PRINCE WILLIAM SOUND
OIL SPILL RECOVERY INSTITUTE

August 11-12, 2015

Oil Spill Technology Adoption Workshop

WORKSHOP SUMMARY

Prepared by Nuka Research and Planning Group, LLC

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Cover photo: Ohmsett testing facility, Leonardo, NJ. Photo by Nuka Research.

1. Introduction

The mission of the Prince William Sound Oil Spill Recovery Institute (OSRI) is to support research, education, and demonstration projects designed to respond to and understand the effects of oil spills in the Arctic and sub-Arctic marine environments. One of the ways they pursue this mission is to identify and evaluate new oil spill prevention and response technologies. It can be challenging to identify the early-stage research and development efforts that have the best chance of successfully transitioning into mature, marketable products that are being deployed to enhance oil spill response.

OSRI convened the Oil Spill Technology Adoption Workshop in Anchorage, Alaska on August 11-12, 2015 to elicit different perspectives on challenges associated with the advancement of oil spill response technologies from research and development (R&D) through commercialization. A Steering Committee[1] provided input on the workshop timing and location, participants, and agenda. Nuka Research and Planning Group, LLC facilitated the Steering Committee and workshop and managed workshop logistics under contract to OSRI.

Workshop participants were invited from both Alaska and the Lower 48. The final list of 27 participants is included in Appendix A. The agenda, which emphasized discussion with some limited case studies, is included as Appendix B. (The agenda was modified during the session to allow for more time for discussion on Day 1 and keep the group together instead of using breakout sessions on Day 2.)

This document provides a high level summary of the key issues and findings that arose through a day and a half of discussion. This final version incorporates comments received from participants during a three-week review period in September 2015.

TECHNOLOGY ADOPTION WORKSHOP GOAL

Gain an understanding of the **key decision points** and **decision-makers** that determine whether a new oil spill response technology reaches commercialization, the **common obstacles** to achieving this, and some **ways of overcoming** those obstacles.

[1] The Steering Committee included Rick Bernhardt, Alaska Department of Environmental Conservation; Kurt Hansen, U.S. Coast Guard; Lee Majors, Alaska Clean Seas; Lori Medley, Bureau of Safety and Environmental Enforcement; and Scott Pegau, OSRI.

2. Overview

Technological advancements that improve the ability to respond to an oil spill typically involve either the modification of existing equipment or procedures or the development of a whole new technology from conception through adoption. The latter process requires that the technology function as intended, and that it meets a market demand from the companies and organizations that purchase spill response resources. Developing a technology requires significant resources, not just including time and materials of researchers or innovators, but to test and document the technology to a sufficient level that it is considered proven and commercially viable. Typically more financial resources are available to support early-stage research and development (R&D) than to carry a product through the testing, demonstration, and integration with an overall response system that is needed to reach the stage where the technology is adquately proven that companies and organizations are willing to purchase it. When technologies that otherwise function as intended do not advance all the way through this process, they are said to have fallen in the well-recognized "valley of death" between research and development (R&D) and commercialization of an oil spill response product. This workshop focused on the challenges associated with advancing an oil spill technology through to adoption and identified some key findings and recommendations based on discussion among a diverse group of participants with relevant experience.

Figure 1 shows a simplified framework for the technology development process that was adopted for the purposes of the workshop. The figure conceptualizes the "valley of death"as happening between stages 3-4 of this framework. During the workshop, however, Paul Panetta of Applied Research Associates (ARA) presented draft Technology Readiness Levels (TRLs) currently being developed as part of a project funded by the Bureau of Safety and Environmental Enforcement (BSEE). TRLs are used in other industries to provide a common language to characterize the progress a specific technology has made along the advancement from concept to commercialization. The beginning and end points are essentially the same as in the simplified framework in Figure 1, but there are more and better-defined steps along the way. ARA will be further refining the TRLs for oil spill response at a workshop in October 2015. Meanwhile, the participants in this OSRI workshop expressed support for this initiative and quickly adopted the terminology for the discussions for the remainder of the workshop. Figure 2 shows the *draft* TRLs as they were presented to the group.

