PROJECT INFORMATION

Project Director's Name*	Antonie Jetter
Organization*	Portland State University
Project Title*	Bringing high-reliability safety culture decisions into focus: Training with interactive fuzzy cognitive mapping
Reporting Period*	1/1/2020-6/30/2023

Note to Grantees: In sections 1 to 5, we ask you to highlight your accomplishments (including outputs and outcomes) through this grant award. These sections of the final grant report will be made available to the public.

1. GOALS AND ACCOMPLISHMENTS

1.1 Please restate the goals and objectives of your project.*

The overarching goal of this project is to improve safety through safety culture training. To this end, the project goal is to create FOCOS (Fuzzy Operational Cognition of Safety Culture), an FCM-based online platform that operationalizes safety culture as a system model and provides simulation-based safety leadership training for frontline managers.

Deliverables for year three of this project are the FOCOS platform, consisting of a website that gives access to:

(1) A manual that provides comprehensive, relatable descriptions of industry safety practices and high-reliability principles; reviewed by industry experts to ensure relevance and alginment with industry language and practices.

(2) An online dashboard to interactively represent the state of high-reliability safety culture in response to different leadership actions (entered by users of the system)

(3) A backend model (based on prior work) of safety culture dynamics, as well as user-provided modifications of this baseline model (occurring in this project)

(4) The technical ability to collect demographic data and data on user interactions with the system, which will permit the definition of user-profiles and the identification of areas for improvement

(5) An evaluation of the complete system through industry experts

1.2 Describe the accomplishments of your project. You should include both the anticipated accomplishments that you outlined in your project proposal as well as any *unanticipated* accomplishments that have since occurred. Describe any activities you have conducted, programmatic progress made, or project benchmarks and milestones met.*

Accomplishment 1: We have completed a fully functional prototype of FOCOS, hosted on the website https://sites.google.com/pdx.edu/focos-project/home. The website consists of the training manual/ book (including an extensive quiz to self-test the knowledge acquired), and the frontend (dashboard) and backend (model, FCM simulation) of the software. To our knowledge, this is the only HRO leadership training that is specifically designed for frontline management in the offshore energy industry. This helps transfer the abstract concept and strategic goal of high reliability to practice. It is also the first training that uses interactive simulations as a means to sensitize decision-makers to the complex and dynamic nature of HRO. All products are available online for free.

Accomplishment 2: We have solicited industry practitioner feedback by exhibiting the work at OTC 2023, reaching an estimated 200 people in a low engagement mode (i.e., watching the promotional video, picking up marketing collateral) and engaging 36 people in deeper conversations. We have used these conversations to solicit feedback about the software/book/approach and to understand potential pathways to disseminating this work more broadly. Three themes have emerged in these conversations: a) Confirming our own assumptions, many conversation partners pointed out that culture change needs to be desired, supported, and modeled from the top - there is no incentive for front-line managers to learn HRO leadership behaviors unless this knowledge aligns with organizational goals and they can put it to work. This applies to every training format. b) Offshore workers are very familiar with online training because of its many logistic advantages, making the format suitable for the audience. The interactive component, provided by the simulation software, is appealing because many online courses are "one-way". The industry-specific examples/scenarios, outlined in the book, are of particular value. c) Challenges to acceptance exist in the form of perceived leadership support (see a), as well as the fact that "promoting a culture of safety" is not necessarily in the official position descriptions of low-level leaders, which might make it difficult for large organizations to identify who will benefit from the training. In addition, there is an increase in required trainings on many levels of organizations, which are all competing for time. Challenges to acceptance might also arise from the length of the book and the difficulty of mapping the book content to the simulation activities. Future development could address these issues in two ways: (1) They could embed the online training into a synchronous workshop format (via video conferencing or in person) that bridges the two media (book vs. software use), with the potential added benefit for promoting team cohesion and shared safety culture. Such an approach is low-cost when few employees are trained, but it does not scale well to thousands of employees or the industry at large (2) A conversational AI-chatbot could integrate book content and simulation, however, the technologies (based on large language models) are emergent, largely unproven in a training context, and require substantial research and development. They are thus more suitable for an academic research project than straightforward industry implementation.

Accomplishment 3 (unanticipated): As outsiders to the offshore energy industry, we realized early that an entree to the industry and fluency in industry terms would be critical to project success. To obtain this, we have analyzed expert reports, publications, court documents, and personal communications about the Macondo (Deepwater Horizon) accident through the lens of High-Reliablity Organizing. This work provides a fresh look at an industry-defining event and is also one of the very few analyses that covered findings in later, civil trials. The work was initially only intended as a means to inform our training design but it has evolved into a paper that is well received in the community. To date, it has over 3000 views and an Alt Metric score of 14. This score measures engagement (conversations, reading, sharing, etc.) of journal articles, rather than citations in the work of other academics and thus provides an (imperfect) measure of the utility and relevance to non-academic audiences. The paper is in the to 25% of all publications.

