More Than One Way to Catch a Fish: Effective Translation of Ocean Science for the Public

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Abstract - **The understanding and use of information, especially scientific and technical information, is increasingly important for citizens and decision-makers. As more Americans live in coastal counties their understanding of the ocean's, coasts' and Great Lakes' influence on their lives and their local economies grows in importance. Yet a majority of Americans know little about the ocean and its impact on their livelihood and many have limited skills to understand the complexities of this environment. Surprisingly little is known about effective translation of complex scientific and technical information into information that is easy to understand, easy to use, and of interest to the public and educators. Information translation is one way to make science and technical information more accessible to the public and thereby, improve scientific literacy of many Americans. We present three information translation models that promote scientific and technical literacy.**

I. Introduction

As more Americans live in coastal counties their understanding of the influence of the ocean, coasts, and Great Lakes on their lives and their local economies grows in importance. Yet a majority of Americans know little about the ocean and its impact on their livelihood. Developing an understanding of this relationship often requires information interpretation skills that many American's lack. Information translation is one way to make complex scientific and technical information like that associated with the ocean, coasts and Great Lakes more accessible and more interesting to the public and can assist in the development of information interpretation skills among children and adults. We present and briefly compare 3 models for information translation that are based on existing, highly effective practices that are known to promote public understanding of complex scientific issues like those associated with the ocean, coasts and Great Lakes.

The similarity and differences between these models are important because they highlight the potential for sharing and streamlining of common processes and products while also highlighting the value of multiple approaches to address differences in depth of learning, learning styles, and availability and access methods. Each of the models will be described and then an analysis of their common strengths and differences will follow; the analysis will focus on how the education community can utilize these different models to maximize learning.

II. Academic Research Organization—Model I (Rutgers)

At Rutgers' Institute for Marine And Coastal Sciences (IMACS) this model for information translation has developed over 10 years and is now mature but not static. The key to its success is the effective collaboration between groups engaged in scientific research, operations and information management, and education. While the three groups were initially independent, today they are tightly integrated which aids greatly in accomplishing common goals (i.e., using oceanographic data visualizations to promote ocean literacy). The organizational structure of the Operations and Education groups (Figure 1) highlights how the two groups interact to provide oceanographic products, programs, and services to the user community. It also highlights how these two groups interact with specific audiences within the user community (defined as scientists, kindergarten through grade 12 (K-12) educators, students, and the public) so that information needs flow into both centers.

The COOL Operations Center maintains one of the ocean science community's most advanced coastal ocean observatories. Start-of-the-art sampling capabilities, developed by the research group, transition into the COOL Operations Center environment. The Operations Center maintains and manages the hardware and software for data collection, and for data processing, access, and archive. It produces data products in real-time and visualizations that are posted to the World Wide Web for viewing by target audiences (scientists, educators, decision-makers and the public). *Annual IOOS Implementation Conference* [4] built upon these prior efforts. Educators, coastal managers, and modelers were engaged in discussions on risk assessment and the impact of coastal inundation on local communities, and on priority education activities to form a coordinated network of educators who work with local populations to understand these events, their risks, and appropriate responses to them.

The Education Center promotes ocean literacy using the unique scientific resources and assets of IMACS. The group serves a variety of *clients,* including kindergarten through grade 20 educators (K-20), scientists, government agencies, non-profit groups, print and broadcast media, legislators, industry, and the public. A small team of professionals (educators and communicators) augmented as needed with

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contact staff serve these audiences with website development and management, education product and program development and deployment increasingly with external organizations, broader impact statements for scientific research proposals, and continuing education for coastal decision-makers (e.g., coastal managers and municipal officials).