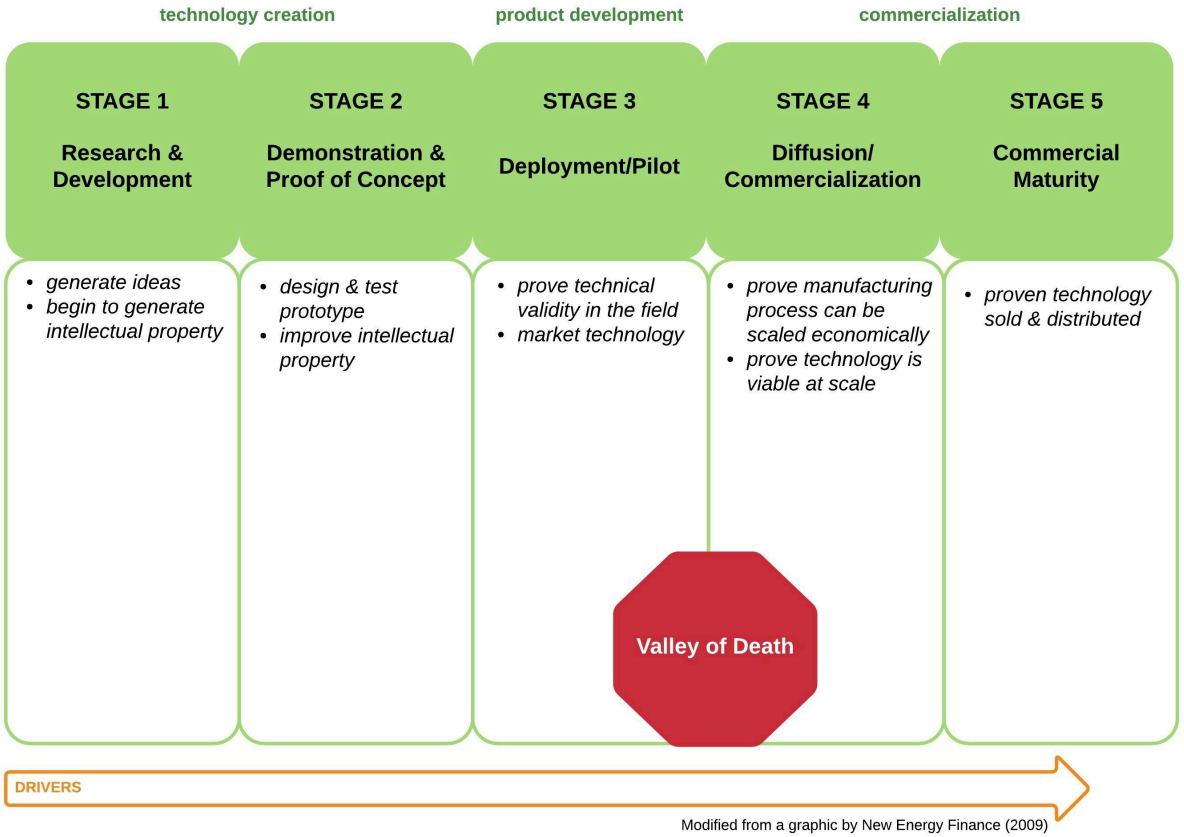

Figure 1. Framework concept for discussion

BSEE Oil Spill Response Technology Readiness Levels v 1.0

TRL	Brief Description	
	Technology Research and Development	
1	**Idea formulation**, basic scientific principles observed or reported	Basic Science: Does the physics/chemistry work?
2	**Technology concept formulated**	
3	Technology **proof of concept** demonstrated	
	Technology Advancement and Demonstration	
4	Technology **prototype/concept demonstrated in lab environment**	Targeted **R&d**
5	Technology **prototype/concept** design performance **tested in relevant environment**	
6	Technology/ **full scale prototype demonstrated in relevant environment**	Targeted **r&D Tech Transfer**
7	**Technology integration tested**	
	Technology Deployment	
8	**Final integrated system** tested in **real or relevant environment**	Deployment/ Commercialization
9	**Final** integrated system **deployed** in **real spill environment** or ready for deployment	

DRAFT

Figure 2. DRAFT Technology Readiness Levels (TRL) under development by ARA for BSEE

3. Case Studies

CASE STUDIES

- Current Buster – Mark Ploen, Qualitech
- Kuyaq – Kevin Kennedy, Pacific Petroleum Recovery
- Tactical Response Airborne Classification Oil Mapping System – Dr. Jan Svejkovsky, Ocean Imaging Corp.
- Sternmax Skimmer – Vince Mitchell, Lamor

Four case studies were presented to share examples of different types of technologies at different stages of development. These technologies have each followed somewhat different paths in terms of the drivers, key players, and funding sources. Similarities and differences among these four examples informed the group's discussion of findings and recommendations.