2. Outputs

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

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** denotes required fields*

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2. OUTPUTS

Outputs are tangible or measurable deliverables, products, data, or publications produced during the project period.

2.1. Please indicate the number of students (K-12, undergraduate, or graduate), postdoctoral scholars, citizen scientists, or other trainees involved in the project. *

Please enter 0 if none were involved.

K-12 students	0
Undergraduate students	2
Graduate students	5
Postdoctoral scholars	1
Citizen Scientists	0
Other Trainees	0

2.2. Has your project generated any data and/or information products? *

Generation of data includes transformations of existing data sets and generation of data from existing resources (e.g., maps and images). Information products include publications, models, software, code, curricula, and digital resources.

(Check all that apply.)

Responses Selected:

Information Products

2.3. Briefly describe how you fulfilled the approved Data Management Plan and, if applicable, any changes from the approved plan. *

Due to Covid, changes to project personnel, and a more challenging than anticipated development path, our approaches to developing and evaluating the FOCOS online training platform changed. Accordingly, many of the specific data formats and data products mentioned in our plan were replaced by others. For example, we did not use the online platform Moodle (as outlined in the Data Management Plan), but Canvas, and later abandoned Canvas for a custom website. We also replaced quantitative evaluation surveys with conversations during OTC conference - a format that does not lend itself to re-use by other researchers. This did not change the fundamental approach to data mangement for short-term storage.
For long-term storage, we published several results during the project duration, thus making them accessible to the public. We provide access to the developed software and training manual via the project website https://sites.google.com/pdx.edu/focos-project/home. We intend to maintain the project website for a minium of three years.

If your project has produced publications, websites or data portals, GIS applications, models or simulations, software packages or digital tools, code, curricula, or other interactive media, please download the Excel worksheet entitled GRP Information Management Reporting. Use the "Information Products Report" tab in the worksheet to create an inventory of these products and to verify deposit in a curation facility. Upon completion, please upload the worksheet to your task list. If you need guidance on how to complete the Information Products Report, please e-mail gulfgrants@nas.edu. A member of GRP's data management staff will reach out to you.

2.4. Aside from data and information products, what other tangible or measurable deliverables or products (e.g., workshops, trainings, and outreach events) were produced during the project period? *

Upon completion of this form, you may upload supplemental material that represent the tangible or measurable deliverables or products to complement this narrative report.

2021 Mary K. O'Connor Process Safety Conference: Designing Scalable Online Training for Safety Culture - Interim results of FOCOS (Fuzzy Operational Cognition of Safety Culture), presenter Jetter, Antonie. Co-authors: Alibage, Ahmed; Kutgun, Hakan; Espinoza-Gala, Lillian; Liang, Peter

2023 Offshore Technology Conference: table at the university showcase (2 full days).

4. Information Products

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

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4. INFORMATION PRODUCTS

In this section, please provide a response to each question to complement the **Information Products Report** in the **GRP Information Products Management** Excel worksheet.

4.1. Please select the type(s) of information products that your project produced. *

Responses Selected:

1. Scholarly publications, reports or monographs, workshop summaries, or conference proceedings
2. Websites or data portals
3. Curricula for education and training
6. Software packages or digital tools, or other interactive media

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Scholarly publications, reports or monographs, workshop summaries, or conference proceedings *

Please provide a list of citations for project publication, reports and monographs, workshop summaries, and conference proceedings.

Espinoza-Gala, Lillian; Jetter, Antonie; Alibage, Ahmed: Listening to the Well, Listening to Each Other, and Listening to the Silence—New Safety Lessons from Deepwater Horizon, ACS Chem. Health Saf. 2022, 29, 1, 5–18, Publication Date:October 18, 2021, https://doi.org/10.1021/acs.chas.1c00050

Jetter, Antonie; Alibage, Ahmed; Liang, Peter; Aminpour, Payam; Gray, Steven: Designing Scalable Online Training for Safety Culture - Interim results of FOCOS, paper at Mary Kay O'Conner Process Safety Symposium 2021, proceedings forthcoming.