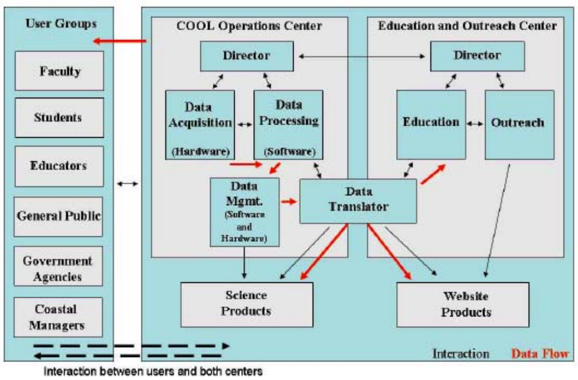

Figure 1. Organizational chart of the Rutgers University COOL Operations Center and the Education Center at IMCS

The Data Translator works between the Education Center and Operations Center. Working closely with these two centers the *data translator* creates visualizations destined for different clients (e.g., scientists, K-12 educators, broadcasters). This position fosters collaboration between the education and operations centers, ensuring the operations group is aware of the visualization needs of the Education Center, and the education group is aware of and has access to upcoming data products and research results for story development.

Success is attributed to a clear mission between and within each group. Success occurs when there is a mutual stated desire and clear path for scientists, data managers, and educators to work toward a common goal of quality education products for the public (Table I). We establish good communication at the beginning of program development by 1) regular facilitated meetings of team members and 2) close physical proximity in the working environment. Program directors provide strong leadership for the development of sound science initiatives and the integrated application of quality education and public awareness strategies designed to create the desired outcomes. All feel equally vested and valued in the overall center mission.

III. Government Research Enterprise—Model II (NASA's Former Earth Science Enterprise)

In 1998 NASA's then Earth Science Enterprise began the process of creating a data translation and story development capability to systemically disseminate knowledge of Earth system science discoveries and enabling technologies supported by NASA to the widest practicable audience. Only fully vetted, peer-reviewed, publication-ready discoveries were considered for dissemination. The capability outlined here focused on providing broadcast and print ready stories and visuals for these discoveries to professional broadcasters (television and radio) and journalists. These professionals embed the stories into news, weather, or public interest reports that appear on television, radio, websites, newspapers, and news magazines. Once established, a secondary audience developed that incorporated the archived stories and visuals into longer format more in-depth reports. This group included filmmakers of both broadcast and educational programs designed for in-class use, and freelance science writers of longer format/in-depth articles for magazines and books.

TABLE I
Characteristics of Data Translation and Visualization Models

Model	I	II	III
Description	Story development, data translation, and visualization tightly coupled with ✓ a research organization, ✓ an operations and data management facility, and ✓ an education organization	Story development, data translation, and visualization ✓ partly embedded within research enterprise, ✓ coupled to large data management and visualization facility, and ✓ public affairs broadcast facilities	Story development and translation of research into ✓ exhibits and programs ✓ collaboration with research community.
Audience Served	Teachers, students, science writers, broadcasters, and the public	Journalists, broadcasters, filmmakers, science writers, Internet providers	Teachers, students, and the public.
Depth of Learning	Depends on audience served—varies from deep to shallow	Shallow-limited to exposure and awareness of results	Moderate—understanding of concepts and principles
Learning Styles	Visual, interactive	Visual, audio, written	Interactive, visual,
Availability and Access	Mass media (internet; pulled by audience)	Mass audiences; (pushed to audience)	Physical presence required; facility limits capacity (pulled by audience)
Primary Venue	Depends on audience served	Radio, television, newspapers	Hands-on informal learning center
Scalability	TBD	Scales to global audience	TBD

The data translation and story development capability, like Model I, took several years to develop and continues to adjust to a changing environment. At the outset four groups of unlikely shipmates were funded to work together to create this capability. Science writers were embedded within the Earth science research community at NASA's GSFC and Langley Research Centers, as were the data translators/visualizers who were in a supercomputing facility that served the NASA funded research community. The fourth member of the team, the professionals in radio and television, were located in the public affairs office.

The science writers, data translators, and radio and television professionals play critical roles as *bridges* between the scientific and technical community and the communication professionals (broadcast and journalists). The data translators and the science writers establish credibility with the on-site and off-site university based scientific and technical community becoming trusted partners, while the science writers with the public affairs staff establish similar credibility and trust with the broadcast and journalistic/science writing community. Establishing credibility and trust with these different communities is critical since it is a major factor in the use of an individual story package. As a *trusted* source of stories and story packages among science journalists and broadcasters your stories are more likely to appear in print and on-air. In a similar fashion, being known a *trusted* developer of stories and story packages among scientists and technologists breeds scientists, university groups, and professional societies who bring high profile stories to you to develop.

