5th Annual AIChE Midwest Regional Conference

January 31st – February 1st, 2013

Organized by the Chicago Local Section of the AIChE

Hosted by the Illinois Institute of Technology, Chicago, IL

Program at a Glance

Thursday January 31, 2013

7:30am - 8:30am	Continental Breakfast
8:30am - 9:30am	**Atomic Layer Deposition: A Powerful Tool for Catalyst Synthesis** (Ballroom) Peter C. Stair, Professor and Chair, Department of Chemistry and Director, Center for Catalysis and Surface Science, Northwestern University
10:00am - 11:30am	Technical Sessions **Advances in Gas Treating** (Armour Dinning) **Fuel Cell Technologies** (Room 007) **New, Sustainable Routes to Chemicals and Fuels** (Trustee Room) **Teaching the Chemical Engineering Capstone Design Course** (Room 005) **Resume Workshop** (Armour Conference Room)
11:30am - 1:30pm	Lunch with HS Outreach Participants (Ballroom and Gallery Lounge)
1:00pm - 2:30pm	Technical Sessions **Advances in Process Equipment** (Armour Dinning) **Nanotechnology** (Room 007) **Refinery Processing of Shale and Tight Oils** (Trustee Room) **Business Issues for Engineers** (Room 005) **New Graduate Engineer Training Practices** (Room 006)
2:30pm - 3:00pm	Networking Break
3:00pm - 4:30pm	Technical Session **Fluidization and Fluid-Particle Systems** (Armour Dining) **Agent-based Systems in Chemical Engineering Applications** (Room 007) **Biochemical Innovation and Commercialization** (Trustee Room) **Career Path Development** (Room 006)
4:30pm - 6:00pm	Poster Session (Expo Room)
6:00pm - 7:00pm	Buffet Dinner (Ballroom)
7:00pm - 8:00pm	**Chicago: A River Runs Through It** (Ballroom) Catherine O'Connor, Director of Engineering Metropolitan Water Reclamation District of Greater Chicago

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Program at a Glance

Friday February 1, 2013

7:30am - 8:30am	Continental Breakfast
8:30am - 9:30am	**TBD** (Ballroom) Dr. Jack Lewnard, Chief Technology Officer Gas Technology Institute
10:00am - 11:30am	Technical Sessions **Renewables Research** (Armour Dinning) **Air & Water Pollutions Controls for Fossil Power Plants** (Room 007) **Characterization Methods for Immunoassay Diagnostic Tests** (Trustee Room) **Biological Water and Wastewater Treatment** (Room 005) **Interviewing Skills Workshop** (Armour Conference Room)
11:30am - 1:30pm	Lunch with HS Outreach Participants (Ballroom and Gallery Lounge)
1:00pm - 2:30pm	Technical Sessions **Sustainable Fuel Processing** (Armour Dinning) **Smart and Intense Chemical Processes** (Room 007) **Process Safety** (Trustee Room) **Engineering Extracellular Matrices** (Room 005) **Unwritten Laws of Engineering** (Room 006)
2:30pm - 3:00pm	Networking Break
3:00pm - 4:30pm	Technical Session **Emerging Technologies in the Oil and Gas Industry** (Armour Dinning) **Emerging Technologies in Power Generation** (Room 007) **Applications of Chemical Engineering in Food Safety** (Trustee Room) **Advances in Biological Engineering** (Room 005) **Career Path Development** (Room 006) **MRC 2014 Planning Session** (Armour Conference Room)
6:00pm-8:00pm	Young Professional Networking Social (*Off-site*) Rocky's Bar & Grill 234 West 31st Street, Chicago, IL 60616 (312-842-9200)

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Session Presentations

Thursday January 31, 2013

Advances in Gas Treating (Th1A) Thursday Jan 31, 2013 (Armour Dinning) *Organizer and Chair: Dennis O'Brien, Jacobs Consultancy.*

10:00am **Advanced Adsorbents for Hydrocarbon Industry** *Vlado Kanazirez, UOP LLC, A Honeywell Company*

10:30am **Adsorbent Solutions for Sulfur Removal in Gas Industry** *Stephen Caskey, UOP LLC, A Honeywell Company*

11:00am **Mercury Removal Adsorbents for Oil and Gas Industry** *Dante Simonetti, UOP LLC, A Honeywell Company*

Fuel Cell Technologies (Th1B) Thursday Jan 31, 2013 (Room 007) *Organizer: Shabbir Ahmed, Argonne National Laboratory. Chairs: Shabbir Ahmed and Debbie Myers, Argonne National Laboratory.*

10:00am **Fuel Cell R&D: Where Are We and Where Will We Go** *Chinbay Q. Fan, Gas Technology Institute*

10:25am **Platinum and Platinum Alloy Electrocatalyst Degradation in Polymer Electrolyte Fuel Cells** *Debbie Meyers, X. Wang, N. Kariuki, S. Arisetty, S. DeCrane, T. Nowicki, R. Subbaraman, R. Ahluwalia, Argonne National Laboratory, M. Gummalla, Z. Yang, S. Zhitnik, United Technologies Research Center, S. Ball, J. Sharman, B. Theobald, and G. Hards, Johnson Matthey TC, P. Ferreira, D. Groom, S. Rajasekhara, University of Texas-Austin, D. Morgan, J. Gilbert, B. Puchala, L. Wang, E. Holby, University of Wisconsin-Madison, J. Meyers, P. Mathew, S. K. Kim University of Texas-Austin, Y. Shao-Horn, W. Sheng, B. Han, MIT*

10:45am **New Approaches to High-Efficiency Non-Platinum Group Metal Catalysts for PEM Fuel Cell Applications** *Di-Jia Liu, J.-L. Shui, D. Zhao, S. Ma, S. Yuan, C. Chen, G. Goenaga, S. Comment, B. Reprogle, A. Mason, Argonne National Laboratory, L. Grabstanowicz, T. Xu, Northern Illinois University*

11:05am **Optimization of Carbon Fiber Usage in Type-4 Hydrogen Storage Tanks for Automotive Fuel Cells** *Thanh Q. Hua, H-S Roh, R.K. Ahluwalia, Argonne National Laboratory*

New, Sustainable Routes to Chemicals and Fuels (Th1C) Thursday Jan 31, 2013 (Trustee Room) *Organizer and Chair: Justin Notestein, Northwestern University.*

10:00am **Steady-Flux Regulation at Primary Metabolic Nodes and Design Implications for Products** *Karthik Sekar and Keith Tyo, Northwestern University*

10:20am **Quantifying CO2 Binding on Titania Based Nanocomposites Using Quartz Crystal Microbalance** *Kevin C. Schwartzenberg and Kimberly A Gray, Northwestern University*

10:40am **The Shale-to-Well Energy and Environmental Impacts of Shale Gas Production in China** *Yuan Chang, Northwestern University, Robert J. Ries, University of Florida, Runze Huang and Eric Masanet, Northwestern University*

11:00am **Kinetics of Reaction of Fructose to form 5-(hydroxymethyl) furfural** *Anirban Das, Jing Zhang and Eric Weitz, Northwestern University*

Teaching the Chemical Engineering Capstone Process Design Course (Th1D) Thursday Jan 31, 2013 (Room 005) *Organizer and Chair: Jeffery P Perl, University of Illinois at Chicago.*

10:00am **Capstone Design in Chicago** *Javad Abbasian, Illinois Institute of Technology, Jennifer Cole, Northwestern University, Joseph F. Pekny, Purdue University, and Jeffery P Perl, University of Illinois - Chicago*

10:45am **Panel Discussion on Capstone Design** *Jeffery P Perl, University of Illinois - Chicago*

Interviewing Skills Workshop (Th1F) Thursday Jan 31, 2013 (Armour Conference Room) *Organizer and Chair: Aaron Matthews, Argonne National Laboratory.*

10:00am **Resume Development 101***Greg Corda and Steve Lohman, Nalco*

10:30am **Resume Critiques** *Jeff Perl, Chicago Chem Consultants Corp*

Advances in Process Equipment (Th2A) Thursday Jan 31, 2013 (Armour Dinning) *Organizer and Chair: Dennis O'Brien, Jacobs Consultancy.*

1:00pm **Membrane Applications in Gas Processing** *Lubo Zhou, UOP LLC, A Honeywell Company*

1:30pm **The Impact of Tray Research on Distillation Efficiency** *Ron Andre, UOP LLC, A Honeywell Company*

2:00pm **The Use of Advanced Heat Exchangers in Oil Production and Refining** *Mike Buettner, Alfa Laval*

Nanotechnology (Th2B) Thursday Jan 31, 2013 (Room 007) *Organizer: Steve Schade. URS. Chairs: Nabil A. Amro, Nanoink and Alak Bhattacharyya, UOP LLC, A Honeywell Company.*

1:00pm **Nanoscale Fabrication with Nanoparticle Based "Inks" Using Dip Pen Nanolithography** *Nabil A. Amro, Nanoink*

1:30pm **Nanoscience and Nanotechnology: From Energy Applications to Advanced Medical Therapies** *Tijana Rajh, Argonne National Laboratory*

2:00pm **Designing Industrially Useful Nanocatalysts** *Alak Bhattacharyya, UOP LLC, A Honeywell Company*

Refinery Processing of Shale and Tight Oils (Th2C) Thursday Jan 31, 2013 (Trustee Room) *Organizer and Chair: Gerald Wilks, Citgo.*

1:00pm **Predict®-Crude: Quantifying Naphthenic Acid Corrosion in Refineries** *Kwei-Meng Yap and Sridhar Srinivasan, Honeywell Processing Solutions*

1:30pm **Managing the Challenges that Arise When Processing Shale Oils** *George Duggan, Baker Hughes*

2:00pm **Water Issues Related to Refining of Canadian Heavy Crude Oil** *Ian Scarth, ChemTreat Inc.*

Business Issues for Engineers (Th2D) Thursday Jan 31, 2013 (Room 005) *Organizer: Donald J. Chmielewski, Illinois Institute of Technology. Chairs: Howard W. Beatty, BP and Nik Rokop, Illinois Institute of Technology.*

1:00pm **Entrepreneurship and You** *Nik Rokop, Illinois Institute of Technology*

1:40pm **Oil Industry Issues and Perspective** *Howard W. Beatty, BP*

New Graduate Engineer Training Practices (Th2E) Thursday Jan 31, 2013 (Room 006) *Organizer and Chair: Pat Shannon, Middough.*

1:00pm **Ambitech New Hire Program** *Ralph Sapko, Ambitech, Inc*

1:30pm **UOP New Hire Program** *Todd Mitchell, UOP LLC, A Honeywell Company*

2:00pm **Ingredion New Hire Program** *Steve Newberg, Ingredion, Inc*

Fluidization and Fluid-Particle Systems (Th3A) *Thursday Jan 31, 2013 (Armour Dining) Organizer: Hamid Arastoopour, Illinois Institute of Technology. Chairs: Hamid Arastoopour, Illinois Institute of Technology and Ray Coco, PSRI.*

3:00pm **Fluidized Bed Design and Pitfalls** *Ray Coco, PSRI*

3:30pm **Introduction to Cyclones** *Bill Heumann, Heumann Environmental Company, LLC*

4:00 pm **CFD Simulation of CO_2 Sorption in a Circulating Fluidized Bed** *Emadoddin Abbasi, Javad Abbasian and Hamid Arastoopour, Illinois Institute of Technology*

Agent-based Systems in Chemical Engineering Applications (Th3B) Thursday Jan 31, 2013 (Room 007) *Organizer: Ali Cinar, Illinois Institute of Technology. Chairs: Hamidreza Mehdizadeh, Illinois Institute of Technology and Eric Tatara, Argonne National Laboratory.*

3:00pm **Applying Agent-based Modeling and Simulation to Engineering Problems – A Review of Recent ABMS Research Program Activities at Argonne National Laboratory** *Eric Tatara. Argonne National Laboratory*

3:30pm **Real-Time Scheduling of Batch Chemical Processes Via Multi-Agent Systems** *Yunfei Chu and Fengqi You, Northwestern University*

4:00pm **Multi-Agent Systems for Modeling Vascularization and Tissue Growth within Porous Biodegradable Scaffolds** *Hamidreza Mehdizadeh, Elif S. Bayrak, Sami Somo, Eric M. Brey and Ali Cinar, Illinois Institute of Technology*

Biochemical Innovation and Commercialization (Th3C) Thursday Jan 31, 2013 (Trustee Room) *Organizer: Donald J. Chmielewski, Illinois Institute of Technology. Chairs: Nik Rokop, Illinois Institute of Technology and Yongyou Hu, Elevance*

3:00pm **Elevance Renewable Sciences Biorefinery Process: Specialty Chemicals from Natural Oils** *Brady Dreyer and Yongyou Hu, Elevance, Woodridge, IL*

3:30pm **Commercializing Gas Fermentation** *Mike Schultz, Lanzatech*

4:00pm **Direct Replacement Fuels and Aromatic Chemicals from Biomass** *Liz Woods, Virent*

Career Path Development (Th3E) Thursday Jan 31, 2013 (Room 006) *Organizer: Aaron Matthews, Argonne National Laboratory. Chair: Tiffany Parrott, Valdes Engineering.*

3:00pm **Personal Finances and Developing a Budget** *Daniel Archer, Electromotive Diesel*

3:30pm **Preparing for the FE and PE Exams** *Angela Bish, Dedert Corp. and Bill Glogowski, Middough*