Jetter, Antonie, Alibage, Ahmed; Liang, Peter: A Training Platform to Enhance Offshore Safety Based on Fuzzy Cognitive Map A Jetter, A Alibage, P Liang, Proceedings of International Conference for Information Systems, Copenhagen, DK, December 2022

Alibage, Ahmed: Dissertation thesis: Achieving High Reliability Organizations Using Fuzzy Cognitive Maps - the Case of Offshore Oil and Gas

self-published FOCOS Book/Training Manual: Antonie Jetter, Ahmed Alibage, Lillian-Espinoza-Gala: Achieving High Reliability Safety Culture in Offshore Energy - A Training Manual, Portland, 2023, available at: https://pdx.pressbooks.pub/hrosafetyoffshore/

Websites or data portals *

Please provide a list of project websites and data portals (including the website URL).

Focos website and training software: https://sites.google.com/pdx.edu/focos-project/home (access to all products, including software)

Software Code developed under this grant: https://github.com/PortNLP/FOCOS

How long beyond the grant period will you maintain the project website/data portal and its contents? Please describe plans to archive the website/data portal and its contents after regular maintenance concludes.*

The project website is implemented with Goolge Sites, which is easy to maintain and free of charge to researchers. We plan to maintain it for a minimum of three years. Most of the content on the site is already available in repositories that are designed for long-term storage (e.g., github, publications, pressbook). When we choose to discontinue the site, we will provide a condensed version of the information under the "past projects" section of the PI's personal website and register the full site with Wayback Machine.

Curricula for education and training, GIS applications, Models or simulations, Software packages or digital tools, or other interactive media, and Other *

If you produced any additional documentation to describe information products, please provide a list of this documentation (e.g., model or simulation documentation, software manuals, source code annotation).

No additional documentation

4.2. Beyond depositing information products in a repository, what other activities have you undertaken or will undertake to ensure that others (e.g., researchers, decision makers, and the public) can easily discover and access the listed information products? *

We have produced the scholarly publications, outlined above, which target different academic and practitioner audiences (e.g., process safety, management of information systems).
The project website is searchable and linked through the personal profiles of researchers.
Our industry consultants have reached out to their networks and informed them about project results.
Dr. Alibage and consultant Espinoza-Gala have posted on LinkedIn.
We have showcased our work at the Offshore Technology Conference. Industry consultant
We have given an interview, featured in Forbes.
We are developing an outreach strategy with industry consultant Vernon Goodwin (in-person meeting scheduled on September 19, 2023 in Portland)

4.3. Are any of the information products you produced confidential, proprietary, or subject to special license agreements? *

No

5. Project Outcomes

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5. PROJECT OUTCOMES

Outcomes refer to the **impact(s), consequence(s), result(s), or effect(s)** that occur from carrying out the activities or outputs of the project. Outcomes may be environmental, behavioral, health-related, or programmatic. Example outcomes include, but are not limited to: increased learning, knowledge, skills, and motivation; policy changes; actions taken by a group as a result of information generated by your project.

5.1. Please describe the outcomes achieved during your project and how they were assessed. For this question, we are interested in learning about the immediate short-term outcomes that have already occurred during or as a result of your project. Do not include long-term outcomes you foresee your work contributing to beyond the end of the project. *

Our research team gained new perspectives on the role of practical tools (software, book, training modules) as the targeted outcome of research projects. Focus on practice and tools changes the dynamics of the research process: it builds momentum around a goal, energizes teams, provides valuable training opportunities for students, and holds the potential to disseminate knowledge much more broadly and reach non-academic audiences. However, too much "practice focus" does not align well with the demands of research universities, which seek generalizable insights that can be abstracted from specific cases. In general, these institutions do not incentivize "practical" work and do not provide necessary resources (e.g. access to teams of software developers and user experts, training in user-focus and industry-specific language, etc.). In the case of FOCOS, we were able to overcome these challenges through an (initially entirely unplanned) collaboration between technology/information system management (at PSU and LSU) and computer science (at PSU). At its core was an interdisciplinary, co-led team of students from management and computer science that worked jointly under an agile project framework. Dr. Agrawal and I are both committed to continuing this approach in future joint projects. Additionally, as the Associate Dean of Research in PSU's engineering college, I am currently working with my colleagues to determine if and how we can bring some of these practices to the college as a whole to support work that is similar to FOCOS.

Concrete, near-term outcomes with regard to the offshore energy industry in the Gulf of Mexico are more difficult to assess: we have received interest and positive feedback from industry practitioners and remain in touch with them. However, our main deliverables were only completed in May and June of this year, so that not yet achieved a change to practice, policy, or plans.

