Overview

IRIS members have increasingly recognized the need to communicate the results of scientific research to the public more effectively, to advance science literacy for greater understanding of our rapidly changing and increasingly technological world, and to attract more students to study science. To address these issues, IRIS created the Education and Outreach (E&O) program to join its existing three core programs in 1998. Since that time, the program has grown to 4.5 IRIS staff managing a number of subcontract and consultant awards, with significant contributions from members of the IRIS community.

Since its inception, the E&O program has explored the needs of the different audiences it serves and has developed a core program to address those needs. In 1998, the IRIS E&O committee convened a conference with representatives from diverse science and science education disciplines, funding agencies, and other Earth science E&O programs to develop a broad vision of how IRIS could uniquely contribute to science education and outreach. The discussions and collaborations that developed during the conference have guided IRIS' E&O efforts ever since and formed the basis for a program plan published in 2002.

The IRIS E&O course of action is to provide products and programs for a variety of audiences, including the general public, K-12 students and educators, and post-secondary students at our nation’s colleges and universities. At the core of all IRIS E&O activities is a focus on the use and explanation of seismic data. Programs range from those that impact large numbers of people for brief time periods to those that impact smaller numbers of people through extended interactions. IRIS’ E&O program also looks inward to develop the talent within the ranks of IRIS’ member institutions so that all may fully participate in building an education program of national scope and prominence.

Our mission is to help create a new generation of Americans with a greater understanding of Earth science and seismology, and to help attract the best and brightest to our discipline. To stimulate an interest in science requires high quality educational resources for teachers in K-12 and for college faculty in undergraduate programs. Providing accurate and efficient professional development and resource materials in Earth science and seismology is especially important for teachers in middle and high school grades who currently teach the bulk of the Earth science concepts that the majority of Americans will ever learn.

We focus on developing people who can help us make a difference, and developing products that support the efforts of those same people. By engaging the full membership of IRIS in E&O activities, we capitalize on our numbers, geographic diversity, and especially the wealth of creativity and knowledge within our community. While IRIS can make advances in science education through seismology, a concerted effort to link seismology across the scientific disciplines helps achieve an even greater impact. We recognize the need to coordinate with other organizations to leverage our impact and seek opportunities to collaborate on education and outreach activities where mutual interests exist.

History and Current Status

IRIS/USGS Museum Exhibits

One of the earliest IRIS E&O activities focused on a traveling museum exhibit designed in collaboration with the USGS. This display has been on loan to the Franklin Institute Science Museum for use in their Powers of Nature exhibit and has traveled to 14 museums since 1998. Since that time the museum program has expanded to four permanent exhibits as well as the traveling display. Our museum partners include the Smithsonian Institution National Museum of Natural History, the American Museum of Natural History (AMNH) in New York, Carnegie Museum of Natural History in Pittsburgh, and the New Mexico Museum of Natural History and Science in Albuquerque. The most recent addition was a new plasma screen display and triple-drum recorder in the Hall of Planet Earth (HoPE) at AMNH. In the next year, more than 16 mil-
The evaluation was to assess audience interest and understanding of the exhibit and to determine how the future exhibits might be improved (Smith et al, 2004, Smith et al, 2005). The evaluation showed that the displays are very popular in both museums, with audiences particularly interested in the presentation of near real-time seismic data. To conduct the evaluation the galleries at both museums were divided into elements of comparable size, of which the IRIS/USGS display was one. In both galleries the display had the largest percentage of visitors who stopped, compared to the other exhibits. In the HoPE the display also had the longest median visitor stop time of the observed elements.

Recognizing the opportunities to increase their educational reach and meet more of their objectives, IRIS and the USGS are now working with the museums to improve the earthquake displays. In addition, over the past year IRIS has developed a second museum product, Museum Lite, aimed at smaller institutions. This computer interactive also provides real-time information delivered via a web browser, but requires less support and maintenance and can be individually tailored to provide relevant content and data for each institution. Museum Lite has so far been successfully installed at one museum and a National park visitor center. Touch screens have been used in both of these displays to provide an interactive experience. The display builds on the lessons learned from the evaluation of the full display.

### Table 1. Museums hosting the portable Museum Display as part of the Powers of Nature Exhibit (April 1998 – May 2005)

<table>
<thead>
<tr>
<th>Date</th>
<th>Museum</th>
<th>Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr 98</td>
<td>Franklin Institute Science Museum, Philadelphia, PA</td>
<td>450,000</td>
</tr>
<tr>
<td>Oct 98</td>
<td>California Museum of Science and Industry, Los Angeles, CA</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Apr 99</td>
<td>Center of Science and Industry, Columbus, OH</td>
<td>350,000</td>
</tr>
<tr>
<td>Oct 99</td>
<td>Ft. Worth Museum of Science and History, Ft. Worth, TX</td>
<td>600,000</td>
</tr>
<tr>
<td>Apr 00</td>
<td>St. Paul Science Museum of Minnesota, St. Paul, MN</td>
<td>375,000</td>
</tr>
<tr>
<td>Oct 00</td>
<td>Boston Museum of Science, Boston, MA</td>
<td>550,000</td>
</tr>
<tr>
<td>Apr 01</td>
<td>US Space and Rocket Center, Huntsville, AL</td>
<td>400,000</td>
</tr>
<tr>
<td>Feb 02</td>
<td>Denver Museum of Nature and Sciences, Denver, CO</td>
<td>500,000</td>
</tr>
<tr>
<td>Oct 02</td>
<td>North Carolina Museum of Natural Sciences, Raleigh, NC</td>
<td>900,000</td>
</tr>
<tr>
<td>Fall 03</td>
<td>Franklin Institute Science Museum, Philadelphia, PA</td>
<td>450,000</td>
</tr>
<tr>
<td>Xx 04</td>
<td>Moody Gardens, Galveston, Texas</td>
<td></td>
</tr>
<tr>
<td>Xx 04</td>
<td>Cincinnati Museum Center, Cincinnati, OH</td>
<td></td>
</tr>
<tr>
<td>Xx 05</td>
<td>Pacific Science Center, Seattle, WA</td>
<td></td>
</tr>
<tr>
<td>Total Audience</td>
<td></td>
<td>&gt;xxxxxxx</td>
</tr>
</tbody>
</table>