4:00pm **Panel on Time Management** *Aaron Matthews, Argonne National Laboratory, Tiffany Parrott, Valdes Engineering, Brian Daly, Fluor, Daniel Archer, Electromotive Diesel, Angela Bish, Dedert Corp. and Bill Glogowski, Middough*

Friday February 1, 2013

Renewables Research (Fr1A) Friday Feb 1, 2013 (Armour Dinning) *Organizer and Chair: James J. Foster, Archer Daniels Midland Co.*

10:00am **Progress Report on Integrated BioRefinery** *Josef Schmid, Archer Daniels Midland Co.*

10:20am **Investigation of the Production of Hydroxymethylfurfural as a Bio-based Platform Chemical** *April Hoffart, Archer Daniels Midland Co.*

10:40am **Building Blocks for a Renewable Chemical Industry** *José Leboreiro, Ph.D., Archer Daniels Midland Co.*

11:00am: **Energy Reduction & Advanced Water Removal via Membrane Solvent Extraction Technology** *Rhea Sammons, Ph.D., Archer Daniels Midland Co.*

Air & Water Pollutions Controls for Fossil Power Plants (Fr1B) Friday Feb 1, 2013 (Room 007) *Organizer and Chair: Andrew Carstens, Sargent & Lundy LLC.*

10:00am: **Results of Emissions Testing with Fuel Additives, Activated Carbon, and an Evaluation of Mercury Re-emission at a Coal-fired Power Plant** *Ajay Jayaprakash, Sargent & Lundy LLC*

10:30am: **Water = Power** *Diane Martini, Sargent & Lundy LLC*

11:00am: **CFD Applications in the Power Industry** *Emily Kunkel, Sargent & Lundy LLC*

Characterization Methods for Immunoassay Diagnostic Tests (Fr1C) Friday Feb 1, 2013 (Trustee Room) *Organizer: Daniel L. Obrzut, Abbott Laboratories.Chairs: Daniel L. Obrzut and Deepak Ahuja, Abbott Laboratories*

10:00am: **Characterizing Antifoams for use in Immunoassays** *Daniel L. Obrzut and Alfredo R. Narvaez, Abbott Laboratories*

10:30am: **Understanding interactions between immunoassay excipient proteins and surfactants using interfacial and bulk characterization techniques** *Shyam V. Vaidya and Alfredo R. Narvaez, Abbott Laboratories*

11:00am: **Development of an Orthogonal Method for Evaluating Antibody Stability and Potency** *Mark A. Kwatia and Troy D. McSherry, Abbott Laboratories*

Biological Water and Wastewater Treatment (Fr1D) Friday Feb 1, 2013 (Room 005) *Organizer: Catherine O'Connor, Metropolitan Water Reclamation District of Greater Chicago. Chairs: Catherine O'Connor and Heng Zhang, Metropolitan Water Reclamation District of Greater Chicago*

10:00am **Microbial Assessment Of Biological Nutrient Removal** *Geeta Rijal Heng Zhang and Joseph Kozak Metropolitan Water Reclamation District of Greater Chicago*

10:30am **Enhanced Biological Phosphorus Removal: Implementation with Existing Infrastructure at the Stickney Water Reclamation Plant** *Heng Zhang, Joseph Kozak and Catherine O'Connor, Metropolitan Water Reclamation District of Greater Chicago*

11:00am **De-ammonification of Wastewater Sidestreams: Process Mechanisms and Pilot Results from the Egan Water Reclamation Plant** *Joseph Kozak, Dongqi Qin and Heng Zhang, Metropolitan Water Reclamation District of Greater Chicago*

Interviewing Skills Workshop (Fr1F) Friday Feb 1, 2013 (Armour Conference Room) *Organizer and Chair: Aaron Matthews, Argonne National Laboratory.*

10:00am **Interviewing 101** *Greg Corda and Steve Lohman, Nalco*

10:30am **Mock Interviews** *Dennis O'Brien, Jacobs Engineering*

Sustainable Fuel Processing (Fr2A) Friday Feb 1, 2013 (Armour Dinning) *Organizer: Rajeswar Gattupalli, UOP LLC, A Honeywell Company. Chairs: Rajeswar Gattupalli and Kirk Liu, UOP LLC, A Honeywell Company*

1:00pm **Alcohol to Jet** *Geoffrey W. Fichtl, UOP LLC, A Honeywell Company*

1:30pm **Overview of Exergy Analysis for Distillation Operation** *Kirk Liu, UOP LLC, A Honeywell Company*

2:00pm **Economic Comparison of Continuous and Batch Production of Biodiesel using Soybean Oil** *Pahola T. Benavides, Juan Salazar, and Urmila Diwekar University of Illinois at Chicago*

Smart and Intense Chemical Processes (Fr2B) Friday Feb 1, 2013 (Room 007) *Organizer: Zhijun Jai, Chart Energy & Chemicals, Inc..Chairs: Steve Vallee and Hani Gadalla, Chart Energy & Chemicals, Inc.*

1:00pm **Smart Grid Coordination in Chemical Processes** *Donald J. Chmielewski, Illinois Institute of Technology*

1:30pm **Compact Heat Exchange Reactors (CHER) for Process Intensification (PI)** *Steve Vallee, Chart Energy & Chemicals, Inc.*

2:00pm **Design and Manufacture of Compact Heat Exchangers/Compact Heat Exchange Reactors** *Hani Gadalla, Chart Energy & Chemicals, Inc.*

Process Safety (Fr2C) Friday Feb 1, 2013 (Trustee Room) *Organizer: Donald J. Chmielewski, Illinois Institute of Technology. Chairs: John Mammoser, Rolf Jensen & Associates, Inc. and Ryan Hart, Exponent, Inc.*

1:00pm **NFPA Codes and their Relevance to Chemical Processes** *Jeremy Lebowitz and John Mammoser, Rolf Jensen & Associates, Inc*.
1:30pm **Chemical Process Safety and Sustainable Materials Hazards** *Ryan Hart and Delmar "Trey" Morrison, Exponent, Inc.*
2:00pm **Dust Explosion Hazards, Prevention & Protection Strategies** *Zachary Hachmeister, Fauske & Associates, LLC*

Engineering Extracellular Matrices (Fr2D) Friday, Feb 1, 2013 (Room 005) *Organizer and Chair: Nancy W. Karuri, Illinois Institute of Technology.*
1:00pm **Optimal Control for Dosage Prediction in Superovulation Stage of IVF** *Kirti M. Yenkie and Urmila Diwekar, University of Illinois at Chicago, Vibha Bhalerao, Jijamata Hospital, Nanded, India*
1:30pm **The Proteolytic Stability and Activity of Fibronectin-polyethylene Glycol Composites** *Nancy W. Karuri, Chen Zhang, Sogol Hekmatfar, Anand Ramanathan, Illinois Institute of Technology*
2:00pm **Three-dimensional Dynamic Transcription Factor Profiling of Cancer Cells in Model Microenvironments** *Juan Sánchez-Cortés and Lonnie Shea, Northwestern University*

Unwritten Laws of Engineering (Fr2E) Friday Feb 1, 2013 (Room 006) *Organizer and Chair: Aaron Matthews, Argonne National Laboratory.*
1:00pm **The Engineer and the Company** *Faith Smock, Navistar*
1:30pm **The Engineer and the Manager** *Kristy Gagoff, Navistar*
2:00pm **Panel on Working with Difficult People in Difficult Situations: Making Smart Choices** *Aaron Matthews, Argonne National Laboratory, Brian Daly, Fluor and Luisa Flechas, UOP*

Emerging Technologies in the Oil and Gas Industry (Fr3A) Friday Feb 1, 2013 (Armour Dinning) *Organizer: Rajeswar Gattupalli, UOP LLC, A Honeywell Company. Chairs: Rajeswar Gattupalli and Reza Mostofi, UOP LLC, A Honeywell Company.*
3:00pm **Hydrodynamics of FCC Riser using Advanced Simulation Tools** *Reza Mostofi and Lev Davydov, UOP LLC, A Honeywell Company*
3:30pm **Creating Opportunities from Challenges: Maximizing Propylene Yields from Your FCC** *Jeff Knight, Robert Mehlberg, UOP LLC, A Honeywell Company*
4:00pm **Offshore Gas Treatment Technology for Natural Gas** *Saadet Ulas Acikgoz, Shain Doong, Pengfei Chen and Lubo Zhou UOP LLC, A Honeywell Company*

Emerging Technologies in Power Generation (Fr3B) Friday Feb 1, 2013 (Room 007) *Organizers and Chairs: William Ryan and Jeffery Perl, University of Illinois at Chicago.*
3:00pm **Understanding the Role of Renewable Energy Credits for the Energy Market** *Kelly Costello, University of Illinois at Chicago*
3:30pm **Recent Improvements in Compressed Air Energy Storage Efficiency and Impediments to Integration of Grid Scale Energy Storage** *Greg Herman, University of Illinois at Chicago*
4:00pm **Al Vanadium and Zinc Bromine Flow Batteries Emerging on the Grid** *Scott Jasinski, University of Illinois at Chicago*

Applications of Chemical Engineering Principles in Food Safety (Fr3C) Friday Feb 1, 2013 (Trustee Room) *Organizer: Robert Brackett, Institute of Food Safety and Health, IIT. Chairs: Robert Brackett and Kathiravan Krishnamurthy, Institute of Food Safety and Health, IIT.*
3:00pm **Microwave pasteurization of shell eggs: Opportunities and challenges** *Gregory Fleischman, Institute of Food Safety and Health, IIT and US Food and Drug Administration*
3:20pm **Is a non-thermal plasma really cold?** *Nathan Anderson, Institute of Food Safety and Health, IIT and US Food and Drug Administration*
3:40pm **Thermal analysis of cooling applications and development of an assessment tool for the performance of cooling equipment** *Andre Rehkopf, Institute of Food Safety and Health, IIT*
4:00pm **Process validation for high pressure processing technology for the food industry** *Jason Wan, Institute of Food Safety and Health, IIT*

Advances in Biological Engineering (Fr3D) Friday Feb 1, 2013 (Room 005) *Organizer: Fouad Teymour, Illinois Institute of Technology. Chairs: Fouad Teymour and Georgia Papavasiliou, Illinois Institute of Technology.*
3:00pm **Sequential Growth Factor Delivery within Fibrin Loaded Porous Degradable Hydrogels** *Bin Jiang, Banu Akar, Thomas M. Waller, Jeffery C. Larson, Alyssa A. Appel and Eric M. Brey, Illinois Institute of Technology*
3:30pm **Design of Cell Instructive Hydrogel Microenvironments to Promote Vascularization of Engineered Tissues** *Georgia Papavasiliou, Illinois Institute of Technology*
4:00pm **Biomaterials for Vascularization of Engineered Tissues** *Eric M. Brey, Illinois Institute of Technology*

Career Path Development (Fr3E) Friday Feb 1, 2013 (Room 006) *Organizer and Chair: Aaron Matthews, Argonne National Laboratory.*
3:00pm **Panel on Options for after Graduation** *Aaron Matthews, Argonne National Laboratory, Ashley Romano, University of Illinois at Chicago, Jerry*

Wilks, Citgo Mike Walker, Northwestern University and Gregory N Corda, Nalco

3:30pm **Software Skills for Undergraduates** *Tom VanderVelde RubberCraft and Aaron Matthews, Argonne National Laboratory*

4:00pm **Presentation Skills Workshop** *James Russin, Kenall*

MRC 2014 Planning Session (Fr3F) Friday Feb 1, 2013 (Armour Conference Room) *Organizer and Chair: Donald J. Chmielewski, Illinois Institute of Technology.*

3:00pm **Review of MRC 2013 Technical and YP Programming** *Donald J. Chmielewski, Illinois Institute of Technology and Aaron Matthews, Argonne National Laboratory*

3:10pm **Review of MRC 2013 General Arrangements** *Azita Ahmadzadeh, Simtech Group and Jennifer Guilfoyle, Middough*

3:20pm **Review of MRC 2013 HS Outreach** *Carol Mak, Illinois Institute of Technology*

3:30pm ***Report from AIChE National Liaison*** *Kristine Chin and Stephanie Orvoine-Couvrette, AIChE Technical Conference Programming*

3:40pm ***Planning for the 2014 MRC*** *Jeff Perl, Chicago Chem Consultants and Adam Kanyuh, UOP*

Presentation Abstracts

Session Th1A: **Advances in Gas Treating**
10-11:30am, Thursday Jan 31, 2013 (Armour Dinning)
Organizer and Chair: Dennis O'Brien, Jacobs Consultancy

Advanced Adsorbents for Hydrocarbon Industry
Vlado Kanazirez, UOP LLC, A Honeywell Company
This presentation will describe new and enhanced adsorbents for use in refinery and petrochemical processing. There has been a very strong demand for better adsorbents in hydrocarbon processing units.

Adsorbent Solutions for Sulfur Removal in Gas Industry
Stephen Caskey, UOP LLC, A Honeywell Company
This presentation will describe new and enhanced adsorbent for use in gas processing. There has been a strong demand for cost effective treating solutions for the new gas fields coming on line in the US.

Mercury Removal Adsorbents for Oil and Gas Industry
Dante Simonetti, UOP LLC, A Honeywell Company
Many gas condensate streams contain low levels of mercury. Processing these streams in a cryogenic unit requires that the mercury be removed so that the "cold-box" is not destroyed. Some of the solutions to this contaminate are expensive and lower cost solutions are being sought.