5.2. We’re interested in hearing not just the results of your project but what are their implications for or contributions to:

- **offshore energy system safety,**
- **environmental protection and stewardship, and/or**
- **health and community resilience**

Please describe what you consider to be the most remarkable accomplishment or finding of your project. What can others learn from your accomplishment and finding? How do you see it fitting in with your greater field of study or community of practice? *

The most remarkable accomplishment of our work is a shift of perspective. It allows us to analyze and understand high-reliability safety culture not as a set of abstract managerial principles to aspire to through good leadership or better communication but as a dynamic system with direct and indirect effects. This perspective achieves multiple things: First, it shifts the focus to front-line safety leaders and the challenges and constraints they experience because we show that their everyday attitudes and behaviors, including how they communicate and implement organizational rules, provide strong leverage for overall system change. Accordingly, we advocate for acknowledging their agency and importance and providing them with leadership training and support. Second, we show that safety interventions, formal rules, and reporting systems affect different aspects of safety culture differently: practices that are good with regard to some goals can backfire for others. In particular, there is an inherent conflict between approaches needed to ensure reliability, rule-following, and reporting in everyday situations that reduce unexpected events and the skillsets needed to identify and respond to the remaining (hopefully very few) unexpected events. It appears that much of the current discussion around industry safety is focused on the former (reliablity). In the extreme, this can result in the goal of removing the "problem" of humans (as sources of variation and non-compliance) through less agency and automated processes. This carries the risk of losing the ability to meet the demands of the latter (resilience). Our work shows that balanced approaches are need. Third, our work shows that safety culture can be approached through a design perspective, as something that does not simply emerge but is (to some extent) consicoulsy created by selecting and calibrating different safety interventions. The simulation software at the core of the FOCOS project makes it possible to test out and explore different "designs".

6. Communication

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Note to Grantees: In Section 6, we seek input from you to help us evaluate the Gulf Research Program's funding strategy. This section will not be made available to the public.

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6. Information to Inform GRP Evaluations

6.1. Sharing the difficulties you encountered helps us learn from your experience. Describe any challenges you encountered in your project and how you addressed or overcame them. Challenges are inherent to conducting any complex project. These may include (but are not limited to): unexpected staffing changes, changes in the community you are working in, appearance of a new technology or dataset in the field you are working in, challenges accessing a field site, policy or regulatory changes that affect the issue you are addressing, low recruitment rates, delays in setting up services, or other problems in implementing and conducting your project. *

We appreciate the flexibility of the GRP that helped us navigate the unusually many challenges of this project, starting with a change of project personnel at LSU and continuing with COVID-19. We had initially envisioned the project to start with in-person training in the PERT lab and to, successively move to more online content until we have obtained a fully evaluated online training. This would have allowed us to do quick and low-cost evaluations early while also building and deepening industry relationships via the in-person training in the PERT lab. COVID-19 made this impossible and we were forced to pursue a fully online approach from (almost) day 1. To make up for the more limited industry involvement during development, we added two industry experts to the team and conducted many interviews with practitioners. However, this did not fully replace the insights and relationships we likely would have gained under the original plan. The early move to online work also forced us to invest more overall effort into software development. An added complication was that the availability of software contractors was diminished due to the pandemic software hiring spree. (We solved this problem by teaming up with computer science). The combined challenges meant that we were not able to recruit an industry organization or company to evaluate our training at the scale we had originally envisioned. Instead, we did qualitative, feedback-seeking interviews. We also showcased the work and solicited feedback at the Offshore Technology Conference. For testing the software and the book we relied on industry experts on the team and student volunteers.

6.2. We like to hear about what you learned from your work and how you feel it affects future work or the work of others. Think back on your project strategies, methods, and activities, what worked and what did not? Is there anything you would do differently in the future? If so, tell us what and why. *

In future projects, we would implement the original plan that included frequent in-person meetings, several training iterations with industry involvement, and successively increasing the share of online/software development work.

6.3. What are the next steps for this work, either for you and your project team or other researchers? Has this project led to other opportunities to work in this area? *

We are committed to finding a broader industry audience for our work in offshore oil and gas. This work will likely continue under the leadership of our industry consultant, Vernon Goodwin. The next step is a planning meeting in Portland, OR. We are also exploring opportunities to use the general FOCOS approach in organizations that are equally committed to high-reliability safety culture in other industries, most notably health care. Additionally, we plan to take some of the software developed in this project back to the community of Fuzzy Cognitive Map modelers, who were involved in our first GRP-funded project. The software code and visualizations we have developed as part of FOCOS can update and improve their commonly used tools. To this end, we are planning a meeting/workshop in late October 2023, with the goal of developing research proposals.

6.4. Have you developed new collaborations or partnerships (formal or informal) as a result of this work? If yes, please describe the new collaborations or partnerships. *

During the project, we established new partnerships with all of the people directly involved, namely Co-PI Peter Liang at LSU and industry experts Lillian Espinoza-Gala and Vernon Goodwin. The project also resulted in a new partnership between the technology management and the computer science department at PSU, described above.

