

TITLE: “*Bridging research to response*” – how the spill response community benefits from academic engagement.

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ABSTRACT:

Often technical advances are made through key industry-academic alliances in a diverse range of engineering, medical and scientific disciplines. Oil spill response studies are no stranger to research programmes within the academic / R&D community and have advanced our knowledge, understanding and capability significantly over the last 50 years. For example, following the use of industrial detergents during Torrey Canyon in 1967, the research, development and scientific rigour behind the latest marine dispersants is testament to the value in investment of resources to develop and deliver solutions to new and emerging risks.

Typically, spill responders are focussed on operational issues and seeking maximum reward when selecting a response technique(s) as part of a given spill scenario. Research scientists conversely may be focussed on a more detailed aspect of the spill such as a sub-cellular, non-lethal biological effect which may have limited relevance to the immediate

clean-up effort. Having a spill response organisation intrinsically involved with academic response research ensures that an element of “*operational realism*” is injected into the programmes to produce outputs with more direct relevance and application to advance the boundaries of future spill response techniques and capability.

The paper discusses the merits and leverage potential of “*Bridging Research to Response*” and offers suggestions for future collaborations potentially adding value to all spill stakeholders.

INTRODUCTION

Industry has a track record of supporting projects that advance spill response science and technology and is currently engaged in forging closer links with relevant institutes / research groups whose expertise may enhance future spill response knowledge via closer co-operation, input regarding research areas and the sharing of expertise and experience.

The global oil and gas industry have a long-established history of working with academia on many aspects of exploration, production and logistics and similarly, the science of spill response has experienced a long association with a variety of research institutes, academic partners and industry researchers. A number of these partnerships have resulted in new and innovative approaches and potential improvements that have added significant value to spill response understanding and capabilities. Examples include, Type 3 marine oil spill dispersants, *in-situ* burning capability, surveillance techniques and a wealth of environmental impact knowledge.

Following all major oil spill incidents there has been a spiked increase in the volume of applied research undertaken (reviewed by Murphy *et al.*, 2016) as funding is pumped into

institutes to investigate specific impacts, improve response techniques and further knowledge on new / emerging risks, e.g., low sulphur fuel oils. The Macondo incident in 2010 resulted in BP establishing the Gulf of Mexico Research Initiative (GoMRI), a \$500M funded program that supported academic research focused on the five US states along the Gulf of Mexico coastline. As part of the GoMRI, an excellent website was established and maintained to provide public access to further information, research results and data on the initiative: <https://gulfresearchinitiative.org/>. The reader is encouraged to review the *Synthesis and Legacy* outputs which recognise the importance of investing in collaborative science. A key benefit of this will be a greater mutual understanding and stronger ties between the academic research parties and the oil industry scientific community (Wilson, 2019).

Oil Spill Response, Ltd. (OSRL) and some of its key member companies have been working on a global outreach programme into academia over the last 5-6 years to help explain how the existing response "toolbox," i.e., mechanical containment and recovery, in situ burn, dispersant use, shoreline clean-up, and monitor and evaluate, feeds into recognized Net Environmental Benefit Analysis and Spill Impact Mitigation Assessment (NEBA/SIMA) justifications and to highlight how lab-based research and experimentation, if done appropriately, can support a response strategy (IPIECA-IOGP, 2015). This is consistent with the concept and intention of "*Bridging Research to Response*." by focussing on science-based discussions with real world applicability to spill response, post spill monitoring and restoration. Our outreach is also aimed at identifying additional areas with potential to leverage and influence future research programs.

APPROACH

Bridging Research to Response has been primarily carried out by building on existing linkages and developing new relationships with targeted research groups who work in areas of mutual interest. Many oil industry groups have scientifically trained staff (many to PhD level) who are being utilised in this bridging activity to leverage their credibility and existing technical networks to represent the knowledge and needs of the spill response community to academic researchers who are relatively new to the area in order to outline industry focus points. Technical discussion areas identified were focussed around the following areas:

- Marine Oil Dispersants – action, chemistry, toxicity impacts, and environmentally relevant exposures for lab research
- Environmental impacts / ecotoxicology of oil and oil-dispersant exposure and associated phenomena, e.g., Marine Oil Snow
- Use of autonomous systems & sensor development
- Surveillance, modelling and visualisation including “big data management”

In addition to research discussions several other activities have been undertaken to bolster and engage the academic community including undergraduate, graduate and post-doctoral seminars, workshops, research topic brainstorming and fieldwork. Disseminating the outcomes of these activities and building new associations has been a key focus area and is being undertaken via conference papers / posters, social media channels and websites, and ongoing regular communications.

