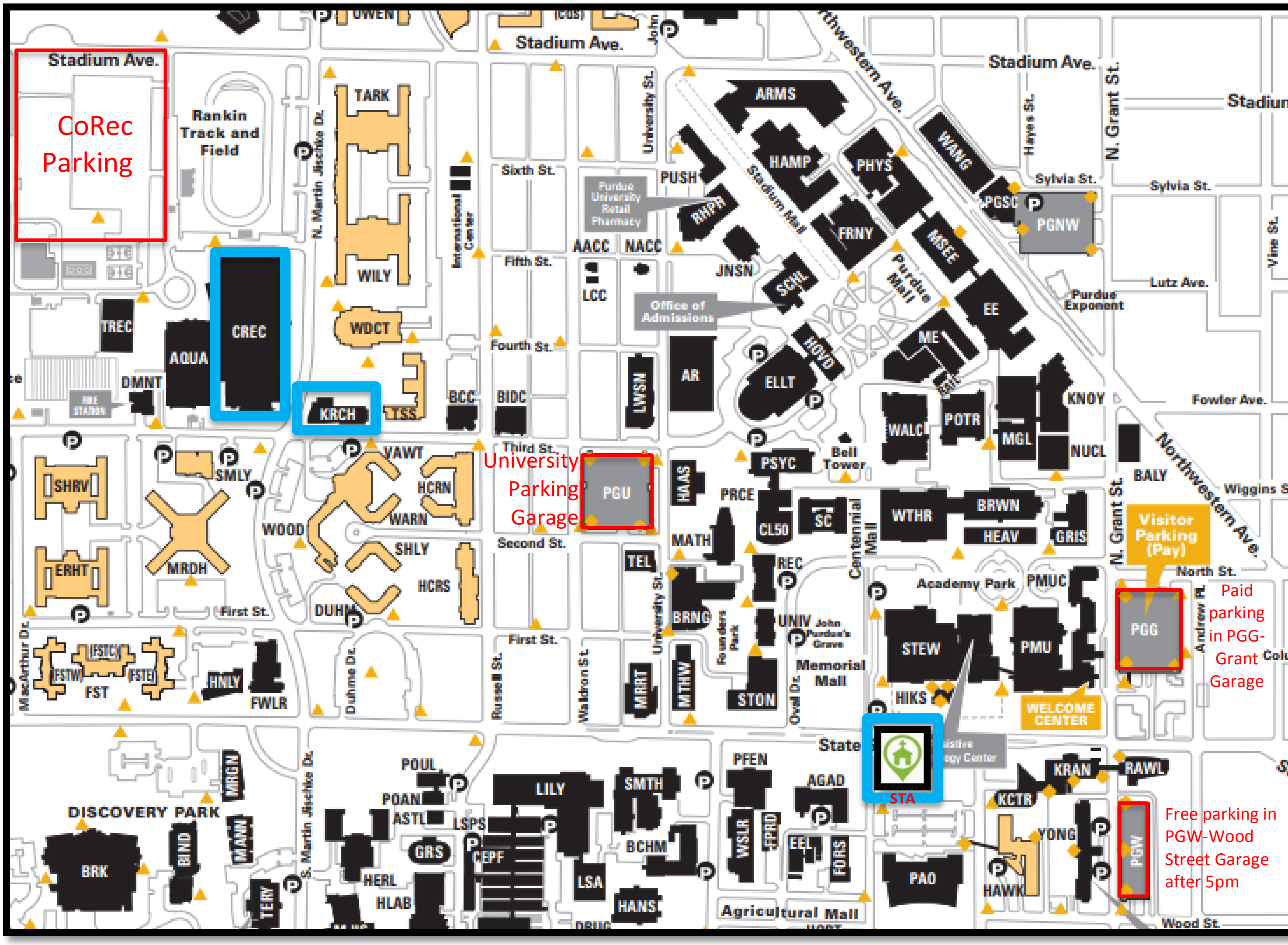
60 Causative factors of fatalities and injuries associated with

Mahmoud Nour, ASH
Advisor: W. Field

Manure storage and handling facilities include enclosed, partially enclosed and open structures generally considered as confined spaces, oftentimes equipped with ventilation systems and are common in loss of lives. In addition, they can include material handling systems such as pumps, conveyors, augers, and scrapers. They are frequently found on large dairy, swine and beef production farms and waste storage areas. The hazards associated with these sites include, manure gases which can be fatal to both humans and livestock as direct exposure can cause asphyxiation; liquid storage structures that have the potential for drowning of workers and livestock; and, mechanical hazards associated with the material handling equipment. The personal risk historically has been exposure to the deadly gases generated as manure decomposers. These gases include Ammonia (NH_3), Carbon dioxide (Co_2), Hydrogen sulfide (H_2S), and Methane (CH_4). While most of the manure storage facilities do not fall under OSHA oversight due to restrictions in the U.S. Department of Labor appropriation language, all workers possess the right to a safe and healthy workplace. Therefore, it is a violation of best safety practices for entering manure storages without adequate contaminant-free environment, a safe harness with a lifeline attached to a rescue-lifting device, or using atmospheric toxic gas monitoring devices. To date, over 200 cases have been documented, most victims being male, with an average age of 31 years old, who became asphyxiated or fell into the manure storage area during handling or loading operations. A total of 200 cases were documented in which the victim was inside an agricultural transport vehicle. Other statistical analyses and results for characteristics and causes manure-related fatalities for this research are ongoing.

Purdue Campus Map with Symposium Locations Highlighted

KRCH – Krach Leadership Center, 1198 Third Street
CREC – The CoRec, France A. Córdova Recreational Sports Center, 355 N. Martin Jischke Dr.
St. Thomas Aquinas (STA) – 535 W State Street



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