As a team, the science writers, data translators, and communication professionals implement the following end-to-end story development and translation process:

1) Identify and track Earth science research results of potential interest to the public—6-9 months before publication,
2) Identify and develop storylines based on these research results,
3) Determine the scope of package for each storyline (Figure 2),
4) Produce/prepare the story components including writing the story, preparing the visualizations, editing the story and the visuals, preparing for interviews,
5) Synchronize deployment to event or publication date,
6) Notify third party outlets of pending story release, primary storyline, and materials to accompany the release including the opportunity for live interviews,
7) Release via website and/or video feed where all materials are accessible and can be easily downloaded (digital) or distributed by a scheduled video feed,
8) Track use of the story upon its release to the public and assess extent of its coverage,
9) Archive the story and visuals on-line for reuse in other venues.

Press Release—provides the highlight of the story, the story's key points, and a contact

Visuals—support the story and improve understanding by the public; spark interest of broadcast media.

Visuals may be:

(1) Scientific visualizations derived from scientific data prepared and packaged for broadcast and on-line use (i.e., a slate describing each visual; visuals without color bars, legends, titles, scales, or units),
(2) Stills in different resolutions for print and on-line publications with appropriate labeling,
(3) Illustrations, both stills and animated illustrations that support understanding of complex concepts or those that are unfamiliar to the public, and
(4) *Live* footage of people, events or phenomena.

Live Shots—used for high profile topics—scientist or technologist answer live questions from broadcasters while on camera (speaker is trained through a series of lower profile yet similarly structured on-camera activities)

Figure 2. Components of a story package.

IV. Informal Learning Center—Model III (Ocean Institute)

The Ocean Institute, like with Model I and II above, has spent several years developing the process outlined here and will continue to refine it. This organization is an independent entity and unlike those associated with the other two models it is not embedded within a scientific and technical research organization. This difference presents unique challenges for the Ocean Institute and other informal learning centers like it, as it strives to incorporate cutting edge basic research into its programs for the public. In addition, as an informal learning center, its focus is on face-to-face visitor programs and *interactive* visitor experiences that seek to deliver a greater depth of learning to fewer individuals that through broadcast and print media as in Model II.

The process developed by the Ocean Institute involves a discrete set of steps that connect current research to the recreational needs of the public and the science standards for middle school students. The process used today has the following steps:

1) Identification of potential researchers,
2) Articulation of the contributions researchers can make with the time commitment and rewards for each,
3) Recruiting researchers with an agreed upon contribution,
4) Conversion of the science into the language used in an informal science center,
5) Describe the complexity of the science through multiple informal science center tools.

Perhaps the greatest challenge was recruiting researchers. To capture and communicate truly current science and invite visitors to experience the edge of a scientific frontier you must be successful at recruiting scientists as partners. Consequently, their participation was essential. They also bring authenticity, accuracy, and real life stories that people relate to, and, above all, an emotional joy of science that cannot be readily replicated. As we developed the process above, three insights provided a solution to this challenge.

First, there are many places to connect with willing scientists, such as, science conferences, education and public affairs departments within large research organizations (e.g., NASA, NOAA, USGS), and collaborative education centers (e.g. Centers for Ocean Sciences Education Excellence). *Second, become a solution for scientists required to participate in education.* The best way to recruit a scientist is to understand their needs and indicate how you will help them meet the education requirements placed on them by a funding organization. *Third, convince scientists you will be efficient with their time.* Scientists are busy and to be successful in recruiting you will need to convince them that you will be efficient with their time and accurate with your translation. At the Ocean Institute we inform the scientists of their time commitment, and we stick to it.

