...helping enable safer and environmentally responsible offshore energy operations
Introduction

2018 was another outstanding year in the development and operations of the Ocean Energy Safety Institute (OESI). OESI not only focused discussion on relevant and important ocean energy industry topics, but also delivered its first round of collaborative research projects. Additionally, training sessions were developed and presented so that the regulator can continue their professional and technical development. OESI also began a review of the Bureau of Safety and Environmental Enforcement’s (BSEE) training program for their engineers, with delivery of the study results in 2018. With new additions to the advisory committee, along with the leadership of long-time members, the committee continued to provide sound advice on the efforts of the OESI.

These research highlights provide a cross-section look, across the three OESI partner universities, into the research efforts that are related to the mission: “help further enable safer and environmentally responsible offshore operations.”
History

In the wake of the Deepwater Horizon disaster that killed 11 people and spilled five million barrels of oil, then Secretary of the Interior Ken Salazar proposed the concept of establishing an Ocean Energy Safety Institute designed to facilitate research and development, training and implementation in the areas of offshore drilling safety, blowout containment and oil spill response. The creation of the institute also stems from a recommendation from the Ocean Energy Safety Advisory Committee, a federal advisory group comprised of representatives from industry, federal government agencies, non-governmental organizations and the academic community.

On Nov. 7, 2013, BSEE announced that the team of Texas institutions led by the Texas A&M Engineering Experiment Station’s (TEES) Mary Kay O’Connor Process Safety Center had been selected to manage the OESI. The press conference was attended by U.S. Congressman Bill Flores (R-Texas) who praised the collaboration between government and academia. Also in attendance was BSEE director Brian Salerno, who traveled with his team to College Station for the announcement, and toured the facilities and met with university professors, TEES researchers and officials from the University of Houston and The University of Texas at Austin.

OESI was tasked with three primary efforts. First, create opportunities for dialogue between all stakeholder groups in the ocean energy realm. Second, develop collaborative research opportunities to help fill knowledge and technology gaps pertinent to enabling safer and environmentally responsible operations offshore. And third, create and provide training opportunities for the regulators to help them stay up to date on new technologies, processes and procedures.
Dr. M. Sam Mannan, principal investigator for the Ocean Energy Safety Institute and the executive director of the Mary Kay O’Connor Process Safety Center (MKOPSC), passed away on Tuesday, Sept. 11, 2018. Mannan’s work at the MKOPSC has influenced the entire chemical engineering industry in the U.S. and worldwide. Throughout Mannan’s more than 20 years with the center, the MKOPSC has been a driving force in industry’s adoption of more rigorous safety standards.

Mannan, Regents Professor and holder of the T. Michael O’Connor Chair I in the Artie McFerrin Department of Chemical Engineering at Texas A&M University, was a fellow of the American Institute of Chemical Engineers, fellow of the U.K. Institution of Chemical Engineers and a member of the American Society of Safety Engineers, International Institute of Ammonia Refrigeration and National Fire Protection Association. Earlier this year, Mannan was also appointed to serve on the Department of Energy's Hydrogen and Fuel Cell Technical Advisory Committee.

He was a prolific author and researcher. He co-authored “Guidelines for Safe Process Operations and Maintenance,” published by the Center for Chemical Process Safety, American Institute of Chemical Engineers. He was the editor of the third and fourth edition of the three-volume authoritative reference for process safety and loss prevention, “Lees’ Loss Prevention in the Process Industries.” He has also published more than 300 peer-reviewed journal publications, more than 220 proceedings papers and more than 270 technical meeting presentations.

To honor the legacy of Mannan, the Artie McFerrin Department of Chemical Engineering has established an endowed scholarship in his name. The Dr. Sam Mannan Endowed Scholarship is designed to prepare chemical engineers for leadership roles in the process safety field, and will be awarded to a student pursuing an undergraduate degree in chemical engineering with a minor in safety engineering from Texas A&M.