Session Th1B: **Fuel Cell Technologies**
10-11:30am, Thursday Jan 31, 2013 (Room 007)
Organizer: Shabbir Ahmed, Argonne National Laboratory
Chairs: Shabbir Ahmed and Debbie Myers, Argonne National Laboratory

Fuel Cell R&D: Where Are We and Where Will We Go
Chinbay Q. Fan, Gas Technology Institute
The use of hydrogen as an energy carrier could help address our concerns about energy security, global climate change, and air quality. Fuel cells are an important enabling technology for the Hydrogen Future especially with low cost natural gas and have the potential to revolutionize the way we power our nation, offering cleaner, more-efficient alternatives to the combustion of gasoline and other fossil fuels. For over 55 years, GTI has been active in Hydrogen Energy research, development, and demonstration (RD&D). The Institute has extensive experience and on-going work in all aspects of the hydrogen energy economy, including production, delivery, infrastructure, use, safety, and public policy. This presentation summarizes the status of the fuel cell R&D, mainly; hydrogen production, hydrogen storage, and proton exchange membrane fuel cells (PEMFC) and solid oxide fuel cells (SOFC). Also this presentation will brainstorm the future of the fuel cells.

latinum and Platinum Alloy Electrocatalyst Degradation in Polymer Electrolyte Fuel Cells
Debbie Meyers, X. Wang, N. Kariuki, S. Arisetty, S. DeCrane, T. Nowicki, R. Subbaraman, R. Ahluwalia, Argonne National Laboratory, M. Gummalla, Z. Yang, S. Zhitnik, United Technologies Research Center, S. Ball, J. Sharman, B. Theobald, and G. Hards, Johnson Matthey TC, P. Ferreira, D. Groom, S. Rajasekhara, University of Texas-Austin, D. Morgan, J. Gilbert, B. Puchala, L. Wang, E. Holby, University of Wisconsin-Madison, J. Meyers, P. Mathew, S. K. Kim University of Texas-Austin, Y. Shao-Horn, W. Sheng, B. Han, MIT
One of the primary challenges facing the development of polymer electrolyte membrane fuel cells (PEMFCs) for automotive and stationary power applications is the durability of the fuel cell materials, especially the platinum-based cathode catalyst. This presentation will discuss the results of a multi-institutional collaborative project focused on elucidating the effects of cathode catalyst and support physicochemical properties and cell operating conditions on the rates and mechanisms of cathode catalyst degradation. The primary reasons for the lifetime limitations of the cathode catalyst and a definition of the catalyst properties and operating conditions that allow fuel cell systems to achieve the lifetime targets for the automotive and stationary applications will be discussed.

New Approaches to High-Efficiency Non-Platinum Group Metal Catalysts for PEM Fuel Cell Applications
Di-Jia Liu, J.-L. Shui, D. Zhao, S. Ma, S. Yuan, C. Chen, G. Goenaga, S. Comment, B. Reprogle, A. Mason, Argonne National Laboratory, L. Grabstanowicz, T. Xu, Northern Illinois University
Oxygen reduction reaction (ORR) represents the most important electrochemical process in a proton exchange membrane fuel cell (PEMFC). An effective catalyst with improved active site design and support architecture could reduce the kinetic barrier, lower the electrochemical overpotential, and enhance the mass transfer as well as energy conversion efficiency. Conventional PEMFC cathode catalysts contain the platinum group metals (PGMs) which contributes significant fraction of the overall stack cost. We report herein our recent progress in developing low-cost, high-efficiency non-PGM catalysts for fuel cell using porous organic material (MOF and POP) based compounds as the precursors. New approaches to prepare the catalysts with high surface area and active site density are demonstrated, supported by the characterization studies.

Optimization of Carbon Fiber Usage in Type-4 Hydrogen Storage Tanks for Automotive Fuel Cells
Thanh Q. Hua, H-S Roh, R.K. Ahluwalia, Argonne National Laboratory
Analysis of carbon fiber requirement for the 5.6-kg 700-bar compressed hydrogen Type 4 tank is presented. Netting analysis is used to determine the optimal dome shape, winding angle, and initial estimates of the helical and hoop layer thicknesses for a given length-to-diameter ratio. Three dimensional finite element analysis using ABAQUS with the Wound Composite Modeler is then used to predict the performance of the composite tank subject to the operating requirements and design assumptions. Doilies are used to provide extra reinforcement of the dome section, which would reduce the number of helical layers wound through the cylindrical section of the tank. A new integrated end-cap vessel (IECV) is proposed as an advanced design for Type 4 tanks. For the 5.6-kg 700-bar compressed hydrogen tank, our finite element analysis of the IECV shows that the total amount of carbon fiber usage can be reduced by ~ 15%.

Session Th1C: **New, Sustainable Routes to Chemicals and Fuels**

10-11:30am, Thursday Jan 31, 2013 (Trustee Room)

Organizer and Chair: Justin Notestein, Northwestern University

Steady-Flux Regulation at Primary Metabolic Nodes and Design Implications for Products

Karthik Sekar and Keith Tyo, Northwestern University

Understanding how cells regulate flux in response to heterologous pathways allows engineers to maximize conversion and productivity toward desired products. We characterize flux regulation with respect to native pathways and a heterologous pathway to poly-3-hydroxybutyrate (PHB) in *Escherichia coli*. We find that glucose uptake can be increased from wild-type condition to recover NADPH and when oxidative phosphorylation saturates, lactate secretion relieves electron imbalance.

Quantifying CO2 Binding on Titania Based Nanocomposites Using Quartz Crystal Microbalance

Kevin C. Schwartzenberg and Kimberly A Gray, Northwestern University

The first step in photocatalytic reduction of CO2 is the adsorption and activation of CO2 on the surface of the catalyst. Titania nanomaterial surfaces contain many sites which can differ in titanium coordination number and Lewis acidity or basicity. This heterogeneity can lead to several different species of adsorbed CO2 including carbonates, bicarbonates, and carboxylates. Co-catalyst materials may also participate in adsorption. Using quartz crystal microbalance (QCM) technique, we quantitatively probe adsorption and reaction under controlled reaction conditions and explore the role of surface site features and co-catalysts on these processes.

The Shale-to-Well Energy and Environmental Impacts of Shale Gas Production in China

Yuan Chang, Northwestern University, Robert J. Ries, University of Florida, Runze Huang and Eric Masanet, Northwestern University

Tapping its large reserves of unconventional gas, China has launched shale gas exploration and started drilling wells in trial development zones. To completely understand the energy and environmental impacts of shale gas production in China, this study developed a process-based hybrid life cycle inventory (LCI) model for estimating the 'shale-to-well' energy and emissions. Results show that the 'shale-to-well' energy for constructing a typical shale gas well in China was 55820 GJ, and the share of upstream and on-site energy was 39% and 61% respectively. The on-site energy depends on diesel consumption, and 54% of on-site diesel was used for oil-based drilling fluid. The product chain greenhouse gas (GHG) emissions were 5120 tons carbon dioxide equivalent, and were dominated by the upstream diesel refining and the fugitive methane in well completion. This study represents an approach to completely quantify the energy and environmental impacts of shale gas production in China, identifies opportunities for impacts reduction, and further contributes to the understanding of potential energy and environmental implications of the 'coal-to-gas' transition in China.

Kinetics of Reaction of Fructose to form 5-(hydroxymethyl) furfural

Anirban Das, Jing Zhang and Eric Weitz, Northwestern University

The acid-catalyzed dehydration of fructose is important in the effective utilization of biomass. This reaction can lead to production of 5-hydroxymethyl furfural (HMF) that can be readily converted into other useful molecules, such as dimethylfuran, furan dicarboxylic acid, gamma-valerolactone, and levulinic acid, which, in turn, can be converted to liquid transportation fuels and chemical feedstocks. The design of an efficient catalyst for this process requires knowledge of the details of the reaction mechanism in order to pin-point the steps that limit selectivity and rate. In the current study, the mechanism of acid-catalyzed dehydration of fructose to from HMF was probed by studying the kinetics of this reaction with an Amberlyst 70 catalyst in DMSO. . Kinetic data for the different tautomers of fructose were obtained at different temperatures, acidity and catalyst to reactant ratios. The implications of all of the kinetic data with regard to the magnitudes of the rates that are observed for different reaction steps, and the rate limiting step in the reaction, will be discussed. This study of the kinetics of the formation of HMF from fructose, and influence of the rate of reaction of individual tautomers on the overall reaction process, provides data that are inputs to the development of a complete molecular level model of the kinetics of the reaction of fructose. We anticipate that these data can be used to optimize the production of desired products and guide the development of new catalysts for the formation of HMF with high efficiency and selectivity. This material is based upon work supported as part of the Institute for Atom-efficient Chemical Transformations (IACT), an Energy Frontier Research Center funded by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences.

Session Th1D: **Teaching the Chemical Engineering Capstone Senior Process Design Course**

10-11:30am, Thursday Jan 31, 2013 (Room 005)

Organizer and Chair: Jeffery P Perl, University of Illinois at Chicago

Capstone Design in Chicago

Javad Abbasian, Illinois Institute of Technology, Jennifer Cole, Northwestern University, Joseph F. Pekny, Purdue University, and Jeffery P Perl, University of Illinois - Chicago

The senior chemical engineering design capstone course has a special place in academia as it brings our students entire school experience to focus on designing a chemical process(s). All the schools take differing approaches to preparing students for their careers, reflecting a diverse faculty and surrounding industry interests. This session will provide an opportunity to share and compare notes, not only amongst fellow academicians, but also with industrial conference attendees in general with an eye towards obtaining input from them as well!

Panel Discussion on Capstone Design

Jeffery P Perl, University of Illinois - Chicago

Session Th1F: **Interviewing Skills Workshop**
10-11:30am, Thursday Jan 31, 2013 (Armour Conf Room)
Organizer and Chair: Aaron Matthews, Argonne National Laboratory

Resume Development 101
Greg Corda and Steve Lohman, Nalco
A resume is an essential step in preparing for a career. It becomes a summary of a person's skills, experience, and accomplishments including education, employment history, professional organizations, and biographical information. Resumes can be difficult for engineers to handle as many aspects of professional development can cover broad areas that are hard to define. The Resume Review Team has a diverse background covering many areas of engineering and development. Learn from the collective expertise on how to best arrange key skills and qualifications when applying for a new position. Also learn how to balance key experience on the resume while highlighting important soft skills and knowledge on a cover letter.

Resume Critiques
Jeff Perl, Chicago Chem Consultants Corp
Get a resume critique from engineering veterans

Session Th2A: **Advances in Process Equipment**
1-2:30pm, Thursday Jan 31, 2013 (Armour Dinning)
Organizer and Chair: Dennis O'Brien, Jacobs Consultancy

Membrane Applications in Gas Processing
Lubo Zhou, UOP LLC, A Honeywell Company
Membranes have been widely used in water desalination, hydrogen purification, and natural gas acid gas removal due to its unique properties. Natural gas from wells usually contains acid gas such as CO2, which needs to be removed before the natural gas is sent the pipelines. Bulk removal of CO2 from natural gas matches membrane properties very well since high pressure natural gas from the gas wells can simply pass through membranes to remove CO2 through permeation while the methane is kept at high pressure for pipeline transportation. UOP has long history to apply the membranes in natural gas processing. UOP's Separex membranes have been applied to many onshore and offshore gas fields. In 1994, UOP successfully applied membranes to shale gas acid gas removal in Michigan. The unit has been running very well since it started. In this presentation, I will start to introduce the fundamentals of membrane and membrane process. Then, I will show the examples of membrane applications in the gas processing industry.

The Impact of Tray Research on Distillation Efficiency
Ron Andre, UOP LLC, A Honeywell Company
Trays hardware has be evolving since the last Symposium presentation 10 years ago. This talk will provide an update on tray hardware and capacity.

The Use of Advanced Heat Exchangers in Oil Production and Refining
Mike Buettner, Alfa Laval
In the petrochemical and refining industry there are increasing pressures to meet the market demands of their customers, while trying to become more energy efficient. In many parts of the world, and more than likely in the US in the near future, energy consumption will be linked to regulated emissions such as carbon dioxide. Alfa Laval uses our technological solutions to break the shell and tube paradigms that exist in these industries to help them meet these new goals. This presentation will discuss the drivers for looking at alternative heat exchangers, details on the technology, and case studies to show where the technology has been beneficial.

Session Th2B: **Nanotechnology**
1-2:30pm, Thursday Jan 31, 2013 (Room 007)
Organizer: Steve Schade. URS
Chairs: Nabil A. Amro, Nanoink and Alak Bhattacharyya, UOP LLC, A Honeywell Company

Nanoscale Fabrication with Nanoparticle Based "Inks" Using Dip Pen Nanolithography
Nabil A. Amro, Nanoink
In many areas of modern technology, from solid state device fabrication to biotechnology, 2-D patterning techniques are used to define structures and boundaries. These patterning techniques ultimately determine features size and density and thus unit performance and price. Much is developed upon the well known techniques of resist lithography yet to achieve extreme spatial resolution or chemical versatility; other techniques are better suited to control chemistry of surfaces on the 1-100 nm length scale. Dip Pen Nanolithography (DPN®) is a scanning probe-based lithography technique in which an atomic force microscope tip is used to deliver chemical reagents (from colloidal particles to metals ions, and from small organic molecules to biological polymers) directly to nanoscopic regions of a target substrate (from metals to insulators and modified-surfaces). This process has been recognized as a powerful and versatile tool for generating micron-, submicron-, and nanometer scale structures. The combination of resolution, registration, and direct-write capability offered by DPN® distinguish it from any alternative lithographic strategy and make DPN® a promising tool for patterning variety of nanostructures. In this talk we will present the fabrication of nanostructures at predefined position on surfaces using a variety of nanoparticles via DPN and their applications, as well as high throughput and large area fabrication of nanostructures using two-dimensional pen arrays. In addition we will give a brief background on nanoparticles manufacturing methods.

