FORUM

Education, Outreach, and Marketing

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Education and outreach programs seek to improve science education and the public's understanding of science. Although many scientists are doing much good work through these programs, others are uneasy with them, believing that they are unseemly and peripheral to 'real' science.

I suggest taking a broader view and adding 'marketing' to 'education and outreach.' Education is business as usual for university scientists. Scientists think they know what to do, do it well at the college level, and can help at secondary and primary grade levels. Outreach sounds like public service—no harm, but not crucial. In contrast, many organizations consider marketing as a vital function and seek to do it better.

Although we equate marketing with selling, marketers instead think of it as influencing behavior. This may sound tacky, but it need not be. High-tech businesses, for instance, market because the most crucial step for a new product is not conceiving, designing, or making it—it's selling it. Many ideas languish until someone, often not the inventor, figures out how to sell them.

If this seems too corporate, consider nonprofit organizations similar to academia. Arts groups market: Symphonies and plays require raising interest in an audience and enticing them to attend. Museums face the same challenge; people need to hear about exhibits and choose to visit.

We Are Marketing

Scientists already are marketing to raise students' interest in science and to convince society that science is interesting, valuable, and worth supporting. Scientists in the private sector recognize that their research depends on public demand for the company's products, but most others, except for a fortunate few, require direct or indirect public support.

Although much of the general public has not lost interest in science and is willing to support it, it may be a mistake to take this for granted. Many demands on public resources seem more immediate, and many in the public are skeptical about the value of science, except for some new technologies that have immediate benefit. The fact that Gallup polls since 1982 consistently find that about 45% of the public believes "God created human beings pretty much in their present form at one time within the last 10,000 years or so" illustrates that many people do not view scientists' ways of studying the world as better than nonscientific approaches.

Scientists should view the marketing of science as important. This does not mean discarding what we do, much of which is good. It means realizing the importance of marketing, feeling comfortable about it, and trying to do it better. We can also get insight from marketing professionals, who have formulated concepts about marketing that we know at an intuitive level.

What Marketers Can Teach Us

Kotler and Anderson [1996] argued for changing organizations' foci from sales-oriented to customer-oriented. They explain that he first assumes the product is fine and the challenge is to sell it by "trying to change customers to fit what the organization offers." The alternative starts not from the needs of the organization but from the needs of potential customers, identifying their "wants, perceptions, preferences, and satisfaction" and tailoring offerings to them.

Much of what we do has the first orientation. We assume our courses are fine; we just need to make them livelier with PowerPoint, videos, demonstrations, and so forth. Departments assume their curriculum is fine; it is just a question of selling it via fancy brochures, an attractive Web site, and so forth. Efforts to encourage careers in Earth science and public outreach efforts often have the same spirit.

However, much of this selling is not working well. The best example, the lack of student interest in Earth science, has been tracked by AGU, the American Geological Institute, the American Institute of Physics, and the U.S. National Science Foundation. Though the details vary depending on the definition of fields and survey methods, the data show that since 1973, the total number of bachelor's degrees granted in the United States rose steadily while those in geology peaked around 1983 and have since dropped (Figure 1). Hence, despite increasing numbers of students, the fraction majoring in geology fell.

Thus, what we view as problems specific to individual universities are instead general. Most geology programs have difficulty keeping adequate enrollments in advanced classes. Similarly, the number of potential Ph.D. students is small. Of the approximately 3000 geosciences B.S. graduates each year, about 25% progress to graduate study, and about 20% of M.S. graduates continue further. These losses are partially offset by degrees in other fields and from overseas, so about 400 Ph.D.s are granted in solid Earth science each year. Of these, for example, about 100 are in solid Earth geophysics, about one per degree-granting institution. Hence, the efforts by departments to attract students via brochures, Web sites, campus visits, and so forth, seek to change the behavior of the few potential students. Because everyone is trying the same things, they generally do not accomplish much.

Although we talk about why we think so few U.S. students major in Earth science — "students do not like math" and so forth—we actually do not know much about this. Some insights emerge from a marketing study of Dutch high school students [*Snieder and Spiers,* 2002]:

- In general, students do not choose a field because it is interesting or socially relevant. (This observation strongly conflicts with attempts to attract students by trying to convince them how interesting and socially relevant Earth sciences are.)
- The major motivation when choosing a field is the future prospect for a successful career, which is usually measured in terms of its financial rewards.
- Earth scientists are not a group to which students would like to belong.

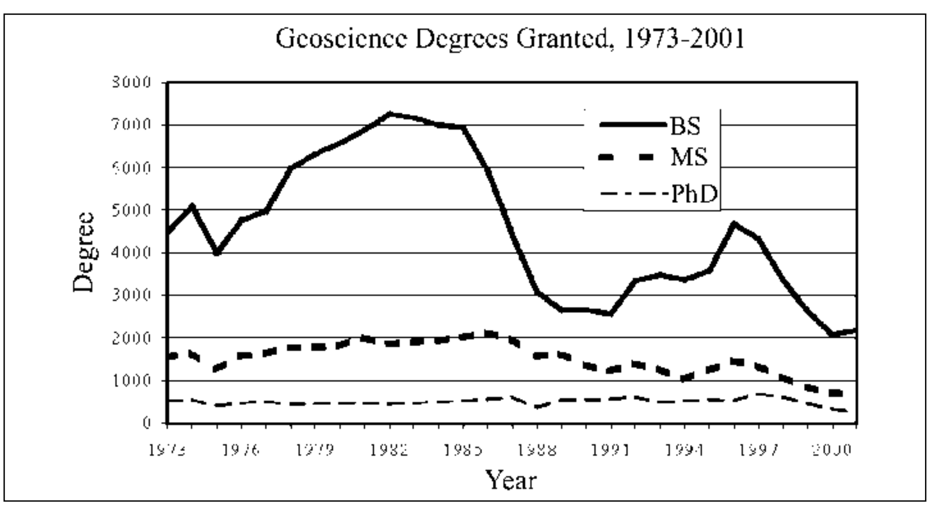

*Fig. 1. U.S. geoscience degrees granted over time [*American Geological Institute*, 2001].*