We mourn his passing but are greatly appreciative of all he has contributed to safer and environmentally responsible ocean energy operations.
Cassio Ahumada (Texas A&M)

**Enhancing the Understanding of Deflagration-to-Detonation Transition**

There are two main combustion modes in vapor cloud explosions: deflagration and detonation. Deflagrations occur when the flame front travels at subsonic speeds leading to overpressure with the same order of magnitude as the atmospheric pressure. Unlike deflagrations, detonations are characterized by supersonic flame propagation velocities and significant overpressures. Several experimental studies have shown that when proper conditions are met, the flame front may accelerate, reaching the detonation combustion mode. This phenomenon is known as deflagration-to-detonation transition. However, more recent large-scale tests have demonstrated that intermediate states between laminar deflagrations and CJ detonations are more likely to happen for fuels with low and medium reactivity, such as methane and propane. Therefore, this research project focuses on studying experimentally and numerically intermediate combustion regimes during deflagration-to-detonation transition. The ultimate goal is to understand the effects of layout and fire suppressants on the final flame speed.

Moustafa Ali (Texas A&M-Qatar)

**Subsea Gas Release Consequence Modeling**

Subsea gas releases can result from different causes including blowouts from oil and gas wells, drilling operations, leakage from transport pipelines or malfunction of subsea processing equipment. Subsea releases will result in the dispersion of the hydrocarbon as it rises to the sea surface leading to potentially catastrophic impacts on human life, the environment and offshore installations. Consequence analysis provides quantitative information on the risk and potential hazards that could be caused by these events. Although many models have been developed for subsea releases, these models present limitations for representing underwater plume turbulences, gas dissolution and high flowrates environment. In addition, phenomena like hydrates formation, bubble size distributions and releases containing toxic gases like hydrogen sulfide have not received much attention. The objective of this research is to develop a comprehensive computational fluid dynamics-based model for subsea gas releases.
Behavior of Nano Calcium Carbonate Modified Smart Cement Contaminated with Oil Based Drilling Mud

Production is expanding in oil and gas around the world; hence, there are challenges in well construction. There are several benefits in using oil based drilling mud (OBM) in drilling operations, especially in shale formations, but there are concerns about the potential contamination of the cement. Recent case studies on cementing failures have clearly identified some of these issues that resulted in various types of delays in the cementing operations. At present there is no technology available to monitor cementing operations and also to determine the potential of contamination in real time during the installation of the oil and gas wells. In this study, the effect of adding up to 1 percent of Nano CaCO3 (NCC) to the smart cement was investigated in order to protect the smart cement against OBM contamination. Variation in the electrical resistivity of the smart cement with curing time was monitored from the initial time of mixing to 28 days of curing under water. Results showed that contamination of smart cement with OBM reduced the long term resistivity of the smart cement but adding NCC enhanced the electrical resistivity of the contaminated smart cement cured under water. In order to evaluate the piezoresistive behavior of the smart cement, 0.075 percent (BOWC) of conductive filer was added to the cement to enhance the piezo resistive behavior of the cement. Results showed that change in resistivity at compressive failure for the smart cement was over 1000 times more than compressive strain and the addition of one percent NCC further enhanced it by about 37 percent after one day and 28 percent after 28 days of curing under water. The OBM contaminated smart cement showed less change in piezo resistivity at maximum compressive stress at failure than the smart cement but the addition of one percent of NCC enhanced the piezo resistivity of OBM contaminated smart cement.

Determining Pressure Drop and the Minimum Fluidization Velocity Across a Gravel Pack Completion to Confirm its Integrity

In a gravel pack completion, a non-uniform reservoir inflow with very high velocity could be capable of eroding the sand screen or may fluidize the gravel. Hence, it is crucial to maintain the integrity and avoid the failure of a gravel pack completion along with optimizing the well production. Previously, works have been carried out to address the risks of fluidizing the gravel pack in high flow rate - deepwater wells, however, there is an absence of formulas or verified safety cutoff velocity values below which a well should be produced to avoid damaging the gravel pack completion.