Themes shared among two or more of the case studies:

- Satisfying regulatory requirements matters, particularly in the U.S. This is less important in Scandianvia and Russia (from the examples shared), but was identified as the primary driver in this country.

- Individual passion and vision may help to advance a product during times when funding or interest wanes. At the same time, all of the examples required a combination of public/private funds and effort to get them to the point they are today.

- Strong relationships matter may provide a valuable early bridge between those conducting research and development (R&D) and those who will use the product in the field.

- Government funding – either as contracts or loans – played a role in all four examples. This included funding from the U.S. (BSEE and USCG) and Finland (SYKE). Collaboration with agencies can also bring access to assets, exposure to other agencies or companies, and knowledge sharing. The technology must meet a need identified by the agency and fit into existing agency priorities and budget, especially since most do not have discretionary funds. (For example, when approached with the Current Buster concept, the U.S. Coast Guard was already interested in fast-current technologies.)

- Building on past experience is valuable. Some technological advancements for oil spill response are really modifications, either for a new operating environment or from other fields.

- Being able to demonstrate a product to potential customers in a realistic operating environment is critical.

- Creativity plays a critical role in success, both during the innovation process and when constructing financial arrangements.

Acknowledgement of the role that government grants can play in technology development led to a discussion of the challenges related to "ownership" or intellectual property when a government funding source is involved. Individuals or companies should be aware of the potential implications for securing patents or other proprietary rights when public funds are used to develop a product.

4. Findings

4.1 Factors considered when companies/organizations acquire new equipment/technologies

Oil companies and oil spill removal organizations (OSROs) purchase the vast majority of oil spill response equipment in the U.S., so their needs and priorities will typically determine whether a technology reaches maturity. For some OSROS, their member companies dictate equipment acquisition decisions, either directly or through the budget process. In the case of for-profit OSROs, equipment may also be acquired if it enhances their competitiveness.

The group identified the primary drivers for the acquisition of new spill response-related technologies, whether by oil companies directly or by OSROs. *The primary drivers are: 1) complying with regulations* and *2) maximizing efficiency.* Overall, for both oil companies and OSROS, new equipment must meet a tangible and measurable need in order to warrant significant capital investment. The following related drivers were also noted:

- *Significantly* enhancing operational efficiency (i.e., by increasing oil recovery rates or efficiency, reducing storage requirements, or reducing transport requirements)
- Enhancing safety, i.e., by reducing exposures to risky operating environments
- Meeting need in a new operating environment, i.e., the Arctic[2]
- Inability to maintain older equipment (i.e., replacement parts no longer available)
- Satisfying public demand/meeting public perception related to benefits of technology to risk mitigation

It was noted that oil companies and OSROS exist for purposes other than to develop oil spill response technologies. Where venture capitalists or other investors may find returns on their investments in innovative technologies, there is significant risk involved as well. Companies that exist to produce oil or respond to oil spills require technologies that are already proven to meet tangible and measurable needs.

4.2 Regulatory environment can both promote and hinder technological advancements

It was generally assumed that most oil spill response equipment acquired by oil companies and OSROS is obtained to meet state and/or federal regulatory requirements. On one hand, achieving regulatory compliance is one of the primary drivers for equipment acquisition (at least in the U.S.). On the other hand, if the regulations are static, once a company complies with regulations there is little incentive to change their inventory (unless a new technology allows them to achieve compliance for significantly less cost) unless the regulations change. They also lack an incentive to acquire new technologies without being sure in advance that

[2] Another example was shared in which ACS and QualiTech worked with ConocoPhillips to develop a containment system to place under an elevated pipeline leak on a lake.

they will satisfy regulatory requirements. As an example, one participant posed the question of whether a remote sensor attached to a balloon tethered to a boat would satisfy a regulatory requirement to have resources for aerial surveillance.

