Lessons Learned
Gulf of Maine Ocean Observing System (GoMOOS)
From Start-Up to Operations

USERS AND THEIR PRODUCTS

1. Concentrate first on primary users of real-time data on sea surface conditions and meteorology.

Sea surface and meteorological conditions are information users intuitively know they need and can talk about. These users are primarily **shippers, fishermen, boaters, and search-and-rescue personnel**. Where and in which form these users want the data will inform the location of buoys and high-frequency (HF) radar and the initial design of the Web site. The site allows you to get data to users quickly – with few value-added pieces required.

2. But don't overlook two other user groups who also can describe what they need and for whom initial positioning of assets needs to be fairly precise.

These two user groups are **research scientists**, who are interested in large-scale systems (e.g., circulation), and **operators of wastewater treatment facilities (and other waste-producing enterprises)**, who need baseline conditions that enable distinctions between wastewater impacts and natural variation in the environment.

When resources are limited, some hard decisions have to be made regarding location of assets to serve mariners and these more specialized users. In the case of wastewater treatment operators, a properly placed buoy can produce quick returns on investment, in terms of savings, by fulfilling permit conditions and monitoring requirements. However, instrumentation and its maintenance are trickier; the managers are interested in biological and nutrient measurements that can require more sophisticated sensors.

3. Large-scale surveys of users will give you a general idea of priorities. But the real information you need to deploy assets and design Web-based products comes through systematic one-on-one meetings and sessions with small industry groups.

Our initial market research with potential users was through personal interviews with a limited number of representatives of user groups. These interviews gave us qualitative information on needs and were quite useful, but it did not give us quantitative information. We therefore followed up with a larger-scale survey with a standard set of questions. The results added little to what we needed to know. They duplicated what was already known from surveys elsewhere. The in-depth discussions with user groups we knew we would serve – shippers, mariners, and others – have proven most valuable. Our advice is to not bother with large-scale surveys. Talk one-on-one with the market.

4. Find the pathways to many users through the Big User—and make sure you are satisfying the Big User's needs.

The best example of what we mean is the National Weather Service (NWS) – a Big User that also is the pathway to many other users, most importantly the TV station meteorologists, newspapers, etc. This class of users thought GoMOOS data were interesting but incidental because they rely on NWS as their primary source. Once GoMOOS data were blessed by NWS and could be channeled through it, voila! The media became important GoMOOS users. Other examples of Big Users might be other governmental agencies, such as the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) and state departments of marine resources, and trade associations or organizations with hot links to the observing system's site, indicating endorsement by the mother organization of the system's data.

The ultimate connection to the Big Users will be achieved when we successfully develop data sharing standards and protocols and integrate our system with theirs.

5. Educators are a huge market for ocean observations – and we haven't yet taken advantage of it.

This includes both formal educational opportunities (K-12, undergraduate, and graduate) and informal opportunities, such as at aquariums and museums. To some extent, these users are self-executing: let them know the data are there and they will find ways to use them. But to truly tap into the potential of this market requires a substantial investment of time to work with the educators, to understand their requirements and objectives, and to think through how the real-time and historic data and data products can best be integrated into the curricula. GoMOOS hasn't yet invested this time, despite clear signals from the marketplace that they are ready for it.

ORGANIZATION AND GOVERNANCE

GoMOOS is a nonprofit corporation. It is structured as an organization of organizations. The member organizations are from the user community, the research and academic community, and the technology design and manufacturing industry. The founding members of GoMOOS established it not as an independent research organization that would compete for the same funds or the same business as its membership, but as a utility that could provide the continuous flow of ocean observation data needed by all (both members and non-members alike). Thus, the mission of GoMOOS is not, for example, to conduct the research necessary to understand the causes and behavior of harmful algal blooms. Rather, it is to provide the data in an economical, reliable way that will enable researchers from member organizations and beyond to discover those causes. Its mission is not, as another example, to create advanced weather forecasts for the shipping industry, but to provide the data so that those in the weather forecasting business can execute their jobs more effectively. GoMOOS has an important research component, but it is aimed at assuring that we have the most appropriate observing technologies at our disposal, deployed in the most appropriate way.

To use an analogy, GoMOOS is less like a research institution, such as Woods Hole Oceanographic Institution, or a research university, but more akin to AT&T with an associated Bell Labs (our science team).

6. There are definite advantages to being organized as a nonprofit membership organization.

- **Credibility** among user groups and those, including legislators providing general operating funds, who want to make sure the system is providing immediate, tangible benefits. The membership provides a pipeline for two-way communications and feedback. It creates constant pressure (which is sometimes uncomfortable because of unsure expectations and can feel like a disadvantage rather than an advantage) to produce useful results that justify membership.

- **Longevity:** An institutional structure – that is, a governing board and a plan of succession – that doesn't depend on any one person or entity and that will survive the departure of any one person or entity. This foundation is essential to a system whose worth lies in its longevity. Of course, longevity also requires funding, which neither this structure nor any other structure guarantees.

- **Public good:** Because the governing board includes representatives of organizations with no self-interest in the funding of the observing system, it is easy to demonstrate the public purpose of the effort.

- **Neutrality:** Our structure allows us to play the role of neutral convener of parties that might (and did) resist collaboration because of competing interests or unnatural alliances. This is now paying off as we expand the system from one of just data acquisition to one of data sharing among multiple entities.

- **Regional associations:** Allows for natural connections to other regional organizations to create a bona fide regional, integrated system.

A disadvantage of this structure is that it requires significant "care and feeding." Unless you have someone devoted to this work – membership recruitment and retention, promotion, response to needs, etc. – the organization will suffer. But with limited resources it is hard to divert someone from other work to do this organizational work.