Monitoring Wellbore Quality in Real-Time Using a Geometrically Derived Tortuosity Metric

Poor wellbore quality can negatively affect operations from drilling to production in unconventional wells. Tortuosity is a geometric concept that provides an indicator of wellbore quality. Several indices exist for quantifying tortuosity, but few of them capture the overall tortuosity of the well in real-time. Building on prior work, a previously published original tortuosity index was modified to better characterize the overall tortuosity of a well in real-time.
Tatiana Flechas (Texas A&M)

**CFD Modeling of Liquefied Gases Discharging Through a Pipeline Full-Bore Rupture**

Large amounts of substances are transported in pipelines worldwide. This activity represents a hazard that needs to be quantitatively assessed through discharge models that are capable of accurately predicting the outflow when a pipeline ruptures. When a pipeline transporting a pressurized liquefied gas ruptures (e.g., CO2, LPG pipelines), the expansion generates a phase transition that results in a two-phase release. Numerous researchers have developed one-dimensional models to describe the discharge of liquefied gases when a pipeline full-bore rupture occurs. However, a systematic study on how the accuracy of different equations of state affects the depressurization prediction is lacking for this case. The main objective of this research is to propose a two-dimensional discharge model using computational fluid dynamic (CFD) tools in order to predict the pressure and temperature profiles along the pipeline, as well as the discharge rate and phase transition, while investigating the effect of different equations of state on the predictions for the full-bore rupture scenario. In order to validate the two-dimensional discharge model, full-bore rupture experiments with dense-phase CO2 pipelines are used. The validation step evaluates the assumptions to model the transient phenomenon. Once the full-bore rupture study is completed, the subsequent step will be to propose a three-dimensional model to predict the behavior of liquefied gases discharging through punctures. The previous scenario will complete the picture for predicting the discharge of flashing liquids when a pipelines ruptures.

Pankaj Goel (Texas A&M)

**Decision Support System for Abnormal Situation Management**

Modern industrial plants have thousands of sensors deployed in the field connected to the control system, units such as distributed control systems (DCS), programmable logic controllers (PLC) and emergency shutdown systems (ESD) for routine operations. In addition, due to the ease in configuring alarms in control systems in the past few decades, the number of alarms in plants has increased significantly. This has resulted in decreased system performance and additional workload on operators, which worsens during an abnormal situation. In this research, it is assumed that the alarm rationalization process has been completed by the organization and that the number of alarms during normal operations is under manageable conditions. However, the alarm flood condition still occurs during an abnormal or upset state. This research is focused on making a decision-support system for the operators using data-driven methodologies. Such a system will improve early detection, prediction of an abnormal situation and provide assistance in decision-making for the operators during abnormal operations. The process includes data acquisition, data mining and analysis, generating information from the available datasets, and creation of a smart dashboard to provide details to the operator. The resultant proactive system would ensure safer, reliable and productive operations.

Christopher Gordon (Texas A&M)

**Maintenance Planning Using Machine Learning and Multiobjective Stochastic Optimization**

Maintenance planning and process operations in chemical manufacturing plants are subject to several sources of uncertainty, ranging from volatile feedstock prices to uncertainty in equipment failure times. In the context of assuring the mechanical integrity of assets in aging plants, the present research employs process systems engineering principles to develop novel optimization algorithms for preventive and predictive maintenance planning in the presence of uncertainty. The research spans different approaches to plant maintenance and consists of three aspects: (1) predictive maintenance using deep neural networks and support vector machines, (2) scheduling of turnaround activities subject to resource constraints using global event-based continuous-time optimization, and (3) preventive maintenance planning using multiobjective, multistage stochastic programming with integer recourse. The results of the research can be used to prioritize maintenance actions, to improve overall equipment availability and to maximize plant productivity.
Zohra Halim (Texas A&M)
Cumulative Risk Assessment Model to Analyze Increased Risk Due to Impaired Barriers in Offshore Oil and Gas Facilities
The Deepwater Horizon incident, as well as many other large-scale disasters, remind us that multiple factors can contribute to a catastrophe, and these factors can be technical, operational, human or organizational in nature. Even though we carry out investigations to learn from these incidents, incidents keep happening as we fail to incorporate those learnings into risk assessment models. There is a need to carry out better risk assessments that will incorporate learning from the past, consider how the various factors are deviating from their safe state and predict the cumulative risk arising from the deviations. Existing risk assessment methods use expert opinion to consider the contribution of human and organizational factors to risk and rely on generic data that cannot capture the deviation of various factors. This research focuses on bridging the gap for a better cumulative risk assessment that will remove complete reliance on expert opinion. It uses learnings from past incidents and current plant data to update the information about how various technical and nontechnical factors are deviating in a facility so that their influence on the failure probabilities of barriers can be better understood and managed.

