Safer Offshore Energy Systems Grants 1
Final Report

Project Title: Developing a Systems-Theoretic, Cross-Disciplinary, Scenario-Based Approach to Reducing Risk in Offshore Oil and Gas Operations
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Project Key Personnel:

- N/A

I. ORIGINAL PROJECT SUMMARY (from proposal)

IMPORTANCE TO ADDRESSING SCIENTIFIC AND SOCIETAL NEEDS:
Major accidents and losses always involve a complex intertwining of a multitude of factors. Preventing major losses in offshore oil and gas operations requires the consideration of scenarios that include technical, organizational, human, environmental, regulatory, and social factors as an integrated whole. The tragedy of the Macondo accident cannot be understood or future losses prevented unless all the factors and particularly their complex interactions are considered.

PROJECT OBJECTIVES AND INNOVATION:
Current approaches to scenario development and analysis either do not (and cannot) include all the causal factors or they consider them only individually: they do not handle their interaction as well as the complexity of today's sociotechnical systems and the organizational, social, environmental protection, and human factors involved in major losses. What are needed are new sociotechnical modeling and analysis techniques that treat the problems as an integrated whole, including environmental losses as well as human and property losses.

The PI has recently created a new accident causality model that is based on systems theory rather than traditional component reliability currently used for scenario development and system safety activities. This new approach treats accidents as complex sociotechnical processes involving the intertwining of social and technical factors. Based on this new causality model (called STAMP or System-Theoretic Accident Model and Processes), there are powerful new techniques being developed for rigorous modeling and analysis of safety in complex sociotechnical systems, including safety culture, organizational design, regulatory oversight, and technical design. These methods include both accident

analysis (retrospective analysis of the causal factors in a loss to understand why it occurred) and hazard analysis (prospective generation of scenarios leading to losses before they occur). The techniques have been applied to technical design and low-level management functions and both formally and empirically evaluated in university research and industrial practice. They do not yet include upper levels of management, government regulators, environmental factors, and other critical components of offshore oil and gas accidents including community preparedness.

This research will extend this paradigm-changing new approach to safety engineering to include these additional factors in accidents and demonstrate its feasibility and efficacy for generating scenarios and minimizing risk in offshore oil and gas operations. One of the goals will be to provide tools that are usable by non-engineers and those without much training in scenario generation and analysis but who are familiar with the relevant social and environmental factors. We need models and analysis tools that allow all stakeholders to participate in developing and using scenarios for losses and in generating ways to design to prevent accidents and to respond to minimize damage if those prevention measures turn out to be inadequate.

The overall goal of the research is to provide powerful new tools to enhance cross-disciplinary efforts to prevent tragedies like that of Deepwater Horizon.

II. PROJECT RESULTS

Accomplishments

Scenario-generation techniques are used to determine how to prevent accidents in the future. The problem we were addressing was to explore how system theory can be used to create more powerful scenario-generation approaches that include the entire sociotechnical system. Major accidents and losses always involve a complex intertwining of a multitude of factors, including technical, organizational, human, environmental, and social. Current scenario-generation techniques do not include all these factors and their interaction in today's complex sociotechnical systems. They treat accident causation in much too simplistic a way. Our goal was to provide powerful new tools to enhance cross-disciplinary efforts to prevent tragedies like Deepwater Horizon.

In this research, we extended and demonstrated a new, more powerful, paradigm-changing approach to safety engineering to show its feasibility and efficacy for generating accident scenarios and minimizing risk in offshore oil and gas operations. One of the goals was to provide tools that are usable by non-engineers and those without extensive training in hazard analysis but who are familiar with the relevant social and environmental factors. We need modeling and analysis tools that allow all stakeholders to participate in efforts to prevent accidents and to respond to adverse events in ways that will minimize damage if the prevention measures turn out to be unsuccessful. The research also included showing how to identify leading indicators of increasing risk to use as part of a risk management system that can identify when the behavior of offshore oil and gas operations and the processes involved in its oversight and contingency planning are starting to migrate to states of higher risk.

Implications

The importance of the results is obvious, that is, we need ways to prevent the extraordinarily costly and disruptive events such as those involved in the oil spill from the Macondo well. Our research has opened up new opportunities for researchers to take a very different approach to solving this problem from what is done today (and has not been very successful). It also provides a way for government and community leaders to participate in protecting U.S. assets, the population, and the environment from injury and damage while also allowing petrochemical companies to engage safely in important business opportunities.

Unexpected Results

N/A

Project Relevance

Researchers, educators, community leaders, local government officials, state government officials, federal government officials, the non-profit private sector, and the for-profit private sector would be interested in the results of this project.

The results provide a method to design safer sociotechnical systems, which benefits everyone.

Education and Training

Number of students, postdoctoral scholars, or educational components involved in the project:

- Undergraduate students: 0
- Graduate students: 2
- Postdoctoral scholars: 0
- Other educational components: 0

III. DATA AND INFORMATION PRODUCTS

This project produced data and information products of the following types:

- Scholarly publications, reports or monographs, workshop summary or conference proceedings
- Models and simulations

INFORMATION PRODUCTS

Citations for project publications, reports and monographs, and workshop and conference proceedings:

Nancy Leveson, Final Report: A Systems-Theoretic, Cross-Disciplinary, Scenario-Based Approach to Reducing Risk in Offshore Oil and Gas Operations, downloadable from http://sunnyday.mit.edu/Final-Report-Gulf-Oil-Spill-Research-Project.pdf