Nanoscience and Nanotechnology: From Energy Applications to Advanced Medical Therapies
Dr. Tijana Rajh, Argonne National Laboratory
Future breakthroughs in nanoscience and nanotechnology rely upon the creation of new classes of functionally integrated hybrid materials that incorporate nanoparticles, three-dimensionally tuned nanoscale architectures, and biologically active molecules, offering opportunities for impact in diverse applications ranging from quantum computation, energy, and advanced medical therapies. Important elementary steps in energy relevant processes such as energy conversion, electronics and catalysis, occur at the nanoscale and require electron exchange within hierarchical structure. However, nanoscale materials absorb, propagate, and dissipate energy very differently than bulk materials. Within this framework, there is great opportunity to realize advances in the conversion, transfer, and storage of energy at the nanoscale. The exchange of electrons in these multiphase systems, designed and assembled to carry out a specific process, defines the functions of the system. Argonne, and the Center for Nanoscale Materials (CNM) in particular, has unique strengths in understanding how deliberate tailoring of materials on the nanoscale can lead to novel and enhanced

functionalities. This strong core area has evolved and matured from breakthroughs in the study of elemental processes in the natural and artificial photosyntheis at Argonne that made pioneering contributions to the field of solar energy conversion. We developed hybrid biomolecule-semiconductor systems that use semiconductor nanoparticles for initial light-induced charge separation while using biomolecules for subsequent chemical/electrical conversion. In the same manner we use photoinduced charge separation in order to control and manipulate processes within living cells. Site selective redox processes occurring upon irradiation of hybrid systems are used to alter cell functioning. The main goal of this research is to achieve control of chemical processes of biomolecules and supramolecular entities within the living cells in order to develop new tools for advanced medical therapies.

Designing Industrially Useful Nanocatalysts

Alak Bhattacharyya, UOP LLC, A Honeywell Company

Desulfurization of emissions from industrial sources has become an integral part of operating a plant. More and more stringent regulations have made this effort an ongoing challenge. Sulfur emissions may contain oxidized sulfur, such as SO_2 and SO_3 or reduced sulfur, H_2S. Desulfurization is also needed to purify a gas stream for further utilization as a chemical feedstock. We have designed a class of mixed metal oxide compositions, derived from hydrotalcite-type clays that can be used for effective abatement of oxidized and reduced sulfur. The primary factors for the effectiveness of these materials are compositions, nano-range crystallites, redox metals, and unique structural domains. If a metal oxide or a mixed metal oxide catalyst is used for the abatement of these pollutants, the material needs to have three functions: 1) chemisorption and transfer of "sulfur" from gas to solid, 2) retention of catalytic properties of the solid to perform other gas phase catalytic reactions, such as the water gas shift reaction, and 3) effective release of the sulfur for the regeneration of the catalyst. This paper will discuss how these three functions were studied and enhanced by designing novel mixed metal oxide materials for effective desulfurization of hot gases from gasification units and refineries. US Patents 7,759,282; 7,811,474

Session Th2C: **Refinery Processing of Shale and Tight Oils**

1-2:30pm, Thursday Jan 31, 2013 (Trustee Room)

Organizer and Chair: Gerald Wilks, Citgo

Predict®-Crude: Quantifying Naphthenic Acid Corrosion in Refineries

Kwei-Meng Yap and Sridhar Srinivasan, Honeywell Processing Solutions

The advent of opportunity crudes and the commercial necessity of processing crudes with widely varying speciation characteristics have highlighted the inadequacies of industry rules of thumb and guidelines such as API RP581 Base Resource Document for crude corrosivity assessment. These guidelines, which focus on TAN, wt% sulfur, temperature and alloy content tend to lead to overt conservatism in alloy selection, and on other occasions, may lead to material choices that suffer significant naphthenic acid / sulfidation corrosion. This talk describes a novel corrosion prediction system called Predict-Crude to quantify potential corrosion damage due to naphthenic acid and sulfidation corrosion in side cut piping. The system captures key parametric relationships gleaned from a recently concluded Joint Industry Project correlating naphthenic acid content, active sulfur content, temperature, wall shear stress and other relevant parameters to corrosion quantification and material selection.

Managing the Challenges that Arise When Processing Shale Oils

George Duggan, Baker Hughes

In the past 2 years, a new source of crude oil has hit the U.S. market. These oils, commonly called Shale Oils, are a class of light crudes produced from various "shale plays" in North America. At first glance, these crudes are light, low viscosity, low in sulfur and asphaltenes, and appear to present a high quality crude for refining. Upon closer examination, severe processing issues are likely, and in fact are being reported on a frequent basis. Processing and managing the Shale Oil requires the following: first, anticipating potential problems; and, second, providing a surveillance plan to give early warning/detection of problems should they arise. This presentation will discuss the challenges encountered, the impacts on refining profits and suggested steps to take in advance to fully prepare the refinery for Shale Oils.

Water Issues Related to Refining of Canadian Heavy Crude Oil

Ian Scarth, ChemTreat Inc.

What used to be classified as opportunity crudes, Canadian heavy, is now the main course in the diet for many refineries in North America. Running these crudes high in viscosity, solids, asphaltenes, TAN and sulfur, often requires additional equipment and significant operational changes to realize their economic benefit. This presents unique challenges to the water systems in these refineries. This paper will discuss these challenges and the mechanical and chemical approaches required to meet them.

Session Th2D: **Business Issues for Engineers**

1-2:30pm, Thursday Jan 31, 2013 (Room 005)

Organizer: Donald J. Chmielewski, Illinois Institute of Technology

Chairs: Howard W. Beatty, BP and Nik Rokop, Illinois Institute of Technology

Entrepreneurship and You

Nik Rokop, Illinois Institute of Technology

Nik Rokop, Managing Director of the IIT Entrepreneurship Academy and the Jules F. Knapp Entrepreneurship Center will use examples from his life as a successful engineer, businessman and entrepreneur to provide insights and resources for your career advancement. See what Entrepreneurship at IIT is all about and how you can benefit from being involved. Bring your questions and be sure to interact to maximize your time!

Oil Industry Issues and Perspective

Howard W. Beatty, BP

This presentation addresses a series of topics which illustrate commercial issues of interest to industry generally and the oil industry in particular but each in a way which leaves the audience with a unique perspective. It is highly audience interactive so bring your views with you! Topics covered are Why Oil?, Business Commitments, You Be the Boss!, Profits and Taxes and Deal or No Deal?

Session Th2E: **New Graduate Engineer Training Practices**
1-2:30pm, Thursday Jan 31, 2013 (Room 006)
Organizer and Chair: Pat Shannon, Middough

Ambitech New Hire Program
Ralph Sapko, Ambitech, Inc
The presentation will describe Ambitech's training program for newly graduated process engineers.

UOP New Hire Program
Todd Mitchell, UOP LLC, A Honeywell Company
This presentation is an overview of UOP's training program for new hires who intend to join the Field Service program.

Ingredion New Hire Program
Steve Newberg, Ingredion, Inc
The presentation will review Ingredion's new hire orientation and training methods.

Session Th3A: **Fluidization and Fluid-Particle Systems**
3-4:30pm, Thursday Jan 31, 2013 (Armour Dining)
Organizer: Hamid Arastoopour, Illinois Institute of Technology
Chairs: Hamid Arastoopour, Illinois Institute of Technology and Ray Coco, PSRI

Fluidized Bed Design and Pitfalls
Ray Coco, PSRI
In the past 2 years, a new source of crude oil has hit the U.S. market. These oils, commonly called Shale Oils, are a class of light crudes produced from various "shale plays" in North America. At first glance, these crudes are light, low viscosity, low in sulfur and asphaltenes, and appear to present a high quality crude for refining. Upon closer examination, severe processing issues are likely, and in fact are being reported on a frequent basis. Processing and managing the Shale Oil requires the following: first, anticipating potential problems; and, second, providing a surveillance plan to give early warning/detection of problems should they arise. This presentation will discuss the challenges encountered, the impacts on refining profits and suggested steps to take in advance to fully prepare the refinery for Shale Oils.

Introduction to Cyclones
Bill Heumann, Heumann Environmental Company, LLC
How cyclones work / Different styles of cyclones / Why use a cyclone/ When not to use a cyclone / Basic metrics of cyclone performance / Cyclone Total Collection Efficiency / Tools for achieving increased cyclone efficiency / Costs of achieving increased cyclone efficiency / How cyclones fail

CFD Simulation of CO_2 Sorption in a Circulating Fluidized Bed
Emadoddin Abbasi, Javad Abbasian and Hamid Arastoopour, Illinois Institute of Technology
Computational Fluid Dynamics (CFD) approach was used to simulate sorption of CO2 using solid sorbents in the riser section of a circulating fluidized bed. The simulation results were compared with the experimental data of KIER for continuous CO2 sorption using Potassium Carbonate in a circulating fluidized bed system.

Session Th3B: **Agent-based Systems in Chemical Engineering Applications**
3-4:30pm, Thursday Jan 31, 2013 (Room 007)
Organizer: Ali Cinar, Illinois Institute of Technology
Chairs: Hamidreza Mehdizadeh, Illinois Institute of Technology and Eric Tatara, Argonne National Laboratory

Applying Agent-based Modeling and Simulation to Engineering Problems – A Review of Recent ABMS Research Program Activities at Argonne National Laboratory
Eric Tatara. Argonne National Laboratory
A general overview of agent-related research programs ANL which would demonstrate the breadth of agent-based modeling and systems in chemical engineering, energy systems, modeling of ecologies and environment, and business processes.

Real-Time Scheduling of Batch Chemical Processes Via Multi-Agent Systems
Yunfei Chu and Fengqi You, Northwestern University
Scheduling is a crucial decision-making activity in batch processes. Optimization methods provide a systematic approach to the scheduling problem and the optimality of the solution is guaranteed. However, due to the combinatorial nature of the resulting mixed-integer programming (MIP) problems, the computational complexity is still a main challenge in spite of the significant advances in the optimization theories and algorithms as well as computational power in recent years. To circumvent the computational complexity in the MIP based approach, multi-agent based modeling provides a powerful option. A major difference between the agent-based approach and others is that it models a process from the bottom up and decisions in the system are distributed across many intelligent agents. This feature equips the agent-based approach with the power of providing a fast and efficient solution that is applicable to real time rescheduling and thus responds to unanticipated events and uncertain processing times. A novel scheduling algorithm that provides a good balance between computational efficiency and solution quality will be presented.

Multi-Agent Systems for Modeling Vascularization and Tissue Growth within Porous Biodegradable Scaffolds
Hamidreza Mehdizadeh, Elif S. Bayrak, Sami Somo, Eric M. Brey and Ali Cinar, Illinois Institute of Technology
Agent-based models (ABM) are naturally suitable for modeling biological systems as they are comprised of individual discrete micro-scale constituents (cells) that interact with each other and their environment (extracellular microstructure) to form non-homogeneous macro-scale bodies (tissues and organs). A multi-layer ABM is developed to model the process of tissue growth within biodegradable non-vascularized porous scaffolds. As scaffolds have dimensions in the order of hundred micrometers, tissue cells require functional blood vessel networks to provide them with required nutrients and hence it is necessary to consider vascularization of the scaffold at the same time as tissue growth. As a result, the model includes separate layers to simulate the scaffold structure, the developing blood vessel network (that invades inside the scaffold), and the tissue cells that grow, migrate, and increase in number.

Session Th3C: **Biochemical Innovation and Commercialization**
3-4:30pm, Thursday Jan 31, 2013 (Trustee Room)
Organizer: Donald J. Chmielewski, Illinois Institute of Technology
Chairs: Nik Rokop, Illinois Institute of Technology and Yongyou Hu, Elevance

Elevance Renewable Sciences Biorefinery Process:

Specialty Chemicals from Natural Oils
Brady Dreyer and Yongyou Hu, Elevance, Woodridge, IL
Elevance Renewable Sciences, Inc., based in Woodridge, IL, creates valued specialty chemicals from natural oils. Using olefin metathesis, the company's proprietary biorefinery process creates high performance difunctional platform molecules which are effective building blocks for ingredients used in personal care products, detergents, fuels, lubricants and other specialty chemicals markets. In this presentation, the biorefinery process, the biorefinery products, and the markets for the products will be discussed.

Commercializing Gas Fermentation
Mike Schultz, Lanzatech
LanzaTech has developed a novel gas fermentation process that can convert carbon monoxide and hydrogen containing gases into fuels and chemicals products. The LanzaTech process can convert these gas streams into Ethanol and 2,3-Butanediol, a C4 dialcohol that can be converted into conventional chemicals such as MEK and butadiene. Synthetic biology techniques have also enabled production of products such as propanol, n-butanol, and acetone. LanzaTech is also actively working with partners for the conversion of these products into downstream petrochemicals, plastic pre-cursors, and drop-in fuels, providing an alternate route to add value to the carbon in these gas streams. This talk will focus on the commercialization of LanzaTech's technology, including the challenges and successes to date.