Prerna Jain (Texas A&M)
Resilience Analysis Framework for Process Design and Operations
Increasing process safety and risk management challenges in the process industries and change in the public perception of hazards and risk globally have necessitated exploring tools for efficient risk management. The application of the resilience engineering perspective is gradually being explored as an approach for considering the dynamics of socio-technical aspects based on systems theory. The resilience methodology emphasizes nonlinear dynamics, new types of threats, uncertainty, and recovery from upset or catastrophic situations. The main focus of this research is to propose a holistic method to integrate both technical (process parameters variations) and social (policy/regulations, human and organizational) factors including prediction, survival and recovery analysis for process facilities. The framework developed in this research is called Process Resilience Analysis Framework (PRAF) comprised of four aspects: early detection, error tolerant design, plasticity and recoverability. PRAF would be applicable to both onshore and offshore installations, primarily focusing on early detection of unsafe zones, assessment of aggregate risks and prioritization of safety barriers during abnormal situations, and reduction in response time resulting in enhanced recovery and mitigation of consequences.

Chenxi Ji (Texas A&M)
Facility Safety Study of LNG Offshore System
The motivation of this research is to establish a general offshore operation system to involve both marine transportation process and chemical safety process. The purpose of this research is to apply chemical process safety methodology to the shipping and offshore industries, trying to support decision-makers facing LNG-FSRU siting problems and to arouse public concern of nearshore/offshore safety. GIS-based multi-attribute decision analysis (MADA) was adopted as the main logic of this research, and the evaluation framework was constituted by four layers (objective layer, process layer, hazard layer and attribute layer) by considering the data availability. Furthermore, three consecutive processes were determined for the whole system. For navigational process and berthing process, the operation process was realized by statistic tools and ship simulators. For LNG transferring process, the simulation runs were carried out by chemical consequence software. The whole evaluation framework was structured by the identified hazards and attributes. Based on the value of final LNG offshore system, the preferred alternative can be determined accordingly.
Zeren Jiao (Texas A&M)

Optimize Ventilation Systems in Confined and Unconfined Workplaces Using Computational Fluid Dynamics

Ventilation is the most common method to control toxic and explosive airborne materials in confined and unconfined spaces. The purpose of ventilation is to dilute or remove toxic and explosive vapors with air to prevent potential poisoning or explosion. In this study, Computational Fluid Dynamics (CFD) tools will be utilized to better understand the efficiency and mechanisms of ventilation systems. The objective of this work is to evaluate the optimized ventilation systems in both confined and unconfined workplaces by considering the installation location and exhaust air flow rate. The results of CFD simulation can serve as a reference to maximize ventilation efficiency and minimize the energy cost.

Ramanan Krishnamoorti (University of Houston)

Hydrocarbon Influx Behavior Within a Deepwater Marine Riser: Implications for Design and Operations

Formation and management of gas within deepwater marine drilling risers poses a variety of challenges and hazards for offshore energy operations. Uncontrolled riser gas build-up and release were major components of the Deepwater Horizon disaster. This project aims to improve understanding of riser gas formation and unloading (i.e., the processes involved in managing riser gas) through the development, calibration and implementation of modeling to describe the dynamics pertaining to riser gas under different situations and operating conditions and the assessment of instrumentation that could be used to detect riser gas properties and behavior.