Nobody has time to waste in the translation process, so efficiency is key. We developed a translation process that maximizes everyone's time so the partners can quickly converge on a common goal and begin dissecting the research for components that are likely to meet the exhibit learning goals and create the strongest visitor experience. The key is for informal science center staff to arrive at the first meeting conversant in the scientists' research and scientists to arrive with a command of learning goals for the exhibit or program. Depending on the learning goals, different aspects of the scientist's research are used, perhaps a portion of a protocol, an interview with a scientist, or a look inside the equipment. Within a week a Program and Exhibit Concept Sheet is created that outlines treatment of the material and requirements from scientists. Scientists review and sign-up for the items they will provide.

As the process developed, the Ocean Institute quickly realized that multiple mechanisms would be required to reach the diversity of audiences that visit the institute and to host the depth of content required for current science. Seven informal learning center tools were identified as potential mechanisms: facilitated and non-facilitated exhibits, family kits, interactive scientist presentations, 60-minute research immersion program, take-out science kits, cruises and other off-site extensions, and self-guided science explorations. Some mechanisms are better suited for particular concepts, for example the 60-minute research immersion program is particularly effective at showing science processes and providing visitors experience with current scientific techniques. While the interactive scientist presentation is one of the most powerful tools for engaging the broadest range of visitors and translating scientists' passion for their work.

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Identifying tools that promote deeper levels of learning among visitors is still challenging although working directly with authentic research topics and artifacts, or experimenting with authentic research equipment appear to be two such tools. We now create broadly defined learning stations with powerful capabilities to accommodate a spectrum of activities from a non-facilitated casual visitor interaction to an 18-hour investigative short course. For example, an interactive scientist presentation can use any combination of lecture, stills, video, and audience participation to connect current research to diverse audiences. Lastly, we now employ site-wide, self-guided science exploration. Visitors combine information and learning from one part of the learning center to another that extends or deepens their learning.

Conclusion

These three models have similarities and differences. The similarities offer the potential to streamline the data translation process so that "building blocks" are created which can be used for the many different purposes, and in the many different venues represented by these models. Such changes would reduce existing duplication of effort and therefore, encourage creation of a greater variety of translated topics. In addition, the cost of creating a variety of robust learning materials that incorporate new and timely research results should decrease since once created, resources are not needed to recreate the blocks (for example visualizations or illustrations) for the second, third or fourth use.

The differences among the models center on the primary venue where the materials are to be deployed, the primary audience for the materials, and the depth of learning that is desired. Materials may focus on particular age demographics, individual learning styles, and access to and availability of the materials. For example, Model II focuses on learning materials for adults who read news sources (newspapers, magazines, websites) or listen or watch news or weather broadcasts to acquire exposure to and broad-based awareness of new scientific discoveries. Since these venues are pervasive in our society, a very large percentage of adults can and do keep abreast of new discoveries and innovation in science and technology through one or more of these venues. However, the depth of understanding is often fairly shallow. Model III, on-the-other-hand, focuses on a much smaller audience of primarily school age children and science attentive adults who will develop a much deeper understanding of scientific concepts through extended hands-on interactive learning that uses inquiry-based learning processes.

Although these models differ in venue and audience, they have much in common. At the most abstract level, the process to identify suitable scientific content, translate it effectively, and incorporate it into learning materials is the same in all three models. In all the process is dependent upon creating a trusted relationship between scientists, educators, and translators. All models also emphasize translation of recent scientific discoveries for public audiences and the use of authentic scientific data and artifacts in that translation. Each includes scientific visualizations or animated illustrations that illustrate complex natural phenomena or concepts, and they increasingly provide mechanisms for individuals to interact with the visualizations or to create their own visualizations using the data. All begin with a *storyline* that is based on recent discoveries and is interesting to the target audience. All models try to develop knowledge and understanding of science within audience through an incremental process of knowledge discovery. The length and depth of learning is tuned to the model and the primary venue and audience—some models are suited to greater conceptual exploration and develop deeper understanding but require a greater commitment from the audience (e.g., Model III), while others are shallower and require less commitment (e.g., Model II).

When these differences and similarities are considered together there are many opportunities to improve practices, reduce costs, and expand venues for learning.

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