7. In a funding world that recognizes only short-term research grants and an oceanography world that has had relatively little experience with long-term operations, the nonprofit corporate approach to operations must be fused with the principal investigator (PI) approach to research.

This has been one of the harder lessons learned. GoMOOS, without clearly understanding what it was doing, started in 1999 as a hybrid organization: nonprofit corporation in form (with a board of directors, chief executive officer (CEO), rules governing contracts and conflicts of interest, etc.) but PI/research-based in the application for funds and deployment of the system. Each of these approaches is valid, but it is hard to fuse them unless assumptions and expectations are clearly discussed at the outset. GoMOOS did not have these discussions. This led to a breakdown in communications between GoMOOS's organizational leadership and scientists as we began to plan for the transition from the research/deployment stage of GoMOOS into operations. At that point, the corporate approach had created one set of expectations that included GoMOOS ownership of assets, competitive requests for proposal (RFPs) and conventional contracts for operations, and a decision-making stream that vested final authority in a CEO and board of directors. The PI/research-based approach created a different and conflicting set of expectations that believed the PIs, who had invested their intellectual skills in design and deployment as well as personal time and resources to make the system work, should be key decision-makers in and have a long-term, sole-source relationship with operations if they want it.

Indeed, the lack of a clear understanding of the hybrid we had created probably led to differing expectations of what "operational" meant – whether the primary objective was to so routinize operations that they could be carried out by skilled technicians with oversight by scientists, or whether the primary objective was to keep a long-term pre-operational dimension to the system, where much of the activities and budget were in applied research involving the scientists.

Throughout this period we found communications very difficult. We have worked through that and created a viable structure – indeed, a novel and workable structure – that accommodates operational needs and the equal need for the ongoing work of our science team to keep the system fresh, relevant, and reliable. But planning for the transition from design/deployment to operations would have been much smoother had we been aware of the different assumptions behind the two approaches and aligned them at the beginning.

OPERATIONS

The IOOS identifies three subsystems for ocean observing: 1) data collection, 2) data management and dissemination, and 3) development of data products. GoMOOS has successfully operated a data collection system (moored array, satellites, modeling) for more than two years.

8. Outside science review and audit can help us meet the needs of users cost-effectively and offset concerns about conflicts of interest.

Although it is currently dormant, GoMOOS is reactivating its Science Advisory Committee to provide an outside audit of the GoMOOS program and advice on its future direction. Feedback from experts outside the region will help ensure that we have the best system and help us avoid potential concerns over conflicts of interests.

9. Serving the needs of small estuaries and bays is a challenge.

The GoMOOS moored array is designed to give the most information for the least amount of money. As such, the buoys are in sentinel positions that monitor large scale trends that affect large areas of the coast. However, some coastal managers are interested in very localized areas. GoMOOS has not yet found funding for small, movable buoys that address this need.

10. Data management: you can't have "interoperability" without standards.

There are no adopted standards to facilitate data sharing between the research community and federal agency partners. Therefore, GoMOOS designed a flexible data management system that could accommodate multiple exchange formats. We prepared ourselves to accommodate the many informal standards developed in federal agencies, many of which have not been adopted by the scientific community. This lack of standards makes the goal of "interoperability" very difficult. There are myriad software technologies available to create the middleware layer, but no clear standards to be implemented by the software. Such a situation is not scalable, meaning that the second system is no easier to set up than the first, and each connection between any two systems is equally difficult to create and maintain. Without agreement on data-format standards (a semantic data model), each of the regional systems will spend a comparable amount of effort to create their own unique data management infrastructure. Fortunately, some members of the ocean observing system community (GoMOOS and the Southeastern Universities Research Association Coastal Ocean Observing Program (SURA/SCOOP)) are actively working with agencies to adopt some standards and create a single "virtual organization" from all of the distributed systems.

11. Don't underestimate the time and effort to do critical analyses of the time series.

We now have two years of time series and must be willing to fund our scientists to invest the time to review these data and highlight the important patterns that are emerging.

12. Once in an operational stage, the scientists who designed the system provide a special form of quality assurance and control.

The scientists know the system they designed and should continue to have certain oversight of it; they provide a specialized kind of quality assurance and control. At the same time, the organization needs to be designed to last beyond the interest of any given scientist and ensure that the data flow is not interrupted.

13. GoMOOS will not be defined solely by the data it collects from its own assets.

To be a truly integrated system, GoMOOS will have to serve a data sharing role among the several entities that do ocean observing. This is the best and perhaps the only way biology will be well integrated into regional ocean observing systems. For example, the research vessels of NMFS, and its surveys of fish for stock assessment, are an important long-term platform for ocean observations. These data and others need to be integrated with the physical oceanography that is typically the purview of the regional systems.

14. Few options exist for sustained funding of observing systems.

We are a long-term observing system, collecting data on an ongoing and continuous basis in a world that only has a short-term funding model. We are a utility in a world that only knows the research/PI model. These fundamental mismatches make for a large challenge to survive.

And don't fall into the trap of thinking a regional system can be largely funded, or even significantly funded, by users. We get a small share of the operating budget from members. But the reality is that ocean observations are a "public good." By that we mean not just that the observations are available to the public and serve an important public purpose. Rather, we mean it in the economic sense: ocean observations, like weather forecasts, are available to all, and they are never "used up." That is, a paying user can't consume the service; once the paying user uses it, it is still available in equally good condition for anybody else. This is precisely why specific groups of users will not pay for the system: they will rationally conclude that they should be free-riders just like everyone else. It is why the transportation industry, tourism, and agriculture – the three sectors that most benefit from weather forecasts – don't bear the cost of the National Weather Service.

Where users *will* pay is for value-added products that are owned by the creators and able to be sold exclusively to buyers. But public goods that have public value will have to be underwritten by public dollars.