Sai Anudeep Reddy Maddi (University of Houston)

Field Test for Real Time Monitoring of Piezoresistive Smart Cement to Verify the Cementing Operations

With reported failures and growing interest in environmental and economic concerns in the oil and gas industry, integrity of the cement sheath is of major importance. The disaster at Macondo claimed 11 lives and caused severe injuries and record-breaking sea pollution by the release of about five million barrels of crude oil. Therefore, proper monitoring and tracking the process of well installation and the performance during the entire service life has become an important issue to ensure cement integrity. Smart cement has been developed that can sense any changes going on inside the borehole during cementing and during curing after the cementing job. The smart cement can sense the changes in the water-to-cement ratio, different additives, temperature and any pressure applied to the cement sheath in terms of piezoresistivity. The failure compressive strain for the smart cement was 0.2 percent at peak compressive stress and the resistivity change is of the order of several hundreds making it over 500 times more sensitive. In this study, a field well was installed and cemented using the smart cement mixture with enhanced piezoresistive properties. The field well was designed, built, and used to demonstrate the concept of real time monitoring of the flow of drilling mud and smart cement and hardening of the cement in place. A new method measures the electrical resistivity of the materials using the two probe method. LCR meters (measures the inductance (L), capacitance (C) and resistance (R)) were used at 300 kHz frequency to measure the changes in resistance. The well instrumentation was outside the casing with 120 probes, 18 strain gages and nine thermocouples. The strain gages and thermocouples were used to compare the sensitivity of these instruments to the two probe resistance measure in-situ in the cement. Change in the resistance of hardening cement was continuously monitored since the installation of the field well for over 500 days. Also, a method to predict the changes in electrical resistance of the hardening cement outside the casing (Electrical Resistance Model - ERM) with time has been developed. The ERM predicted the changes in the electrical resistances of the hardening cement outside the cemented casing well. In addition, the pressure testing showed the piezoresistive response of the hardened smart cement and a piezoresistive model has been developed to predict the pressure in the casing from the change in resistivity in the smart cement.
Ranjana Mehta and Camille Peres (Texas A&M) with Eric van Oort (University of Texas at Austin)

**Factoring in the Human in Offshore Operations: Forces for Scenario Planning**

Researchers plan to explore how fatigue affects workers' performance during simulated offshore drilling scenarios. They also plan to identify which methods drillers would be most likely to adopt to reduce fatigue during their shifts. By characterizing drillers' cognitive performance across shifts and capturing the physiological impact of maintaining performance, this project could help planners develop scenarios to prevent or mitigate human (or systems) error that align more closely with workers' capabilities.

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Edna Mendez (Texas A&M)

**Effects of Flow Conditions on the Performance of Corrosion Inhibitors in Pipes**

Major process safety incidents have been caused by corrosion all over the world. These incidents are usually linked to leakage of highly flammable liquids or gases, causing severe damage to the environment, affecting people and ultimately resulting in monetary losses. Despite the increasing knowledge of corrosion, efforts are still needed to understand different damage mechanisms and their control methods. One of the most common active corrosion mitigation techniques in refineries is the use of corrosion inhibitors. Film-forming corrosion inhibitors create a protective layer that can be influenced by different flow characteristics and flow regimes. These changes in hydrodynamic conditions have an effect on the performance of corrosion inhibitors. This work focuses on the fundamental understanding of the hydrodynamics of the system coupled with analysis of the corrosion behavior using electrochemical techniques. The objective of this research is to study the influence of different flow parameters on the efficiency of corrosion inhibitors under corrosive environments such as CO2.

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Ala Eddine Omrani (University of Houston)

**Gas Kick Early Detection**

Using data-driven modeling for drilling system condition-monitoring, real-time sensors' sampled data is analyzed and processed to determine the well condition and early detect gas influxes. In addition to kick prediction, real-time downhole gas volume can be determined allowing the adjustment of the control strategy. A multiphase flow transient model is developed and used to estimate the gas flowrate using the sampled data. Key Words: Blowout Preventer, Multiphase Flow Modeling, Gas Influx Early Detection, Influx Control, Numerical Modeling.