Direct Replacement Fuels and Aromatic Chemicals from Biomass
Liz Woods, Virent
Virent creates the chemicals and fuels the world demands from a wide range of naturally occurring, renewable resources. Using patented catalytic chemistry, Virent's technology can replace over 90% of a barrel of crude oil. Our breakthrough catalytic technology transforms renewable plant sugars into the same range of hydrocarbon molecules historically made from refining petroleum, including gasoline, diesel, jet fuel, paraxylene, and other petro-chemicals. Virent's direct replacement drop-in products can be blended in high concentrations with no new infrastructure investment; they are ready to work in today's chemical and fuel supply chains. Additionally, Virent's BioForming™ process is able to use a wide variety of feedstocks, including cellulosic feedstocks like bagasse, corn stover, grasses, sorghum and wood as well as conventional feedstocks like beet sugar, sugar cane and corn starch. Virent's feedstock flexibility enables optimization based on availability, price or other considerations important to our customers. With 30 awarded patents and more than 150 pending applications, Virent has solidified our position as a leader in the biofuels and chemicals arena. Beyond the ground breaking research and development, Virent has developed key strategic relationships with Cargill, Coca-Cola, Honda and Shell, adding vital resources and expertise required to accelerate commercialization of our technology. With the crucial combination of technology and strategic relationships, Virent is poised to break into the market place.

Session Th3E: **Career Path Development**
3-4:30pm, Thursday Jan 31, 2013 (Room 006)
Organizer: Aaron Matthews, Argonne National Laboratory
Chair: Tiffany Parrott, Valdes Engineering

Personal Finances and Developing a Budget
Daniel Archer, Electromotive Diesel
Financial planning is an important step after graduation. Preparing short and long-term savings plans while paying down student loan debt requires a balance of priorities. A sudden increase of spendable income can be quickly offset when student loans go into re-payment status. With good foresight major items can be purchased while still paying back the loans.

Preparing for the FE and PE Exams
Angela Bish, Dedert Corp. and Bill Glogowski, Middough
A look into benefits of getting FE and PE certifications, preparing the applications, and developing a study plan.

Panel on Time Management
Aaron Matthews, Argonne National Laboratory, Tiffany Parrott, Valdes Engineering, Brian Daly, Fluor, Daniel Archer, Electromotive Diesel, Angela Bish, Dedert Corp. and Bill Glogowski, Middough
Share the experience of 6 young professionals who have been working for 3-6 years. Some of these panel members have pursued advanced degrees and volunteered with AIChE while working and still managed to maintain a social life. Come ask them how!

Session Fr1A: **Renewables Research**
10-11:30am, Friday Feb 1, 2013 (Armour Dinning)
Organizer and Chair: James J. Foster, Archer Daniels Midland Co.

Progress Report on Integrated BioRefinery
Josef Schmid, Archer Daniels Midland Co.
For some biorefineries a single product is the goal of the project. Sometimes it is ethanol or an oil or perhaps a select chemical compound, but it is focused on optimizing one product that will make or break the project. While sometimes it is good to be focused, it can lead to tunnel vision that can prematurely crash a project. We believe a better method is run the biorefinery as having a number of co-products which allow multiple outlets for the different natural fractions of biomass. In our current biomass project, partially funded by the Department of Energy, we can produce ethanol, butyl acrylate, fiber and lignin. Butyl acrylate can be used as a drop in replacement for current petroleum based acrylates, lignin can be used as a fuel source for power or steam generation, and the fibers can be used as a feedstock for further conversion or sold as animal feed. As part of the presentation we will list some of the challenges with the start-up of the pilot plant and the concerns of building a full scale plant including the technical issues and regulatory issues.

Investigation of the Production of Hydroxymethylfurfural as a Bio-based Platform Chemical
April Hoffart, Archer Daniels Midland Co.
Hydroxymethylfurfural (HMF) is a chemical receiving a lot of attention in industry research. The reason for the attention is its usefulness as both a platform chemical and a fuel additive coupled with its ability to be synthesized from biomass sources. While HMF is often considered an unwelcome contaminant in food processing involving high heat, research focus had begun to shift to the purposeful production of HMF by similar methods. Produced via the acid catalyzed dehydration of hexoses, HMF shows value in the fuel, polymer, and pharmaceutical industries for the production of bio-based alternatives to current petroleum-based products.

Research assessments of production methods of HMF involve a wide variety of reaction and separation solvents, acids and reaction mechanisms, many of which prove to have a marked effect on reaction yield and selectivity. In addition, selection and design of downstream purification processes can ultimately determine the economic viability of the commercial production of HMF.

Building Blocks for a Renewable Chemical Industry

José Leboreiro, Ph.D., Archer Daniels Midland Co.

The petrochemical industry relies on a relatively small number of hydrocarbon building blocks to produce chemical compounds for a large number of applications; these blocks are methane, ethylene, propylene, butanes, butadiene, benzene, toluene and xylenes. A similar approach has to be developed to expand the use of chemicals from renewable resources. Significant progress has been made by the scientific community to identify building blocks from renewable resources. ADM is working to develop processes for renewable chemicals based on the building block approach; several examples will be presented.

Energy Reduction & Advanced Water Removal via Membrane Solvent Extraction Technology

Rhea Sammons, Ph.D., Archer Daniels Midland Co.

ADM is currently participating in a cooperative project with the Department of Energy and 3M on the development of a pilot scale facility that will demonstrate and validate ethanol recovery through membrane solvent extraction (MSE). The key goal of this project is to prove that the MSE process can efficiently reduce the energy and water consumption of a conventional ethanol fermentation process. The project will also test the feasibility of accelerating the fermentation to reduce retention time and increase ethanol yield. This presentation will give an overview of the MSE process and the potential impact it will have on production scale ethanol plants.

Session Fr1B: **Air & Water Pollutions Controls for Fossil Power Plants**

10-11:30am, Friday Feb 1, 2013 (Room 007)

Organizer and Chair: Andrew Carstens, Sargent & Lundy LLC

Results of Emissions Testing with Fuel Additives, Activated Carbon, and an Evaluation of Mercury Re-emission at a Coal-fired Power Plant

Ajay Jayaprakash, Sargent & Lundy LLC

In an effort to prepare for the Utility MATS (Mercury and Toxics Standards) Rule the Lower Colorado River Authority (LCRA) and Sargent & Lundy (S&L) developed and executed a testing program to evaluate control options for mercury and other HAP emissions at the Fayette Power Project. The Fayette Power Project is located in Fayette County, Texas and consists of three coal-fired units. Units 1 & 2 are 645 MW each and Unit 3 is rated at 470 MW. All three units fire Powder River Basin (PRB) coal and are equipped with electrostatic precipitators (ESP's) and wet limestone-based forced oxidation Flue Gas Desulfurization (FGD) systems.The full-scale test program was carried out on Units 2 and 3 and included the injection of halogenated and non-halogenated activated carbons into the flue gas upstream of the air heater, fuel additives onto the coal prior to combustion, and a consideration to add mercury re-emission prevention additives into the wet FGD systems. In addition to mercury concentrations in the coal and flue gas, measurements included hydrogen chloride, particulates, oxidation/reduction potential (ORP), and non-mercury metals. Fly ash was tested for its continued suitability for reuse in byproducts with both foam tests and air entrainment testing. This paper will review the protocols and procedures used in the test program, as well as the results of the emissions testing and process stream analysis. Emissions levels achieved during testing will be compared with the limits imposed by the Utility MATS. Additionally, the paper will discuss the degree of mercury re-emissions from a wet FGD system to affect emissions and the significance of FGD system measurements on these re-emissions.

Water = Power

Diane Martini, Sargent & Lundy LLC

According to the United States Geological Survey (USGS), power plants account for over half of the surface water used in the US. This session will discuss the ways that power plants use water, how they treat the wastewater that is generated, and how they are working to reduce the amount of water that is used and discharged. We will briefly discuss the steam cycle, cooling tower use, ash sluicing, flue gas scrubbing, wastewater treatment and solids handling. We will also discuss how regulations are changing for using water and for discharging wastewater, and the meaning of Zero Liquid Discharge (ZLD).

CFD Applications in the Power Industry

Emily Kunkel, Sargent & Lundy LLC

Achieving good flue gas flow distributions in ductwork is important to maximize the effectiveness of air quality control equipment as well as to minimize auxiliary power consumption in existing power plants. With more air quality control equipment retrofits being required for existing plants, ID fans need to overcome higher pressure drops and fans consume increasing quantities of auxiliary power to overcome the additional pressure drop. If pressure drop can be reduced by optimizing flow distribution through ductwork, significant reductions in operations and maintenance (O&M) costs can be realized. Computational fluid dynamics, or CFD, modeling can be used to mimic and predict flow patterns of flue gas through duct geometry. The modeling predicts problem areas that result in high/low velocity areas, high turbulence zones, and can also predict pressure drop through the course of ductwork. These results can then be analyzed and the problem areas can be mitigated before installation. The importance of addressing these problem areas ahead of time can result in improved equipment performance and reduce outage costs. This presentation will highlight the applications of CFD modeling in the power industry and illustrate examples of completed work.

Session Fr1C: **Characterization Methods for Immunoassay Diagnostic Tests**

10-11:30am, Friday Feb 1, 2013 (Trustee Room)

Organizer: Daniel L. Obrzut, Abbott Laboratories

Chairs: Daniel L. Obrzut and Deepak Ahuja, Abbott Laboratories

Characterizing Antifoams for use in Immunoassays

Daniel L. Obrzut and Alfredo R. Narvaez, Abbott Laboratories

Polydimethylsiloxane-based antifoams are used in immunoassay solution formulations to deter foam formation due to the presence of foaming agents (e.g. surfactants and proteins). Antifoams must not interfere with assay performance while still defoaming solutions. Antifoam

selection, concentration selection, and manufacturing procedures have been implemented to effectively use antifoam in immunoassay solutions. Antifoam selection is based on potency to select foaming agents via a shake test, visual flocculation inspection, lifetime of potency, and effect on assay performance. When formulating an assay diluent, the minimum antifoam concentration to defoam individual solutions is determined before setting the final concentration. When manufacturing an immunoassay solution, the antifoam is prediluted before addition to the bulk solution to ensure proper mixing and minimize assay interference. The effective level of predilution has been studied using rheology and visualization. These methods have been used to effectively include antifoam in immunoassay solution formulations.

Understanding interactions between immunoassay excipient proteins and surfactants using interfacial and bulk characterization techniques

Shyam V. Vaidya and Alfredo R. Narvaez, Abbott Laboratories

Excipient proteins and surfactants play a key role in determination of performance and stability of immunoassay reagents that are used for detection of biomarkers in bodily fluids. Various interfaces are created during manufacturing, shipping, and use of the immunoassay reagents. Understanding behavior of immunoassay components at these interfaces is critical for optimal reagent performance. An attempt at obtaining this understanding using interfacial and bulk characterization techniques has been presented. Air-liquid interfacial properties of four excipient proteins commonly used in reagent formulations were studied with shear rheology and surface characterization methods. A Du Noüy ring geometry was utilized to quantify the elastic (G') and viscous (G") shear moduli of protein interfacial networks and to probe effect of several nonionic surfactants at various concentrations. Formation of elastic protein network structures was observed in case of globular proteins such as BSA. Effect of surfactants was concentration dependent and the magnitude of protein displacement from the interface varied with Tween 20 > Triton X-100 > Triton X-405. Surface tension data obtained using the Wilhelmy plate suggests that the interactions between proteins and surfactants are not only driven by the surface tension but also by the interfacial network formation abilities of the protein molecules. Solid-liquid interfacial interactions were characterized using Quartz Crystal Microbalance with Dissipation monitoring (QCM-D). Adsorption behaviors on reference polystyrene and stainless steel surfaces were studied to differentiate non-specific binding efficiency of various excipient proteins and as well as effectiveness of cleaning solutions. Differential scanning calorimetry was utilized to understand interactions between excipient proteins and nonionic surfactants in solution bulk.

Development of an Orthogonal Method for Evaluating Antibody Stability and Potency

Mark A. Kwatia and Troy D. McSherry, Abbott Laboratories

To date there is no method for determining optimal final antibody formulation and its effects on stability. This study describes the ability of new test methods to monitor stability over time. A Biacore system is used to characterize antibodies based on their binding response, establishing a baseline for comparison over the course of stability testing. Accelerated stability is implemented to determine optimal antibody formulation. Antibodies prepared under multiple formulation conditions are subjected to mild heating. Samples taken periodically are tested to determine changes in purity, charge variance, and potency, thus providing optimal final formulation conditions and uncovering potential antibody stability issues.