RESULTS & DISCUSSION

Most academic engagement has taken place in either the UK and North America by a range of oil industry / response contractor scientific staff. Effort has specifically focussed on key research groups / individuals whose research outputs have generated much interest and discussion in the oil spill response community. Examples of topics include the role of photo-oxidation / dispersant interactions, the Marine Oil Snow hypothesis, laboratory-based protocols for toxicity testing, and a basic understanding of the realities associated with oil spill response. Several successful collaboration examples follow:

Case Study #1 – Application of Marine Autonomous Systems (MAS) in spill response (UK)

During 2017, a six-month industry/academia collaborative project between Oil Spill Response Limited (OSRL) and the UK National Oceanography Centre (NOC) was funded by the Natural Environment Research Council (NERC, www.nerc.ac.uk) under its Innovation Partnership scheme. MAS are used extensively in the marine/oceanographic research field and the scope was to explore how MAS can be used to improve data collection and increase situational awareness in detecting and characterizing plumes in oil spills. The project drew on a scientific literature review, the experiences of the NOC Marine Robotics Innovation Centre, OSRL's operational expertise and advice from manufacturers and service providers to review the capabilities of different MAS and sensors. The project culminated in observation of OSRL's "*Oil on Water Exercise 2017*" in which two marine autonomous systems were deployed. Overall, the short project clearly demonstrated the leveraging value of industry-academia engagement and attracted the attention of UK Government funding (NERC) to enable the technology.

Case Study #2 – Rapid Assessment Toolkit for Oil Spills-University of Exeter, UK.

Ecotoxicology as a science has increased significantly over the last 50 years and has direct application to oil spill impact assessment and post-spill monitoring. The University of Exeter is no exception and its marine ecotoxicology group was identified as a potential collaborative partner for spill response. A consortium was put together of oil industry researchers at Shell, BP, ExxonMobil & Chevron alongside CONCAWE (www.concawe.eu), CEFAS (www.cefas.co.uk) and Exeter University and a robust PhD proposal put together. The research aims to explore how the toxicity of oil to marine organisms could potentially be predicted from laboratory-based toxicity tests (using commercial test kits) against the measured concentration of dissolved oil hydrocarbons in the water column. The aim is the practical application of such test kits being applied during spill responses to inform NEBA/SIMA based decisions and assist in predicting impact on marine ecosystems. This PhD program bridges a gap between industry, government and academia and is a textbook example of how combining expertise can strengthen a research project's aim and objectives. Over the four-year period (2017-2021), the results have, and will be disseminated across various conferences, e.g. Interspill 2018 (Colvin *et al.*, 2018) and scientific publication (Colvin *et al.*, 2020).

Case Study #3 –NERC funded research and science delivery support

The Natural Environment Research Council (NERC, www.nerc.ac.uk) is a funder of UK government environmental science research with £330M per annum invested. NERC supports research in over 50 universities and 20 research institutes for around 3000 scientists and 1500 PhD students. Over the last 4 years, OSRL has built up a strong collaboration with both NERC funded researchers and supporting at a higher level through NERC's management support in a variety of activities:

- Delivering lectures to first year PhD students at NERC training events providing clear messaging on NEBA-based response strategy development,
- Industry mentors to four NERC funded PhD students ensuring the real-life challenges of spill preparedness and response are included in research activity,
- Representation on the ARIES Doctoral Training Programme Strategy Board providing industry perspective to new generation environmental scientists,
- Representation on the NERC Innovation Programme in Oil & Gas (IPOG) providing advice and ideas for future funding calls,
- Representation on a new NERC Advisory Network – strategic advice role from industry perspective direct into NERC Science and Management Boards – a significant achievement.

NERC have welcomed industry engagement into their remit as it assists in their objective to leverage and maximise their science outputs to a wider audience.

Case Study #3 –Gulf of Mexico Research Initiative (GoMRI)

On May 24, 2010, shortly after the Macondo Well release, BP announced a commitment of up to \$500 million over 10 years to fund an independent research program designed to study the Gulf of Mexico and the impact of the oil spill and its associated response on the environment and public health in the Gulf of Mexico.

Following initial funding of five studies to establish critical baseline data as the foundation for subsequent research, the Gulf of Mexico Research Initiative (GoMRI) announced additional funding of eight research consortia on August 30, 2011 over three years to study the effects of the oil spill on the Gulf of Mexico.

The Consortium for the Molecular Engineering of Dispersant Systems (CMEDS) was one of the eight groups funded in 2011. The consortium involved eight institutions from the

five Gulf of Mexico states with 22 participants, and 14 institutions from the other states with 20 participants. The Consortium had an Advisory Board with a variety of representatives from industry (including the board Chair) and the federal laboratories. In keeping with GoMRI's expectations, the CMEDS principal investigators were comprised of a mix of established researchers and promising junior faculty members. Most investigators supervise graduate students working toward a doctoral degree. The structure of the CMEDS group allowed for effective interaction between industry and academia and provided a conduit for the sharing of oil spill response-related information across several institutions. As with all the GoMRI efforts, interaction with graduate students, i.e, the future research community, was extremely important and has resulted in the development of a number of ongoing scientific relationships. (Coolbaugh *et al.*, 2014).