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Trent Parker (Texas A&M)

**Risk-based Optimization of Alarm Systems Used in Industrial Applications**

Alarm systems serve a critical role in the safe operation and control of plants by alerting operations staff of possible process deviations from normal operation. However, even with alarm systems installed, up to 90 percent of process incidents are attributable to human error. Thus, user-friendly alarm systems are crucial to ensure effective operator responses and thus, safe plant operation. Alarms may fall into the categories of process alarms or critical safety alarms. However, there often exists a large number of alarms that fall in the range between these two categories. At times, the role of alarm management for operations staff can become unclear, particularly when multiple alarms occur simultaneously. This research aims to provide a framework to determine the optimum combination of audible and visual signals so as to prioritize operator response time to safety issues and process upsets based on relative risk and minimize the likelihood of alarm flooding.
Parham Pournazari (University of Texas at Austin)

Self-Learning Control of Automated Drilling Operations

In recent years, drilling automation has sparked significant interest in both the upstream oil and gas industry and the drilling research community. Automation of various drilling tasks can potentially allow for higher operational efficiency, increased consistency and reduced risk of trouble events. However, wide adoption of drilling automation has been slow. This can be primarily attributed to the complex nature of drilling and the high variability in well types and rig specifications that prevent the deployment of off-the-shelf automation solutions. Such complexities justify the need for an automation system that can self-learn by interacting with the drilling environment to reduce uncertainty. The aim of this dissertation is to determine how a drilling automation system can learn from the environment and utilize this learning to control drilling tasks optimally. To provide an answer, the importance of learning, as well as its limitations in dealing with challenges such as insufficient training data, are explored. A self-learning control system is presented that addresses the aforementioned research question in the context of optimization, control and event detection. By adopting an action-driven learning approach, the control system can learn the parameters that describe system dynamics. An action-driven approach is shown to also enable the learning of the relationship between control actions and user-defined performance metrics. The resulting knowledge of this learning process enables the system to make and execute optimal decisions without relying on simplifying assumptions that are often made in the drilling literature. Detection of trouble drilling events is explored, and methods for reduction of false/missed alarms are presented to minimize false interruptions of the drilling control system. The subcomponents of the self-learning control system are validated using simulated and actual field data from drilling operations to ascertain the effectiveness of the proposed methods.

Vivek Singhal (University of Texas at Austin)

A Novel X-Ray Based High Pressure Mass Flow Rate Sensor for MPD Operations

Managed Pressure Drilling (MPD) allows one to drill through formations with narrow pressure windows, thereby making those formations that cannot be drilled with conventional techniques accessible. It also provides the capability for early detection and safer handling of well control events. This technique requires accurate estimation of the annular pressure profile and the delta mass flow rate. These measurements can be improved through accurate density and mass flow rate measurement at the high pressure (7500 psi) input side of the well. Since no good metering technologies exist to make these measurements, the objective was to develop a high pressure density and mass flow rate sensor. A comprehensive review of all existing flow rate and density measurement instruments suggested that an X-ray based sensor was the best option for the high pressure fluid line. Multiple experiments were conducted to determine the electrical power range (voltage and power) for the X-ray tube that would work best for mud between densities in the range of 8 to 20 ppg. Experiments were then conducted to test the accuracy and feasibility of techniques developed for density and volumetric flow rate measurement. Based on these experiments, an X-ray source and detector were identified and a sensor was designed for inline use on 4 inch pipes. Two approaches were developed to estimate density using the sensor. The first was an empirical approach where sensor gray level values were directly mapped onto mud density values though in laboratory experiments. These mappings can then be used in the field to estimate density. The second was a model-based approach that estimates density based on the Beer Lambert’s law. A mechanism that uses X-rays to determine volumetric flow rate was also designed and tested using both simulations and experiments. A real-time calibration subsystem had to be added to the sensor to preserve measurement accuracy and precision over time. Based on encouraging results from simulations and experiments, a laboratory prototype was built and is currently undergoing flow loop tests. This is the first time an X-ray mass flow rate measurement sensor has been designed to be used on high pressure lines. Preliminary findings indicate that no existing sensors used for similar applications can match the measurement accuracy and frequency that may be offered by this technology. Development of this sensor would improve the safe drilling of complex wells with narrow drilling windows.
Changwon Son (Texas A&M)