Uncertainty in the regulatory environment compounds this challenge. If new capital expenditures may be required in the future - for example, if a new approach to measuring response capacity for regulatory compliance purposes is adopted - there is a natural concern with investing in new equipment or technologies until new requirements become clear. In an effort to cue industry to potential future regulatory changes, the Washington Department of Ecology's new Best Achievable Protection program publicizes general areas where the Department is interested in learning about emerging technologies and solutions.

In the case study provided by Lamor, the customers were non-U.S. companies looking for skimming technology to be used outside the U.S., where there is greater flexibility to comply with oil spill response standards. This example highlighted the relatively greater flexibility in some other countries when it comes to the adoption of new technologies.

4.3 Market size

Participants emphasized the small size of the market for oil spill response technology, particularly within the U.S. alone, as compared to other commercial products. With a small market, there are minimal potential returns on R&D investment – particularly if limited to the domestic market alone. The size of the market is impacted by the fluctuating but inconsistent demand for products or technologies (inherent to the oil spill business), which can mean that equipment goes unused for long periods of time; the fact that some technologies are designed for certain operating environments, or may require modifications to be used in other conditions; and a static regulatory environment.

4.4 Communication gaps

If there is not an existing relationship between those conducting early-stage work on product development and those who will ultimately make the decision about purchasing and deploying it, the technology may have less chance of successfully reaching commercialization. The importance of relationships – particularly strong relationships between technology developers and users – was emphasized, along with some practical steps that could be taken to help overcome gaps in communication (see Recommendations, Section 5).

In some cases, the future adopter or customer for a technology is involved in research and development or another part of the development process. For example, the Joint Industry Program (JIP) for Arctic Oil Spill Technology is a consortium of oil companies working to develop response tools for Arctic areas. Lamor's skimmer development was initiated in response to a request from Arctia Shipping. Technological development that happens within an established partnership between developers and end-users likely has an advantage since the development process is directly informed by the future end-users.

4.5 Primary gap exists between a laboratory-tested system and a fully integrated system

The group agreed that the valley of death generally exists between the end of R&D funding after laboratory tests have been conducted and having a fully integrated system that is tested in a realistic environment. Using the TRL framework, the financial challenges for new technologies are greatest somewhere between TRL 4 – 7. This is in addition to the fluctuating nature of funding in general due to having limited funds for spill response technology advancement in general, grant cycles, waning interest unless there is a major spill, and/or changes in oil prices.

4.6 Timing

Challenges related timing came up in two respects: (1) it can be difficult to synchronize R&D efforts with grant funding cycles and access to Ohmsett, the primary testing facility in the U.S. located in New Jersey, and (2) when companies invest in R&D, they may want to see a return on those investments more quickly than can be delivered.

Timing also relates to the regulatory context discussed previously. Most oil spill products and technologies will take time to get to market, and without a comprehensive understanding of the regulatory context this process may be out of sync with emerging regulatory drivers.

4.7 Financing options

In the U.S., the federal government and some non-profit organizations such as OSRI and XPrize provide grants to support the early stages of technology development. In some other countries, such as Norway and Finland, government agencies or corporate spill response entities may provide additional kinds of support such as loans or other financial incentives which can supplement grants or help to finance later stages of the development process.

Companies marketing spill response technologies can also consider creative "sales" options, such as leasing equipment or otherwise retaining ownership but contracting out the use of the equipment or associated service.

5. Recommendations

This section describes the recommendations developed during the workshop based on the key findings. Specific actors were identified in some, but not all cases.

1. ***Develop and adopt TRL framework for oil spill response technologies.***

   The use of TRLs is common practice in other fields, and the almost immediate adoption of the terminology by this group indicated a need for a shared language when discussing stages of technological development. Further refinement and adoption of TRLs is underway through a project implemented by ARA and funded by the BSEE.

   Once complete, it will be important to communicate the framework – and how to use it – as widely as possible within the oil spill response industry to maximize the benefits in communication and coordination that it is anticipated to provide.

2. ***Facilitate an exchange of information between R&D (TRL 1-3) and equipment end users.***

   There was general support for facilitating an exchange of very practical information between those developing technologies and those who represent the marketplace for oil spill response technologies.

   2a. Convene developers and OSROs to exchange information on technological developments and needs in the field. This may also provide an opportunity to consider how minor adjustments could be applied to adapt technologies for different operating environments. This kind of exchange could be coordinated with an existing conference or other event; ideas include a side event at Clean Pacific/Clean Gulf/International Oil Spill Conference, or designating a section of the trade floor for experimental or emerging technologies.