Surprisingly, we do not have similar studies of U.S. students, and thus do not know how U.S. students, a more diverse population, compare. Presumably, given world youth culture, many Americans will have similar attitudes, but some likely will differ. For example, at some universities skepticism about evolution and the age of the Earth may be reflected among students. At others, it seems that interest in the outdoors does interest students in Earth science. It would help to know more about what does and does not work, and where and why, analogous to *Hilborn and Howes*'s [2003] investigation of why some physics departments do well attracting undergraduates.

Marketing is Okay

I suspect there are two major reasons why we do not have such studies: We do not think we will like what we will hear, and we do not want to change current practices. Although we may not want to change the science, we need to know why more students are not attracted to Earth science despite public interest in the environment and natural disasters and exciting results such as space missions. We need to know this if we are to develop programs that attract both students considering careers in Earth science and ones interested in acquiring an Earth science background as part of preparation for other careers, such as public service or law.

Viewing what scientists do as marketing offers other insights. Marketers create artificial 'pseudoevents' such as press conferences that draw media coverage. Although we do not view publishing papers or giving meeting talks as pseudoevents, they draw media that we can work with by viewing them as customers and understanding their needs [*Funsten,* 2003].

Real events such as natural disasters and space missions provide teachable moments. We have learned to use the brief period before public interest wanes to explain not only what happened, but why, what can be learned, and what needs to be done. For example, the disastrous tsunami following the December 2004 Sumatra earthquake drew media attention for several weeks [*Lerner-Lam and Seeber,* 2005] until it was overshadowed by Brad Pitt and Jennifer Aniston's marital problems. Scientists explained plate motions, the earthquake cycle, the need for tsunami warning systems, and more.

Hence, once my colleague Emile Okal and I realized that the earthquake was bigger than first appeared [*Stein and Okal,* 2005], we explained to the media that the longer rupture generated the large tsunami amplitudes in Sri Lanka and India and left no immediate danger of a comparable tsunami from the segment of the plate boundary that had just broken. Similarly, scientists used the media interest that followed Hurricane Katrina to explain hurricane physics, the possible role of global warming, and issues related to land subsidence and building below sea level. Thus, important mitigation policies likely will be adopted after these disasters.

Much of what scientists already do is market scientific results, ideas about the Earth sciences, and their implications for society. Recognizing this as marketing can help scientists do a better job of reaching the public.

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MEETINGS

Understanding Sea Level Rise and Variability

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The coastal zone changed considerably during the twentieth century due to growing populations and increasing urbanization. A recent study indicated that in 1990, 23% of the world's population (1.2 billion people) were living within both a 100-kilometer distance and a 100-meter elevation of the coast at densities 3 times higher than the global average. Society is becoming increasingly vulnerable to sea level extremes, as Hurricane Katrina demonstrated. Rising levels will result in more flooding, even if storm intensities do not increase. Improved understanding of the reasons for sea level rise and variability is required to reduce the uncertainties in sea level rise projections, and this improved understanding could contribute to more effective coastal planning and management.

The World Climate Research Programme (WCRP) convened a workshop to identify the uncertainties associated with past and future sea level rise and variability, and to determine the research and observational activities needed for narrowing these uncertainties. The workshop was also conducted with the aim of obtaining consensus on sea level observational requirements for the Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan.

The workshop was hosted by the Intergovernmental Oceanographic Commission of UNESCO in Paris, France, during 6–9 June 2006, and it was cosponsored by 34 organizations. The workshop assembled a wide range of expertise with the participation of 163 scientists from 29 countries. Presentations by Robert Nicholls (University of Southampton, U.K) and Ralph Rayner (Ocean Numerics, U.K.) on impacts of sea level change were provided at the start of the workshop to emphasize the importance to society of the research.

Participants reviewed current knowledge in all areas contributing to present day sea level rise, and they provided recommendations on reducing uncertainties. Methods for determining paleo-sea level changes were introduced by Kurt Lambeck (Australian National University, Canberra). Geological indicators are used to infer vertical land movement at tide gauges resulting from glacial isostatic adjustment (GIA) and other factors. Lambeck indicated that the geological database for the Holocene is limited in many regions and requires enhancement.

A further important research objective concerns whether complementary techniques can constrain estimates of ongoing contribution of the ice sheets to sea level rise, and can resolve long-term variability in sea level trends. Lambeck noted that salt marsh, coral reef, and archaeological information have been used to show an acceleration of the rate of sea level rise during the latter half of the nineteenth century similar to that observed by tide gauges. An extension of the historical record of sea level change over several hundred years using these techniques at more locations around the globe was identified by Lambeck as a particularly promising area for further study.

Gary Mitchum (University of South Florida, St. Petersburg) and Mark Merrifield (University of Hawaii, Honolulu) led the session on historical and present-day sea level change. Beginning in 1992, global mean sea level has been observed by tide gauges as well as by altimeters to be rising at a rate of 3.2 ± 0.4 millimeters per year, compared to 1.7 ± 0.3 millimeters per year from tide gauges over the previous century. However, the speakers indicated that it is not clear whether this increase reflects a genuine acceleration or