Identifying and Enhancing Resilience of an Incident Management Team

Disasters have long been a persistent threat to social systems including organizations, communities and government. Uncertainty and complexity of the disasters, either being natural or technical, gave rise to resilience in incident management during disasters. Resilience is generally defined as a system’s capacity to adjust the system’s performance and to meet both routine and non-routine work demands from a disaster. To identify and enhance resilience of an incident management team (IMT), the research conducts various methods including naturalistic observation, interviews and experimental study. As an initial attempt to understand the IMTs actual operations and identify resilient performance, a naturalistic observation was conducted and analyzed. This analysis will help identify challenges to coping strategies and success patterns and develop technical work process and training supports to enhance resilient performance of the IMT, which will be examined via experimental study.

Yang-Denis Su-Feher (Texas A&M)

Quantifying Ease of Control for Inherently Safer Design

The most cost-effective approach to prevent incidents is to add process design features to prevent hazardous situations rather than having to rely on mitigative or emergency response measures to deal with process upsets once they occur. This is the fundamental principle behind inherent safety. However, process control systems are ubiquitous and necessary to maintain control over the process once it is put into operation. Furthermore, it is known that the ability of the process control system to maintain control over the design depends on the design itself. A more accurate assessment of safety can be obtained in the early design stages by integrating inherently a safer process design with an understanding of the ease by which the design can be controlled, also known as its “ease of control.” This research seeks to create an index that will quantify the inherent safety of the process design and its ease of control. This index will be used to compare the inherent safety of different chemical processes, and how changes to the design can impair or improve the ease of control.
Nafiz Tamim (Texas A&M)

Developing Leading Indicators Framework for Predicting and Preventing Offshore Blowouts

Leading indicators are effective organizational tools that can identify vulnerabilities in a system. Offshore drilling operations and well activities have always been very challenging due to technological and operational complexities, and thus, it is quite difficult to develop well-specified risk indicators for these high-risk operations. This research aims to develop leading risk indicators-based probabilistic models for offshore drilling and other well operations (e.g., workover) to predict gas kicks and possible blowout scenarios. This work proposes a cause-based approach to develop sets of leading indicators for different categories and organizational levels. Probabilistic models are developed for evaluating the relative importance of different leading indicators and for assessing their impacts on the key causal factors of well control barrier failure. This work continues to build comprehensive risk models combining real-time indicators with operational and organizational factors to predict and prevent blowout incidents.

Joshiba Ariamuthu Venkidasalapathy (Texas A&M)

A Systematic Approach to Alarm Identification with Application to Tennessee Eastman Problem

Abnormal event management (AEM) of process plants has garnered attention in recent years. It has been estimated that $20 billion is lost due to abnormal situations each year. Efficient monitoring of process variables and timely corrective measures are at the crux of AEM. Most process monitoring techniques in current practice involve the use of alarms to alert the operator, thereby requiring a corrective action to restore normal operation. The “alarm identification” is an important aspect of the alarm system design, which is the focus of this research project. It concerns the selection of a potential subset of process measurements to configure to the alarm system. Most of the previous works on alarm identification involved a qualitative approach. This project aims to develop an alarm identification design technique that incorporates quantitative aspects. The operator-centered approach aims at providing the operator ample time to respond while having fewer active alarms. The proposed approach is implemented on the benchmark industrial case study, the Tennessee Eastman process control problem.

Wesley Williams (Louisiana State University) with A. Rashid Hasan (Texas A&M)

Experiments on Multiphase Flow of Live Muds in a Full-Scale Wellbore with Distributed Sensing for Kick and Gas-in-Riser Detection/Mitigation

Pressure barriers provide the primary means of preventing uncontrolled hydrocarbon releases in offshore wells. However, these barriers are only effective if they have been designed, properly operated and maintained for the conditions of the environment in which they are employed. The project focuses on gaps in understanding about the behavior of riser gas under high temperature and pressure. Testing will be done using an existing well retrofitted with pressure and temperature sensors to produce data for validating and verifying riser gas models that inform design of pressure barriers and techniques for preventing uncontrolled hydrocarbon releases.
Lecheng Zhang (Texas A&M)