   2b. Funding agencies could require or request applicants for R&D funding to provide an expression of interest from an oil company or OSRO. The intent is to anticipate potential future interest in the technology and/or to ensure that developers/researchers are considering needs in the field. The intent is *not* to require companies to commit to purchasing equipment that is still in the very early stages of development. (It was also acknowledged that there may be cases where improvements or needs are recognized by entities *other than* the final product end-users, such as government agencies, or where technologies must be demonstrated before their benefits are fully appreciated by all parties.)

3. ***Support innovators/developers to give them the best chance of success (and the best chance of achieving funding agency goals).***

People with good ideas for technology innovation or experience with R&D may be unfamiliar with oil spill response generally or may lack business experience. The group discussed some suggestions to try to help developers/researchers to understand the field, assess the needs of spill response equipment users/purchasers, pitch their product or idea, and have the most informed perspective possible on the potential future market for their product. The following suggestions were offered for this issue:

3a. Provide "Oil Spill Response 101"-level information regarding the players, regulatory environment, response issues, R&D funders, etc. This could be a video or training, or simply information and links on a website. The intent is to bring people who are not immersed in the oil spill response industry up to speed quickly and efficiently. Funding entities could encourage or require that proposed grantees have considered this information.

3b. Provide guidance to support the development of strong funding proposals. Funding entities shared that it is not uncommon that they receive poorly written proposals, and the need was recognized that this type of support – along with mentorship in general – would be beneficial for some developers. While funding agencies cannot write proposals, or fund someone else to write proposals, they can provide general guidance on the type of information they require and what makes a strong proposal.

3c. Provide access to Ohmsett for emerging technologies. Ohmsett is a valuable resource as a testing facility, but it can be expensive to use and access may also be limited by scheduling as well. One participant suggested that making this facility more accessible would help. While the intent is to reduce the barrier to testing emerging equipment, considerations were raised related to nondisclosure, efficiency (lining up tests to make transitions between them as short as possible), and determing who gets access.

4. ***Develop model regulation/policy to support technolgoical innovation.***

The Best Achievable Protection (BAP) regulations in Washington and Best Available Technology (BAT) regulations in Alaska provide two examples of state-level regulations that seek to ensure that technological advancements are adopted for the benefit of protectin their state waters. (Related policies also exist in Oregon, California, and some other states). Developing a common approach among states, to the extent possible, may help to provide greater predictability for industry and increase market demand for emerging technologies by requiring them – or something with the same level of performance – in multiple states. The BC/Pacific States Task Force could be an effective

forum for this for the west coast. The suggestion was made to develop a model policy that would serve this purpose. Washington's policy could serve as a starting point for that model; it was adopted fairly recently and built on a review of other state approaches.

Regulators need information about technolgoical advances as well; one element of Washington's policy, a BAP conference, seeks to provide this in a public forum. There are challenges with this as well however; at the federal level, Federal Advisory Committee Act (FACA) requirements can stifle the free flow of information among regulators and private interests.

5. ***Coordinate the use of spills of opportunity or set aside areas for emerging technologies***

Testing technologies with real oil and in realistic conditions is important for demonstrating their efficacy; however, the use of oil for R&D purposes is challenging in the U.S. and most relatively early testing takes place at Ohmsett. There is an effort underway to coordinate access to spills of opportunity. Workshop participants recognize the benefit and encourage this effort. (This also provides an example of a context in which widely adopted TRLs will be useful in determining what technologies are "ready" to be deployed during spills of opportunity.)[3]

[3] BSEE project #1032 explored the potential for the use of oil simulants and surrogates to advance spill response planning and technology development. Having an approved oil simulant would facilitate the testing of oil spill response technologies in real-world conditions without releasing petroleum oil to marine waters.

6. Conclusion

The "valley of death" between product development and commercialization emerged as the key challenge to bringing new oil spill response technologies to market. In the U.S., grant funding available from sources such as the U.S. government agencies and OSRI to support early stage development, but this typically drops off once "proof of concept" or prototype development is achieved, but before a product is commercially mature. Sometimes there are disconnects between what funders believe is needed and the demand in the limited market place. The small U.S. market is a disincentive to investment for many, but it is unlikely to increase without changing regulations to require more or higher performing equipment (in the U.S), or developing a product that is marketable internationally. Historically, demand for new technologies increases following major oil spills, but is not sustained.