Case Study #4 Nova Southeastern University Oceanographic Center (NSUOC)

In 2014, Nova Southeastern University Oceanographic Center researchers began a highly collaborated study to determine coral toxicity to crude oil components and ultimately dispersant and dispersed oil. This study was initially sponsored and funded by Clean Caribbean & Americas (CCA, 2014-2016) and later funded under GOMRI auspices (2017-2019). An Oversight Committee and a Collaborator Group from industry (ExxonMobil, Shell), government (NOAA), and academia (Texas A&M) jointly refined the research design and toxicological protocols. This highly engaged cross-section of expertise assured wide-acceptance of peer-reviewed results. The study was designed to import coral toxicity threshold outputs into NOAA's Chemical Aquatic Fate and Effects (CAFE) database and have supported NEBA assessments in Area Contingency Plans in Hawaii (Renegar *et al.*, 2017a).

Case Study #5–TROPICS

TROPICS field study (1984-2016) was originally an API-sponsored research project that examined the relative effects of crude oil versus dispersed crude oil on tropical marine ecosystems consisting of mangrove, seagrass, and coral, and their associate flora and fauna. The 32-year visit in 2016 by a team of academia (NSUOC, Texas A&M, CEDRE), and government/responders (NOAA, OSRL), examined both the “moment-in-time” and a 32-year progression of damage and recovery of the crude oil site and the dispersed crude oil site (Renegar *et al.*, 2017b). Both the NSUOC coral toxicity study and the TROPICS field study were heavily referenced in the National Academy of Sciences “*The Use of Dispersants in Marine Oil Spill Response*” (NAS, 2019).

Case Study #6 – ITAC: convening academia and industry

The Industry Technical Advisory Committee (ITAC) is a technical forum which was established in 1996 to address oil spill response technology and issues of interest to its member organisations and the wider response community. ITAC’s participants comprise oil industry, international organisations (ITOPF, IMO, IOPC etc), Governmental organisations (USCG, NOAA, etc.) and R&D institutes (SINTEF, CEDRE, GoMRI etc.). It also includes academic institutes involved in industry-backed studies, and other organisations with a non-commercial interest in improving oil spill response.

The connection with academia is an important feature of the ITAC model, recognising that industry is a significant financial supporter of university-based research. However, there has been an occasional disconnect regarding the sharing of knowledge and outputs from these

studies with “industry,” which ITAC tries to address. Every year, industry organises the ITAC conference, rotating through Europe and North America with several key objectives:

- Providing a forum for presenting and exchanging scientific and technical information on spill preparedness and response,
- Assembling a diverse group of spill response and research professionals,
- Articulating industry positions on key international issues,
- Identifying and addressing high consequence issues that impinge on effective oil spill preparedness and response,
- Developing dialogue and links between the research/academic and the response communities to enhance mutual understanding, improve science-based decision-making, scientific support to ongoing responses, and to promote relevant oil spill research,
- Engaging and encouraging new adherents and next generation interest in oil spill preparedness, response, technology and management,
- Highlighting advances and emerging technologies in oil spill preparedness and response.

The 2019 ITAC meeting, held at the UK National Oceanography Centre had one of the largest attendances in recent years and included presentations from the National Academies of Science, Engineering and Medicine (USA), the Multi-Partner Research Initiative (Canada), and PhD research students from several UK research groups.

CONCLUSIONS & FUTURE OUTLOOK

Industry has always had valued interactions with the academic community and in recent years the directed and purposed engagement with those stakeholders has proved time and time again that it should be maintained and pursued. Through this effort the preconceived ideas of many students and researchers over many response techniques / impacts have been worked through and assumptions recalculated through a NEBA-based decision framework. In addition, many potential joint research proposals have been formulated and moved to solid proposal stage attracting funding from established research bodies (e.g. NERC, CONCAWE) thus solidifying strong collaborative links between the two communities.

Industry have teamed up with the University of Essex's marine microbiological research group on a PhD research studentship proposal to further investigate the Marine Oil Snow topic. Much discussion has taken place in both the academic and response communities (reviewed by Brakstad *et al.*, 2019) such that it warrants further investigation. As of December 2019, there is a PhD call for interest and we hope the research will commence in late 2020: <https://www.aries-dtp.ac.uk/studentships/mckew/>

In the field of marine autonomy and robotics, the UK National Oceanography Centre in Southampton, UK has established a Marine Robotics Innovation Centre (MARSIC; <https://noc-innovations.co.uk/marine-robotics-innovation-centre>) where a collaborative community of technology developers and end-users from across industry and academia work together on joint industry and scientific challenges. At present, three large oil and gas majors are members of the MARSIC and OSRL will be joining the fold in early 2020 as they pursue projects around the future of autonomous system applications into the world of spill response. Subject to regulatory approval, a real oil release experiment will take place in summer 2021 to test / validate a range of marine autonomous systems (surveillance, tracking, dispersant

effectiveness, environmental monitoring etc.). Only by carrying out such trials, can advances be made from traditional techniques to more efficient and cost-effective methodologies.

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