Biodegradable Low-Temperature Oil Herder

When oil is spilled offshore, the harsh conditions at the remote location may make the oil spill response challenging. The weathering effect and evaporation of oil can also slow down the cleaning process. In the open water region, the spilled oil could spread much quicker due to gravity, wind, current and wave effects, which would hinder the mitigation process. The countermeasures of open-water oil spillage generally include mechanical recovery, oil herders combining in-situ burning and dispersant biodegradation. Among those methods, oil herder is more applicable at remote locations with limited resources (i.e., the Arctic area). We are developing a biodegradable herder formula based on Konjac powder to increase the crude oil clean up ratio. The herder/cosurfactant formula is easily applicable in terms of effectiveness, cost and nontoxic nature. Compared to other products on the market, the Konjac-based oil herder has a better oil herding performance at low temperature.

Jiayong Zhu (Texas A&M)

Sour Gas Dispersion Modeling

Heavy gases, such as hydrogen sulfide and chlorine, are hazardous materials that maximize the dangerous effects on nearby people and the ecosystem because the gases tend to travel near the ground where wind speed decreases and gases dilute slowly. Heavy gas dispersion models are crucial to provide decision makers with a quick assessment of potential impacts as well as land-use planning. Many heavy gas models are available, but some of them may not be fully validated against experimental data in complex situations. DEns e Gas DIspersion (DEGADIS) and computational fluid dynamics (CFD) models are widely used in current industries. However, they both have their limitations: the DEGADIS model cannot consider different wind directions and varying wind speeds, while CFD models generally take a large amount of time for one scenario simulation. More importantly, the near-field (within 100 meters) results obtained from the DEGADIS model are conservative, with predictions being two to five times larger than the experimental data, whereas CFD models sometimes underestimate the results. We need to overcome the disadvantages of current models. The objective of this research is to develop a semi-empirical mathematics equation to estimate hydrogen sulfide gas concentration profile in the near field. The proposed model will consider obstacles, varying wind speed and humidity.

Junxiao Zhu (University of Houston)

Development of PZT based Impact Detection System for Subsea-Tree Structures

Structural impact events, such as impact events on structures by foreign object debris always endanger the integrity of the structures and lead to serious consequences, which highlight the structural health monitoring with the capability of detection and location of the impact events in a rapid pace. An innovative algorithm and investigation the sensing model of piezoelectric ceramic sensors was developed to estimate the propagation distances of versatile ultrasonic guided waves, thus both detect and locate the impulse events for various structures.
OESI Leadership

Principal Investigator (through 9/2018)
Dr. M. Sam Mannan
Texas A&M University, Regents Professor
Executive Director,
Mary Kay O'Connor Process Safety Center

Co-Principal Investigator
Dr. Ramanan Krishnamoorti
University of Houston
Chief Energy Officer

Principal Investigator (as of 10/2018)
Director of Operations
James Pettigrew
Captain, U.S. Navy (Ret.)

Co-Principal Investigator
Dr. Eric Van Oort
The University of Texas at Austin
Petroleum Engineering

Co-Principal Investigator
Dr. Rashid Hasan
Texas A&M University
Larry Cress Fellow

Program Manager
Paul Robinson
The Ocean Energy Safety Institute (OESI) is a collaborative initiative between the Texas A&M Engineering Experiment Station’s (TEES) Mary Kay O’Connor Process Safety Center, partnering with Texas A&M University, The University of Texas at Austin and the University of Houston. The institute provides a forum for dialogue, shared learning and cooperative research among academia, government, industry and other non-governmental organizations in offshore energy-related technologies and activities that ensure safe and environmentally responsible offshore operations. While there have been efforts to identify scientific and technological gaps and to recommend improvement of drilling and production equipment, practices and regulation, the OESI will strive to coordinate and focus these products. Initial funding of the Institute came from the Department of the Interior and the Bureau of Safety and Environmental Enforcement (BSEE).