Session Fr1D: **Biological Water and Wastewater Treatment**
10-11:30am, Friday Feb 1, 2013 (Room 005)
Organizer: Catherine O'Connor, Metropolitan Water Reclamation District of Greater Chicago
Chairs: Catherine O'Connor and Heng Zhang, Metropolitan Water Reclamation District of Greater Chicago

Microbial Assessment Of Biological Nutrient Removal

Geeta Rijal Heng Zhang and Joseph Kozak Metropolitan Water Reclamation District of Greater Chicago

Enhance Biological Nutrient Removal (EBNR) has become more prevalent in the wastewater industry as regulations have begun to include stringent nutrient limits. The microbial population dynamics of Ammonia Oxidizing Bacteria (AOB), Nitrite Oxidizing Bacteria (NOB), and Phosphorus Accumulating Organisms (PAO) play an important role in the removal of nutrients in the wastewater. These microorganisms are dependent on the optimization of wastewater treatment plant design and operating conditions. Microbiological assessment of PAO, AOB and NOB population is necessary to facilitate wastewater treatment enhancement and operation. This presentation will provide a review of the microorganisms involved in EBNR processes using fluorescently labelled gene probes, as well as simple microscopic staining methods as a screening tool for the full-scale EBNR testing at the Metropolitan Water Reclamation District of Greater Chicago's Stickney and Calumet Water Reclamation Plants. The preliminary findings suggest the presence of PAOs, AOBs and NOBs in certain quantity in the full-scale testing facilities. Additional investigation will focus on the influence of key environmental and operational parameters on the abundance of these microorganisms and comparison with the enumerated baseline PAO and AOB/NOB ratio. The data acquired will guide the full-scale test and assist the EBNR operations.

Enhanced Biological Phosphorus Removal: Implementation with Existing Infrastructure at the Stickney Water Reclamation Plant

Heng Zhang, Joseph Kozak and Catherine O'Connor, Metropolitan Water Reclamation District of Greater Chicago

In November 2011, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) informed IEPA of a multi-year plan of implementing enhanced biological phosphorus removal (EBPR) with existing infrastructure at its three large water reclamation plants (WRPs). As the initiation of this plan, a full-scale test was conducted in 2012 at one of the four secondary treatment batteries of the Stickney WRP. This battery was converted to three different zones to biologically reduce phosphorus concentrations in the liquid stream. The main objective of this plan is to reduce final effluent TP concentrations to less than 1 mg/L on a monthly average basis. The Stickney WRP has four nearly identical aeration batteries. Each battery has 8 aeration tanks and each tank has 4 passes. The overall length to width ratio is about 49, which indicates that the flow in a tank has a plug flow pattern and the tank is ideal for conversion to different zones. Each battery also has a return activated sludge (RAS) channel for conveying the activated sludge from final settling tanks to aeration tanks and a mixing channel for distributing the

mixture of primary-treated effluents and activated sludge to eight different aeration tanks. For achieving EBPR, an anaerobic zone should be created at the location where activated sludge in the system meets the primary-treated effluent or immediate downstream, and the anaerobic zone should be large enough, generally providing 45 minutes to two hours residence time, so that phosphate accumulating organisms (PAOs) in the activated sludge can be proliferated. Dissolved oxygen (DO) and nitrate, the end product of nitrification for ammonia removal, are inhibitory to PAOs in the anaerobic zone. Therefore, an anoxic zone is created in the RAS and mixing channels to reduce DO and nitrate concentrations before the anaerobic zone, which is located in the first 12.5 percent of an aeration tank. The anoxic and anaerobic zones are created by turning air in these zones to minimal to support the suspension of activated sludge. EBPR was evident in the test battery, because it had relatively lower effluent TP and higher phosphorus content in its waste activated sludge (WAS). Initial results indicated that the average effluent TP concentration was 0.97 mg/L in the test battery, compared to 1.15 mg/L in the control battery. The average percent TP in WAS was slightly higher in the test battery (2.23%) relative to the control battery (2.18%). Whereas the preliminary results show that the difference between the test and control batteries may not be significant enough, further improvement in phosphorus removal efficiency at the test battery is expected through process optimization which is currently ongoing. As a side benefit of EBPR, more denitrification occurred in the test battery because of lower DO concentrations in the RAS, mixing and anaerobic zones. In the three month evaluation in Spring and Summer 2012, the average daily total nitrogen concentration was 9.4 mg/L in the effluent of the test battery, compared to 11.6 mg/L at the control battery, which was achieved with no increase in operation cost and no compromise of effluent quality. In contrast to biological phosphorus removal, chemical phosphorus removal requires a significant increase in operational cost. In the full-scale demonstration study conducted at the Egan WRP by MWRDGC, TP concentrations in the final effluent decreased from an average of 3.7 mg/L to about 0.5 mg/L by chemical precipitation using ferric chloride ($FeCl_3$). To meet the effluent TP target of 0.5 mg/L, approximately 12 pounds of $FeCl_3$ was required to remove one pound of phosphorus and 10 pounds of chemical sludge was generated in the process. The operational cost for the chemical phosphorus removal was about $1,300 per day for chemical and $400 per day for chemical sludge disposal at the Egan WRP with average daily flow of 27 MGD. The data from this full-scale study was used to estimate the consequence of chemical P removal at the other WRPs in the metropolitan Chicago area based on average plant flows and phosphorus concentrations. For a total flow of 1350 MGD from 7 plants and a target effluent TP of 0.5 mg/L, approximately 31.5 million gallons of $FeCl_3$ per year would be consumed and 51,300 dry ton of chemical sludge generated. Transporting the chemical and sludge would result in a significant negative environmental impact to the area.

De-ammonification of Wastewater Sidestreams: Process Mechanisms and Pilot Results from the Egan Water Reclamation Plant

Joseph Kozak, Dongqi Qin and Heng Zhang, Metropolitan Water Reclamation District of Greater Chicago

The conveyance of the centrate from the Metropolitan Water Reclamation District of Greater Chicago (District) John E. Egan (Egan) Water Reclamation Plant (WRP) to the North Side WRP has historically caused odor problems in the sewer lines. This ammonia (NH_3)-rich centrate cannot currently be recycled at the Egan WRP due to limited nitrification capacity in its aeration basins. In order to mitigate the odor problem in the sewer lines and to be able to recycle the centrate continuously within the plant without imposing harm on the existing operations, sidestream ammonia removal treatment technologies were reviewed. The deammonificaition sequencing batch reactor suspended growth process (Demon®) was determined to be one of the most suitable technologies. Demon® is a partial nitritation and ammonia oxidation process. The first step of the process is that only nitrite is produced aerobically by controlling the ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB) in the bioreactor. Then NH_3 is converted to nitrogen gas (N_2) directly by Anaerobic Ammonia Oxidation (ANAMMOX) bacteria that use nitrite (NO_2^-) as an electron acceptor under anaerobic conditions. In this process, the fundamental control parameters are aeration and anoxic times, solids retention times (SRTs), temperature, pH, dissolved oxygen (DO), NH_3 and NO_2^- concentrations, phosphate, sulfide, seed concentration, and inoculation time. More than 80% nitrogen removal has been documented at current Demon® plants treating wastewater from recycle streams. Additionally, compared to conventional nitrification/denitrification technology, Demon® can significantly reduce energy costs by 60 percent. Furthermore, no carbon substrate is required in the process, because NH_3 itself is an electron donor. Given its viability and cost effectiveness, the District is investigating the nitrogen removal of the Egan WRP centrate sidestream by a Demon® pilot reactor. The Egan pilot reactor has been in operation for two months starting September 2012 to assess the ammonia removal efficiency through monitoring of the influent and effluent. Special consideration was given to: length of startup time; process control including fill, react, and decant cycles and extent of aeration and mixing times; ease of operation; and affect of influent characteristics including but not limited to ammonia, temperature, alkalinity, suspended solids, nitrite, and organics. The initial nitrogen (N) loading rate was kept low in order to minimize nitrite and nitrate effluent concentrations as well as to avoid shock feed to the system. Subsequently, the load to the pilot system was gradually increased to 0.6 kg N/m^3-day (85% of 0.7 kg $/m^3$-day target loading) over the two-month period while achieving an average ammonia nitrogen (NH_3-N) removal efficiency of 88%. The system was considered alkalinity limited due to the fact of ferric chloride ($FeCl_3$) is added upstream to the centrifuges to minimize struvite precipitation in the centrate lines and to improve dewatering characteristics of digested sludge. Thus, sodium bicarbonate ($NaHCO_3$) was added to the pilot unit when lacking in alkalinity and reduction in performance. Results of the pilot study show that once alkalinity was restored to the system, its removal efficiency increased. The future goal of Demon® operation is to continue increasing the centrate loading rate to the system to determine the maximum nitrogen removal capacity; to increase the mixed liquor inventory; to investigate impact of low temperatures on pilot operation performance; and to optimize

process control. This data along with a full evaluation of the pilot study results will be presented at time of the conference.

Session Fr1F: **Interviewing Skills Workshop**
10-11:30am, Friday Feb 1, 2013 (Armour Conference Room)
Organizer and Chair: Aaron Matthews, Argonne National Laboratory

Interviewing 101
Greg Corda and Steve Lohman, Nalco
Performing well in an interview is a challenge especially when you are not prepared. Learning how to sell yourself with confidence but without arrogance is a unique task to master and can be very influential during an interview. Work with the Interviewing Skills Team to understand how to navigate different types of interviews with different people. For example, explaining your communication skills to HR rep and your experience to a manager. Through example the team can highlight how to prepare you to answer behavioral questions with experience. Also learn how that although you are knowledgeable you are still willing to learn and develop new skills as a company meets new challenges.

Mock Interviews
Dennis O'Brien, Jacobs Engineering
Test your interviewing skills with a mock interview hosted by engineering veterans

Session Fr2A: **Sustainable Fuel Processing**
1-2:30pm, Friday Feb 1, 2013 (Armour Dinning)
Organizer: Rajeswar Gattupalli, UOP LLC, A Honeywell Company
Chairs: Rajeswar Gattupalli and Kirk Liu, UOP LLC, A Honeywell Company

Alcohol to Jet
Geoffrey W. Fichtl, UOP LLC, A Honeywell Company
In the interest of energy independence and reduction of greenhouse gas emissions, alternative fuels derived from renewable rather than fossil sources is a major topic of R&D within private industry, universities, and government. The Alcohol to Jet (AtJ) pathway is of major interest recently, especially as routes to higher-carbon bio-alcohols, such as bio-butanol, have become commercially viable. In the standard AtJ pathway, dehydration of bio-alcohol (usually bio-butanol) yields the versatile butene platform molecule, which can be oligomerized to form pure olefins that boil in the jet range. Upon further hydrogenation by well-established hydrotreating technology, the olefins are converted into stable paraffins with high yield of jet-boiling product.

Overview of Exergy Analysis for Distillation Operation
Kirk Liu, UOP LLC, A Honeywell Company
Exergy analysis provides insights on opportunities for more thermodynamically efficient distillation operations. Typically, the use of this analysis has shown distillation column designs with new heat exchanger integration locations. This paper will provide a brief overview of the concepts for exergy analysis and simulation tools available to perform such an analysis. The paper will then end with a case review to demonstrate an implemented design with economic incentives from increased thermodynamic efficiency.

Economic Comparison of Continuous and Batch Production of Biodiesel using Soybean Oil
Pahola T. Benavides, Juan Salazar, and Urmila Diwekar
University of Illinois at Chicago
Continuing depletion of fossil fuel reserves and increasing environmental concerns have encouraged engineers and scientists to look for alternative, clean and renewable fuels that can reduce fossil-fuels' negative environmental impact and secure the energy supplies. Biodiesel has been considered as one of the best candidates for these renewable fuels. For its production, transesterification reaction of triglycerides is recognized as a feasible pathway. This reaction can be carried out in a continuous or batch reactors, however, most of the other unit operations, like decanters and distillation columns, are operated continuously. Most of the studies of biodiesel production have been done in continuous models. In this paper, we evaluate batch and continuous processing options for biodiesel production from the economical point of view. The economic feasibility of biodiesel as well the plants configuration not only depends on technical design aspects but also on other important factors such as seasonal variation of feedstock, transportation costs, and storage costs of material. Therefore, our comparison involves size of the market, transportation distance from supplier to producer facility, and feedstock availability of soybean oil by the allocation of supply of raw material. It was found that based on these aspects, batch processing shows interesting results and should be considered for production rather that continuous production as done today. Moreover, a sensitivity analysis provides more insights of the flexibility of batch processing when scheduling variation is considered.

Session Fr2B: **Smart and Intense Chemical Processes**
1-2:30pm, Friday Feb 1, 2013 (Room 007)
Organizer: Zhijun Jai, Chart Energy & Chemicals, Inc.
Chairs: Steve Vallee and Hani Gadalla, Chart Energy & Chemicals, Inc.

Smart Grid Coordination in Chemical Processes
Donald J. Chmielewski, Illinois Institute of Technology
One aspect of the smart grid is to use a real-time price structures within electricity markets as a vehicle to mitigate source-load inequities resulting from the uncertainty associated with renewable power sources (solar and wind). Under such price structures, manufacturing facilities with an ability to change energy consumption rates can expect to capture more profit while providing the societal benefit of improving grid reliability. Although facility managers qualitatively agree with the dual benefit of adopting smart grid operating policies, they lack quantitative methods to construct these policies as well as predict revenue gains. In this paper we will illustrate the use of Economic Model Predictive Control (EMPC) as a vehicle to construct demand response policies for the flexible manufacturing application. In addition, we will propose a linear surrogate for the demand response policy, which will facilitate the development of a quantitative method to assess smart grid coordination opportunities. As an illustration of the approach a chemical processing plant will be investigated where process steam can be generated from a simple furnace or from an electric co-generation plant. In the second part of the example we will consider the additional opportunity of deferment of sub-operations based on supply-chain inventory levels.