While hard science and "hard dollars" are behind much of the effort that goes into technological developments, workshop participants also highlighted the importance of communications and relationships when it comes to advancing technologies in the oil spill response field.

Appendix A – Final Participant List

First Name	Last Name	Affiliation
Government		
Kion	Evans	Alaska Department of Environmental Conservation
Kristin	Ryan	Alaska Department of Environmental Conservation
Lori	Medley	Bureau of Safety and Environmental Enforcement
Steve	Pearson	Bureau of Safety and Environmental Enforcement
Catherine	Berg	National Oceanic and Atmospheric Administration
Kurt	Hansen	U.S. Coast Guard
Todd	Bagetis	U.S. Coast Guard Sector Anchorage
Chief Eric	Vogel	U.S. Coast Guard Sector Anchorage
Sonja	Larson	WA Department of Ecology
Organizations		
Sue	Saupe	Cook Inlet Regional Citizens' Advisory Council
Scott	Pegau	Oil Spill Recovery Institute
Roy	Robertson	Prince William Sound Regional Citizens Advisory Council
Matt	Huelsenbeck	XPrize
Oil Companies and Oil Spill Recovery Organizations		
Mark	DeVries	BP
Tony	Parkin	BP
Jeanie	Shifflett	ConocoPhillips
Barkley	Lloyd	Alaska Clean Seas
Lee	Majors	Alaska Clean Seas
Matt	Melton	Alaska Chadux
Brian	House	Moran Environmental Recovery
Technology Developers and Manufacturers		
Gregory	Johnson	Alion Science and Technology
Paul	Panetta	Applied Research Associates
Chris	Wiggins	Inland Gulf Maritime
Vince	Mitchell	Lamor
Jan	Svejkovsky	Ocean Imaging
Kevin	Kennedy	Pacific Petroleum Recovery
Mark	Ploen	QualiTech

Appendix B – Agenda

The agenda was modified during the workshop based on the flow of conversation and timing.

Day 1

8:30 am **Coffee and registration**

9:00 am **Welcome and introductions**

Welcome and purpose of the workshop – Scott Pegau, OSRI
Review key concepts and approach – Tim Robertson/Sierra Fletcher, Nuka Research
Participant introductions: How do you fit in?

9:45 am **Case study:** Current Buster – Mark Ploen, QualiTech

10:05 am **Case study:** Kuyaq – Kevin Kennedy, Pacific Petroleum Recovery

10:30 am **BREAK**

10:45 am **Focus group: Role of oil companies**

When do you acquire new technologies, and why? What role do you play in the development/adoption of new technologies?

Noon **LUNCH**

12:45 pm **Case study:** Aerial remote sensing system – Dr. Jan Svejkovsky, Ocean Imaging Corp.

1:05 pm **Focus group: Role of government**

What policy drivers exist to promote technological innovation? How do regulations help or hinder the adoption of new technologies?

2:15 pm **BSEE's Technology Readiness Level (TRL) initiative** – Paul Panetta (ARA)

2:45 pm **Focus group: Role of oil spill response organizations**

What role do you play in the development/adoption of new technologies? When do you acquire new technologies, and why?

3:30 pm **BREAK**

3:45 pm **Case study: Sternmax Skimmer** – Vince Mitchell, Lamor

4:05 pm **Focus group: Developers/manufacturers**

What role do you play in the development/adoption of new technologies? What are your greatest challenges and how do you overcome them? Who do you rely on to advance technologies?

5:15 pm **Wrap-up**

Day 2

9:00 am **Recap and agenda review**

9:10 am **Focus group: Role of non-governmental organizations**

What role do you play in the development of new technologies? What are your goals? What do you need from others in order to reach those goals? What are the biggest challenges? What are satisfactory outcomes of your R&D funding?

10:10 am **Breakout sessions (2 groups)**

What are the key decision points? Who are the key decision makers? What are common obstacles at each stage?

11:30 am **Group discussion:** Reconvene to report back

NOON **LUNCH**

12:45 pm **Group discussion:** How can obstacles be overcome? What needs to happen in order to implement suggestions made? Who is involved**?**

2:00 pm **Wrap-up**

2:30 pm **Meeting adjourns**