6.5. What, if any, positive changes in policy or practice do you foresee as a result of your work? *

As discussed above, this project was an unusually "tool-development-oriented" research project. This necessitated changes to our usual research practice, including the formation of an interdisciplinary student-led development team under an agile framework. The success of this approach and the benefit to the students has prompted wider discussions on how to support researchers in PSU's engineering school and may, long term, also result in new educational initiatives such as interdisciplinary, industry-sponsored capstone projects.
At this point, we do not know if the project will see the necessary industry adoption to induce a change in industry practice or policy.

6.6. If you could make one recommendation to the Gulf Research Program for how best to build on the work you conducted in this project, what would it be? *

This is not a fully-formed recommendation: We have observed that access to the offshore energy industry is more challenging than what we are used to from other (tech-heavy, IP-concerned, competitive) industries. In our case, this is likely a mix of multiple factors, such as project leadership (in "liberal" Portland and not part of local networks), project team (shift from LSU's PERT lab to LSU's Business School), and times of extreme stress (pandemic, lowest crude oil price ever).
Nevertheless, it appears that university-industry relations with regard to strategy, human resources, leadership, safety, and other sensitive topics are less common and harder to achieve in offshore energy than in other industries. (This might be different for projects that are exclusively focused on technology). These difficulties are reflected in interview partners being very guarded and concerned about privacy, career impacts, legal protection, etc. and obviously unfamiliar with how universities protect participants, use data, and fund and benefit from research. If other research teams experience the same challenges, GRP might be able to address them through its programming. In addition to "match-making", there need to be efforts to increase absorptive capacity and trust. This may include informing industry participants about the nature and objectives of university research and how to best engage. Additionally, GRP may want to propose templates (e.g. for informed consent statements) and best practices that are jointly developed and vetted by universities and industry and therefore acceptable to both. Moreover, programs that are designed to provide frequent touchpoints between both parties may be beneficial. This could be funding for industry, contingent upon engagement and co-leadership in the research. Also, programs that incentivize universities and industry partners to send interested graduate students (on GRP research projects) to industry sites for multi-month internships would likely make an impact. Interns would split their time between project-related work (e.g., on site data collection and interviews) and more general tasks, that help them understand the industry context, while giving industry access to smart, emerging researchers. Many research funding schemes in the European Union are designed to directly benefit industry and to serve as a means for workforce development. There may be adaptable models that better align with GRP impact goals than, for example, common NSF of NIH practice.

7. Communication and Dissemination

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

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Note to Grantees: In Section 7, we ask you to help us communicate the importance, progress, and accomplishments of your work. Information provided in this section will be used by the Gulf Research Program to highlight its funded projects in print and electronic informational and promotional materials. The intended audience for the information provided in this section is different and should be thought of as a general audience. When you return to the dashboard, you may upload images that represent and illustrate the work of your project.

7.1. Please describe the most exciting or surprising thing you have learned while working on this project in a way that is understandable by a general audience. *

Many companies in offshore energy want to foster a "culture of safety" but their employees regularly struggle with putting this fuzzy-sounding idea into action. This is particularly problematic for managers and supervisors on the front lines, who strongly influence how employees think and act with regard to safety. These leaders are usually at the receiving end of safety initiatives - tasked with implementing and enforcing approaches but with little information about how this work contributes to the big goal of safety culture. The FOCOS training for high-reliability safety culture provides a solution: It is specifically designed for front-line leaders in the offshore energy industry, accessible online, and self-paced. Industry examples and a novel, interactive simulation platform let users experience how everyday actions impact safety culture.

7.2. Do you have any stories that capture the impact of this project? (optional)

If so, please share one or two. Examples of what we are interested in include stories of people/communities that the project has helped; lives that have changed; work that led to policy change, such as legislation or regulation; and research breakthroughs.

(No response)

7.3. Have any communications, outreach, or dissemination activities occurred in relation to your project?*

Please describe:

- Any press releases issued (other than that issued by the National Academies of Sciences, Engineering, and Medicine) about the project.
- Any media coverage or news stories about the project.
- Any social media accounts, websites, listservs, or other communication vehicles used to communicate information about this project. Please include relevant web addresses if available.

Project website: https://sites.google.com/pdx.edu/focos-project/home
Media coverage Forbes: forbes.com/sites/uhenergy/2022/01/14/listening-to-the-well-listening-to-the-workers-a-new-approach-to-safety-communications-offshore/?sh=562d18472694