Compact Heat Exchange Reactors (CHER) for Process Intensification (PI)

Steve Vallee, Chart Energy & Chemicals, Inc.
Process Intensification (PI) is a process design philosophy to bring about dramatic improvements in manufacturing, processing, equipment size/production ratio, energy consumption, or waste reduction by the development of novel apparatuses and techniques as compared to the present state-of-the-art. This leads to substantially smaller, cleaner, and more energy-efficient technology and processes. In many conventional chemical reactors the reaction rate can be limited by heat transfer capability or mixing in the reactor, rather than the actual reaction kinetics. This results in reactors and supporting equipment that is larger than it needs to be and decreased operating efficiency. Chart's Compact Heat Exchange Reactor (CHER) combines a heat exchanger and reactor into a single device and is used to overcome heat transfer and mass transfer limitations to allow reactions to proceed at or closer to the kinetic limits. The role of heat transfer and mixing in controlling chemical reactions will be presented, as well as techniques for identifying when CHER should be considered for PI. Examples of CHER in the fine chemicals, pharmaceutical, and fuel processing fields will be shown. Chart Energy & Chemicals has been manufacturing brazed aluminum plate-fin heat exchangers for over 50 years, and brazed CHER known as FinTec® since as early as 1979. Over the last 15 years a shim-based, diffusion bonded CHER known as ShimTec® has also been developed and widely applied. Compact Heat Exchange Reactors have been constructed using aluminum, stainless steel, or specialty metals.

Design and Manufacture of Compact Heat Exchangers/Compact Heat Exchange Reactors
Hani Gadalla, Chart Energy & Chemicals, Inc.
Compact heat exchangers and compact heat exchange reactors are used in industries where efficient heat transfer is necessary to achieve the requirements for unit performance, reliability and efficiency leading to Process Intensification (PI). Advantages of compact heat exchangers include high heat transfer coefficient, high surface area-to-volume ratio, and narrow approach temperatures. For the compact heat exchanger reactors, advantages include reaction control for highly exothermic or endothermic reactions, near-isothermal operations for improved selectivity and controllability, improved internal mixing and more uniformity in performance. Chart Energy and Chemicals specializes in two types of metal compact heat exchangers/heat exchange reactors: brazing and diffusion bonding. In this presentation, the two types will be compared to each other as well as to conventional exchangers and reactors. The basic exchanger design and general manufacturing steps will be presented. The performance of the units, potentially with some examples, will also be discussed.

Session Fr2C: **Process Safety**
1-2:30pm, Friday Feb 1, 2013 (Trustee Room)
Organizer: Donald J. Chmielewski, Illinois Institute of Technology
Chairs: John Mammoser, Rolf Jensen & Associates, Inc. and Ryan Hart, Exponent, Inc.

NFPA Codes and their Relevance to Chemical Processes
Jeremy Lebowitz and John Mammoser, Rolf Jensen & Associates, Inc.
The National Fire Protection Association (NFPA) has several hundred codes and standards in print designed to increase fire protection and life safety across a wide range of occupancy classifications. NFPA has numerous codes devoted to the specific hazards posed by chemical process plants. This presentation will introduce a variety of relevant codes, how they are applicable, and their relevance to improving chemical process safety. It will also discuss the main focuses of these codes and several ways in which process areas can easily become safer.

Chemical Process Safety and Sustainable Materials Hazards
Ryan Hart and Delmar "Trey" Morrison, Exponent, Inc.
The core Chemical Engineering disciplines (i.e. chemical kinetics, mass transfer, thermodynamics, process design, and process safety) are integral to the application of fossil fuels to deliver products and services to society. Chemical engineers are also at the forefront of the development of sustainable petroleum alternatives including renewable raw materials, renewable energy sources, and sustainable solvents. As these novel materials and processes are scaled up from R&D laboratories to pilot plants, and ultimately to commercial scale operations, the process safety aspects related to the design, operation, maintenance, and management stands paramount. In this talk, process safety management elements (of which CCPS identifies 20 distinct elements) will be highlighted with respect to the design and development of novel sustainable materials. As this topic is uniquely large in scope, the discussion will focus primarily on two sustainable material classes: ionic liquids and biomass. Ionic liquids are being developed as low vapor pressure solvents replace conventional volatile organic solvent systems. In contrast, biomass is a more mature industry, which is being shaped to expand beyond combustion-related power to motor fuels and traditionally petrochemical raw materials. A brief discussion of pertinent aspects of each novel technology will be provided, and then the presentation will highlight the process safety management elements that are unique to the novel sustainable material classes. The process safety of ionic liquids and biomass will then be contrasted with conventional petroleum-based technologies, summarizing with guidelines that the professional Chemical Engineer can use to address sustainable material hazards that may be encountered in their workplace.

Dust Explosion Hazards, Prevention & Protection Strategies
Zachary Hachmeister, Fauske & Associates, LLC
The first reported dust explosion occurred on Dec 14, 1785 at a bakery in Turin, Italy and have continued to result in the destruction of process plants and equipment, injury to workers, and loss of production. Even with today's current safety standards and regulations, dust explosion hazards are still prominent in the workplace. This is largely due to the lack of awareness and knowledge about this subject matter in industry. This presentation will identify hazards associated with handling combustible dusts, illustrate test strategies for quantifying the hazard and provide general guidance for mitigation strategies that reduce the risk associated with handling combustible dusts. Approaches for dust fire and explosion protection will be based on National Fire Protection Association (NFPA) guidelines as well as best practices in industry.

Session Fr2D: **Engineering Extracellular Matrices**
1-2:30pm, Friday, Feb 1, 2013 (Room 005)
Organizer and Chair: Nancy W. Karuri, Illinois Institute of Technology

Optimal Control for Dosage Prediction in Superovulation Stage of IVF

Kirti M. Yenkie and Urmila Diwekar, University of Illinois at Chicago, Vibha Bhalerao, Jijamata Hospital, Nanded, India

In vitro fertilization (IVF) is one of the most highly pursued assisted reproductive technology worldwide. The IVF procedure is divided into four stages: Superovulation, Egg-retrieval, Insemination/Fertilization, Embryo transfer. Superovulation is the most crucial stage in IVF, since it involves external injection of hormones to stimulate development and maturation of multiple oocytes. The maximum amount of effort and money for IVF procedure goes into superovulation. Although numerous advancements have been made in IVF procedures, medication quality, etc little attention has been given to modifying the protocols based on a predictive model. A model for the follicle growth dynamics and number as a function of the injected hormones and patient characteristics has been developed. The modeling basics were adapted from batch crystallization moment model, since moments are representatives of specific properties like number, shape and size of the particles under consideration. Based on this model, the dosage of the hormones to stimulate multiple ovulation or follicle growth is predicted by using the theory of optimal control. The objective of successful superovulation is to obtain maximum number of mature oocytes/follicles within a particular size range. Using the mathematical model involving follicle growth dynamics and the optimal control theory, optimal dose and frequency of medication is predicted for obtaining the desired result. The model will be modified to consider the sources of uncertainty due to patient's age, previous medical history, suitability of medicine and protocol used. The optimal drug delivery regime predicted in the presence of uncertainty will be compared to the current dosage regime predicted. Thus, a phenomenon currently based on trial and error will get a supportive basis to start with. This will aid as a predictive tool for medical professionals and provide them with a specific dosage strategy for a patient. This will bring down the probability of failure, decrease cost of complex monitoring and excess medication. Thus, it will decrease the overall cost of IVF treatment for the patient as well as the physician.

The Proteolytic Stability and Activity of Fibronectin-polyethylene Glycol Composites

Nancy W. Karuri, Chen Zhang, Sogol Hekmatfar, Anand Ramanathan, Illinois Institute of Technology

Delayed wound healing in many chronic wounds has been linked to the degradation of fibronectin (FN) by abnormally high protease levels. We sought to develop a proteolytically stable and functionally active form of FN. For this purpose, we conjugated 3.35 kDa polyethylene glycol diacrylate (PEGDA) to human plasma fibronectin (HPFN). Conjugation of PEGDA to HPFN or HPFN PEGylation was characterized by an increase of approximately 16 kDa in the average molecular weight of PEGylated HPFN compared to native HPFN in SDS-PAGE gels. PEGylated HPFN was more resistant to α chymotrypsin or neutrophil elastase digestion than native HPFN: after 30 minutes incubation with α chymotrypsin, 56% and 90% of native and PEGylated HPFN respectively remained intact. PEGylated HPFN and native HPFN supported NIH 3T3 mouse fibroblast adhesion and spreading, migration and focal adhesion formation in a similar manner. Fluorescence microscopy showed that both native and PEGylated HPFN in the culture media were assembled into extracellular matrix fibrils. Interestingly, when coated on surfaces, native but not PEGylated HPFN was assembled into the extracellular matrix of fibroblasts. The proteolytically stable PEGylated HPFN developed herein could be used to replenish FN levels in the chronic wound bed and promote tissue repair.

Three-dimensional Dynamic Transcription Factor Profiling of Cancer Cells in Model Microenvironments

Juan Sánchez-Cortés and Lonnie Shea, Northwestern University

The cellular niche refers to the immediate microenvironment around a cell, and has been instrumental supporting a range of biological processes. Reconstituting this niche in vitro can provide mechanistic insight into biological systems and may be key for developing novel therapies. Several micro-environment cues affect cellular function by imparting changes in signaling pathways within the cell. These chemical factors, wherever soluble or embedded within the matrix, are presented in vivo within a three--dimensional environment. Though the potential of in vitro three-- dimensional cell niches to recapitulate biological effects has been recognized, these technologies suffer from the shortcoming of being impractical to use with standard molecular analysis used to scrutinize signaling pathways. In this talk, I will introduce a novel technique that combines the analysis of signaling pathways with model three--dimensional niches that support relevant cellular function. This method relies on the dynamic measurement of transcription factor (TF) activity based on the bioluminescence of TF-luciferase constructs. This method employs large scale delivery of TF reporter constructs combined with bioluminescence imaging, to capture the activity of numerous TFs, which can identify synergistic or counteracting signaling pathways. The first part of the talk will describe the system: its opportunities and challenges. Further, two examples of the application of this method will be presented: the changes in TF activity as a result of changes in ErbB2 signaling in cancer cells, and also the effect of cell surface receptor binding and matrix degradation in cancer cell TF activity. Taken together, this technology will prove useful to study changes in TF activity as a result of micro-environmental cues in normal and disease states.

Session Fr2E: **Unwritten Laws of Engineering**
1-2:30pm, Friday Feb 1, 2013 (Room 006)
Organizer and Chair: Aaron Matthews, Argonne National Laboratory

The Engineer and the Company

Faith Smock, Navistar

What the employer expects from you and you can expect from an employer. Including some insight into how to represent the company in and out of the office.

The Engineer and the Manager

Kristy Gagoff, Navistar

Clarifying the expectation of the manager and how open dialogue can help you get the development and support you need.

Panel on Working with Difficult People in Difficult Situations: Making Smart Choices

Aaron Matthews, Argonne National Laboratory, Brian Daly, Fluor and Luisa Flechas, UOP

Co-workers, managers, or clients can create unnecessary tension in the workplace. Alleviating it can require some careful choices with words and usually is not easy. Come learn from a panel of YPs who have worked through these situations with both success and failure. Get insight on how to mitigate an issue before it becomes a larger problem.

Session Fr3A: **Emerging Technologies in the Oil and Gas Industry**

3-4:30pm, Friday Feb 1, 2013 (Armour Dinning)

Organizer: Rajeswar Gattupalli, UOP LLC, A Honeywell Company

Chairs: Rajeswar Gattupalli and Reza Mostofi, UOP LLC, A Honeywell Company

Hydrodynamics of FCC Riser using Advanced Simulation Tools

Reza Mostofi and Lev Davydov, UOP LLC, A Honeywell Company

"Non-ideal" riser hydrodynamics can lead to "under-conversion" of feed in the core of the riser and overcracking of products in the annulus of the riser. Computational Fluid Dynamics (CFD) is used to understand and improve the flow behavior of FCC risers using different approaches. One method is the two-fluid model where the particles are treated as fluid and can be applied to riser's flow. Another approach that can be used to model such systems is based on the Lagrangian formulation. These two CFD approaches were successfully validated by cold flow results and applied to several commercial FCC units. In this presentation several examples of these methods for different flow rates and/or geometries will be discussed.

Creating Opportunities from Challenges: Maximizing Propylene Yields from Your FCC,

Jeff Knight, Robert Mehlberg, UOP LLC, A Honeywell Company

Fluid Catalytic Cracking (FCC) technology has been the refining industry's conversion mainstay for gasoline production over the last 70 years. Over the decades, it has proven to be the cheapest form of carbon rejection in the conversion of heavy gasoil feedstocks into lighter, more valuable fuel products. However, emphasis on energy independence and climate change is leading to significant changes in the motor gasoline market as ethanol addition and vehicle efficiency reduce the demand for petroleum-derived blend components, thus creating a challenge for FCC-based refineries. At the same time, petrochemical producers are looking for propylene yields exceeding 20 wt% and BTX yields approaching 10 wt% of gas oil feed. This demand for petrochemicals offers a potential answer to this challenge by re-purposing the FCC unit as a means to increase propylene yields. This presentation will summarize UOP's response to customer requirements for a high propylene-yielding FCC process and through case studies. It will also highlight key features of and learning's from the development of UOP's 2-stage RxPro FCC process.

Offshore Gas Treatment Technology for Natural Gas

Saadet Ulas Acikgoz, Shain Doong, Pengfei Chen and Lubo Zhou UOP LLC, A Honeywell Company

Offshore liquefaction of natural gas is expected to be the next technological breakthrough for capitalizing stranded natural gas resources. There are several technology options that can be used for acid gas removal or pretreatment of FLNG (Floating Liquified Natural Gas) plants. The traditional amine absorption processes have been widely used for the treatment of feed gas for onshore LNG plants. Due to limited space available on the offshore facility, the gas treatment units on FLNG plants have to be designed with smaller weight and footprint. A hybrid system is a combination of membranes for bulk CO_2 removal and amine units as polishing systems. Membranes have been proven in multiple offshore applications and suitable for offshore environment due to their compactness, minimal weight, footprint and insensitivity to sea motion. These hybrid systems can reduce the size and weight of the total pretreatment unit, minimize the effect of sea motion on the amine column performance and offer a cost effective solution.

Session Fr3B: **Emerging Technologies in Power Generation**

3-4:30pm, Friday Feb 1, 2013 (Room 007)

Organizers and Chairs: William Ryan and Jeffery Perl, University of Illinois at Chicago

Understanding the Role of Renewable Energy Credits for the Energy Market

Kelly Costello, University of Illinois at Chicago

Numerous companies are willing to pay for electricity that is produced by cleaner, renewable generation sources for its environmental benefits, reduced emissions and even for building their company green portfolio. Individual and organizational buyers have a variety of renewable power product choices available for purchase in this regard. These options include buying renewable energy certificates (RECs) by themselves, buying bundled RECs along with physical electricity from their utility service provider, or developing on-site renewable projects. Many state utilities are required to make a specific amount of contribution toward these renewable energy options. To meet these mandates, many organizations are electing to buy renewable energy certificates. RECs serve as the currency for renewable energy market development. This paper will provide an analysis of what RECs, their development and their importance to purchasers in the marketplace. RECs are purchased either for compliance requirements or voluntarily to support renewable energy generation progress. Certifying and tracking the purchased renewable energy from point of creation to final point of use allows for companies to verify that they got what they paid for. This protects against fraud and double-selling of excess generated renewable energy. Thus this paper will provide further investigation on the guarantee of REC purchases. Lastly, this paper will investigate debate surrounding the renewable energy certificate market due to different understandings of RECs by the public and the industry. Above all, RECs provide a great opportunity in the power market for renewable energy innovation. As a result, it is important for all energy professionals to understand the role RECs play in the industry and the future of clean energy.

Recent Improvements in Compressed Air Energy Storage Efficiency and Impediments to Integration of Grid Scale Energy Storage

Greg Herman, University of Illinois at Chicago

Stabilization of the power grid utilizing energy storage will become more critical as renewable power sources achieve higher levels of penetration into the system. Although pumped hydroelectric storage (PHES), with a capacity of 22 GW at 150 facilities in 19 states has been the workhorse of grid storage to date, it has become clear that the geographic and environmental limitations of this technology will prevent it from being able to provide sufficient capacity to accommodate levels of renewable energy that have, in some cases, become legislated mandates. Compressed Air Energy Storage (CAES) has emerged as one of the most economically and functionally viable options for additional grid scale energy storage, but to date only two grid-scale CAES plants are operating in the world today. Although it is clear that the highly dispatchable nature of electrical generation using some form of combustion turbines makes CAES an obvious solution for grid stabilization, the economics of the technology have not proven lucrative enough to generate large scale interest in development. Recent, promising improvements have been made in the "round trip efficiency" of the combined compression and expansion cycle through the conservation of the heat of compression. These improvements, as well as factors that impede investment in this maturing technology, are the subject of this paper.

All Vanadium and Zinc Bromine Flow Batteries Emerging on the Grid

Scott Jasinski, University of Illinois at Chicago

Many countries have set renewable power generation goals. As these renewable sources come online with the grid, the intermittency, which is notorious with these systems, arise issues regarding grid stability and reliability. Significant research has been pursued in electrical energy storage to help support the addition of renewable electric generation. There are many different types of electric storage such as pumped storage hydropower, compressed air energy storage, batteries, and flywheels. Specific application of each technology depends on what type of power and energy issue is being corrected. Flow batteries are a battery technology, which has the unique property that the power rating and energy capacity are independent of each other. This characteristic allows for the technology to successfully be deployed for power quality and reliability issues, renewable energy management, customer energy management, transmission voltage regulation and stability, and can be applied to the micro-grid as well. Two specific technologies: all vanadium and zinc bromine utilized at the grid scale are investigated in this paper with example installations and costs.

Session Fr3C: **Applications of Chemical Engineering Principles in Food Safety**

3-4:30pm, Friday Feb 1, 2013 (Trustee Room)

Organizer: Robert Brackett, Institute of Food Safety and Health, IIT

Chairs: Robert Brackett and Kathiravan Krishnamurthy, Institute of Food Safety and Health, IIT

Microwave pasteurization of shell eggs: Opportunities and challenges

Gregory Fleischman, Institute of Food Safety and Health, IIT and US Food and Drug Administration

With over 60 billion eggs produced every year, and an estimated 1 in 20000 eggs harboring Salmonella, potentially millions of eggs could contain the organism. Shell egg pasteurization does exist, but in the form of a hot water dip that, due to its batch nature and relying on slow conductive heating, severely limits the amount of eggs that can be produced. In this talk, the opportunities and challenges in applying microwave heating to solve these issues will be discussed.

Is a non-thermal plasma really cold?

Nathan Anderson, Institute of Food Safety and Health, IIT and US Food and Drug Administration

Cold plasma is an emerging "non-thermal" technology for decontaminating foodstuffs. Surface and internal temperatures of almonds during plasma treatment were studied to determine whether product heating may provide a significant contribution to microbial destruction.

Thermal analysis of cooling applications and development of an assessment tool for the performance of cooling equipment

Andre Rehkopf, Institute of Food Safety and Health, IIT

Inadequate cooling of prepared foods can lead to food safety problems. Data show that most cooling procedures do not meet the FDA Food Code requirements. Using thermal analysis and numerical modeling a sensor and a dynamic table were developed. Depending on the performance of the on-site cooling equipment this table suggests maximum fill heights in serving pans to meet the Food Code.

Process validation for high pressure processing technology for the food industry

Jason Wan, Institute of Food Safety and Health, IIT

High pressure processing is one of the successful nonthermal food processing technologies owing to its effectiveness in inactivating pathogens and preserving food quality. However, there are several engineering and microbiological challenges which need to be addressed for successful application. This presentation will shed light on overcoming these challenges.

Session Fr3D: **Advances in Biological Engineering**

3-4:30pm, Friday Feb 1, 2013 (Room 005)

Organizer: Fouad Teymour, Illinois Institute of Technology

Chairs: Fouad Teymour and Georgia Papavasiliou, Illinois Institute of Technology

Sequential Growth Factor Delivery within Fibrin Loaded Porous Degradable Hydrogels

Bin Jiang, Banu Akar, Thomas M. Waller, Jeffery C. Larson, Alyssa A. Appel and Eric M. Brey, Illinois Institute of Technology

Proper microvascular network formation is essential for engineered tissues. Vascularization occurs via a complex temporal delivery of growth factors. The goal of this study is to develop a biomaterial system that can deliver two growth factors with distinct kinetics, while providing structural and mechanical support for tissue regeneration. PLGA microspheres encapsulated with PDGF-BB was prepared with a double emulsion process. A salt-leaching technique was used to synthesize porous PEG-PLLA-DA/PEG-DA hydrogels (300~500μm pore size) with PLGA microspheres and thrombin. Fibrinogen (Fg) solution mixed with FGF-1 and heparin was loaded in pores to where thrombin initiated polymerization of Fg to fibrin. The degradation rate of the hydrogels can be controlled by varying the ratio of PEG-PLLA-DA to PEG-DA, with degradation time ranging from less than 1 week to over 7 weeks. The incorporation of PLGA microspheres accelerated degradation. The release of PDGF-

BB from microspheres showed sustained growth factor delivery for weeks, while FGF-1 exhibited rapid release from the fibrin gel within 3 days. A rodent subcutaneous implantation model was used to evaluate hydrogel degradation and tissue response *in vivo*. Preliminary animal study showed hydrogel degradation rate *in vivo* was similar to *in vitro*. By week 1, fast degradable hydrogels (degraded within 1 week *in vitro*) were completely degraded, while medium degradable hydrogels (degraded within 2 week *in vitro*) were partially degraded, and slow degradable hydrogels (degraded within 4 week *in vitro*) were mostly intact. Further histological and vascular analysis are being performed for evaluating the effect of growth factors delivery to tissue invasion and vascular formation *in vivo*. In conclusion, we described a biomaterial system with a degradable scaffold for structural support, PLGA microspheres for later stage drug delivery, and fibrin for earlier stage drug delivery, which can be used for vascular tissue engineering applications.

Design of Cell Instructive Hydrogel Microenvironments to Promote Vascularization of Engineered Tissues

Georgia Papavasiliou, Illinois Institute of Technology

Cells and tissues must reside within 200 microns from the nearest capillaries for adequate oxygen and nutrient transport. Therefore, the volume of tissue that can be engineered is limited by the extent to which vascularization can be stimulated to form within the implant. Current advancements in the field of tissue engineering are highly dependent on designing scaffolds that exhibit spatial and temporal control in biomaterial properties in order to guide cell behavior and promote neovascularization. To this end, we have developed novel free-radical photopolymerization approaches to design synthetic proteolytically degradable poly(ethylene glycol) (PEG) hydrogel scaffolds that result in (1) tunable gradients of covalently incorporated cell adhesion ligands, crosslink density, and material degradation that lead to directional vascular sprout invasion in the direction of the gradients, (2) independently tuned variations in cell-mediated scaffold degradation rate and hydrogel crosslink density that promote enhanced and rapid neovascularization over a broad range of hydrogel elastic modulus and (3) controlled pore size and porosity using gelatin leaching to provide large surface area to volume ratios in the scaffolds for the enhancement of vascular ingrowth. *In vitro* and *in vivo* data suggest that these biomaterial approaches allow for systematic tuning of hydrogel properties and incorporated biofunctionality which can be tailored towards designing tissues that require controlled and rapid vascularization and regeneration.

Biomaterials for Vascularization of Engineered Tissues

Eric M. Brey, Illinois Institute of Technology

The fields of regenerative medicine and tissue engineering have received significant attention for their potential to provide alternatives to traditional clinical options for organ replacement and tissue reconstruction. While success has been achieved for some clinical situations, the ability to regenerate tissues of sufficient size and complexity for many applications is limited by the ability to control vascularization. Neovascularization has been an active area of research in regenerative medicine for the past two decades. A number of different approaches for enhancing network formation in tissues have been explored, including seeding cells, delivering growth factors, prevascularizing materials through cell self-assembly, material patterning, and surgical techniques. The optimal approach is likely to vary depending on application. The goal of our research is to increase our understanding of the process of neovascularization in regenerative medicine and then use this information to guide the development of new methods for promoting tissue regeneration. In this presentation our recent work in two areas of regenerative medicine will be presented: sustained release of soluble growth factors for vascularization of encapsulated islets for treatment of type I diabetes and the optimization of porous hydrogel scaffolds for vascularization of engineered tissues. For each area the material procedures, 3D cell culture models, novel imaging techniques, and animal models used to evaluate the success of these approaches will be described.

Session Fr3E: **Career Path Development**

3-4:30pm, Friday Feb 1, 2013 (Room 006)

Organizer and Chair: Aaron Matthews, Argonne National Laboratory

Panel on Options for after Graduation

Aaron Matthews, Argonne National Laboratory, Ashley Romano, University of Illinois at Chicago, Jerry Wilks, Citgo Mike Walker, Northwestern University and Gregory N Corda, Nalco

Master of Science, Engineering, Management, or Business, Ph.D., J.D., and professional training courses are all common paths for recent graduates and those with some work experience. Come ask this panel how they weighed the options and ultimately chose what they did.

Software Skills for Undergraduates

Tom VanderVelde RubberCraft and Aaron Matthews, Argonne National Laboratory

Knowing which software package to learn as an undergrad to prepare for an internship, the workplace, or to boost a resume is a challenge. Is it better to learn a specific type of simulation software, learn how to code, or learn how to process the results? Learn some advantages and disadvantages of focusing on one vs. learning parts of several. Additionally, many software packages can be easy to learn but difficult to master. Learn how to explain skills on a resume or during an interview.

Presentation Skills Workshop

James Russin, Kenall

Some general guidelines for publishing a technical paper and presenting technical information. This will also cover preparing for the first workplace presentation and preparing a poster for collegiate design competitions.

Session Fr3F: **MRC 2014 Planning Session**

3-4:30pm, Friday Feb 1, 2013 (Armour Conference Room)

Organizer and Chair: Donald J. Chmielewski, Illinois Institute of Technology

Review of MRC 2013 Technical and YP Programming

Donald J. Chmielewski, Illinois Institute of Technology and Aaron Matthews, Argonne National Laboratory

Review of MRC 2013 General Arrangements

Azita Ahmadzadeh, Simtech Group and Jennifer Guilfoyle, Middough

Review of MRC 2013 HS Outreach

Carol Mak, Illinois Institute of Technology

Report from AIChE National Liaison

Kristine Chin and Stephanie Orvoine-Couvrette, AIChE Technical Conference Programming

Planning for the 2014 MRC
Jeff Perl, Chicago Chem Consultants and Adam Kanyuh, UOP