Two examples of our ongoing evaluations are the formative evaluations conducted by the museums during their design of the exhibits and the summative evaluation of our AMNH and Smithsonian Institution National Museum of Natural History displays that was conducted in 2004. The goal of the evaluation was to assess audience interest and understanding of the exhibit and to determine how the future exhibits might be improved (Smith et al, 2004, Smith et al, 2005). The evaluation showed that the displays are very popular in both museums, with audiences particularly interested in the presentation of near real-time seismic data. To conduct the evaluation the galleries at both museums were divided into elements of comparable size, of which the IRIS/USGS display was one. In both galleries the display had the largest percentage of visitors who stopped, compared to the other exhibits. In the HoPE the display also had the longest median visitor stop time of the observed elements.

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### Professional Development Program

The E&O Program continues to refine its highly effective, one-day professional development experience designed to support the background and curricular needs of formal educators. The program for teachers and college faculty began as a one-day workshop at annual meeting of the National Science Teachers Association, and now also includes workshops at the annual meetings of the California Science Teachers Association and the Geological Society of America, as well as one to two other selected venues each year. A new, focused workshop was added in 2004 for teachers who use AS1 seismographs in their classroom that they received through the IRIS seismographs in schools program. This workshop provided
critical training in the interpretation and use of seismic data. Some of the workshops are conducted in collaboration with other organizations. Workshops have also been held to train seismologists to run their own teacher-training workshops.

A major new collaboration was initiated with the Yuma Union High School District in 2005. It is part of a systemic reform endeavor to support the district’s need to prepare its Earth Science teachers (largely teaching out of academic specialty) to adequately address the newly adopted AZ state science standards, as well as developing a scope and sequence of resources to support all of the district’s Earth Science teachers. The 3-day workshop was the first in an ongoing series of professional development sessions for the high school teachers. The students in the district are 97% Hispanic.

Leveraging the expertise of the consortium, IRIS delivers content such as: plate tectonics, propagation of seismic waves, seismographs, earthquake locations, and Earth’s interior structure. At the core of the IRIS professional development model is the philosophy that classroom teachers are the decisive component in reforming science education (Bybee, 1993) (Duschl, 1990). Thus to support both the science education reform movement and classroom teachers, IRIS professional development strives to increase teacher comfort in the classroom by providing professional development which:

- Provides educators with inquiry-based learning experiences,
- Provides direct contact with IRIS research and E&O individuals

Teacher comfort is a prerequisite for teachers to select and effectively use instructional activities that involve learners in higher-order thinking skills. This comfort is the sum of teachers’ efficacy beliefs in each of three areas; knowledge of the scientific content, familiarity/experience with the learning tool, and pedagogical content and tool knowledge (Lumpe, A.T et al, 1999).

The development of a coordinated assessment effort has provided critical decision making data and has begun to document the impact the program has on educators. Over 600 teachers and college faculty have attended 1-day or longer IRIS workshops since the initiation of the E&O program. Those instructors now reach nearly 50,000 students per year. As reflected in the follow-up assessments of our 2003 (Hubenthal et al, 2003a) and 2004 NSTA workshops, this model has proven to be highly effective at extending into the participants’ classrooms. 100% of respondents report increasing the amount of time they spend teaching seismology or related topics in their classroom as a result of participating in IRIS professional development experience. This increase can be directly attributed to the workshop as 91% of participants report using at least one activity modeled during the workshop upon returning to their classrooms. The reported mean activity usage by teachers upon returning to the classroom was 4.2 activities per teacher. Using this information as a guide IRIS will continue to monitor and alter its curricular resources and implementation style in an effort to maximize this impact. Internal evaluations are used in a similar manner throughout the IRIS E&O program to improve and guide our activities.
The E&O Program recently partnered with the National Earth Science Teachers Association (NESTA) to produce a Seismology/IRIS focused issue of their journal The Earth Scientist. This publication is designed to keep Earth Science teachers abreast of relevant scientific and pedagogical research as well as serving as a place to share practical instructional strategies for the earth science classroom. The Earth Scientist has a regular distribution of 1100 members and IRIS will be widely distributing the issue to help publicize the society and to provide seismology content and classroom activities to a wide audience. The issue has already generated over 100 new members for NESTA.

**Summer Internship Program**

Since its inception in 1998, The IRIS Undergraduate Internship Program has been providing students with engaging 8 to 10 week research opportunities through partnerships with the universities of the IRIS consortium and the USGS. The primary goal of this program is to provide students with research opportunities early in their educational careers, in an effort to encourage more students, representing a more diverse population to choose careers in earth science and seismology. A secondary goal of the program is to help the schools in the consortium attract well-prepared, outstanding students for graduate studies in the earth science.

Research projects, proposed by members of the IRIS community may involve the deployment of seismic instruments in the field (within the US or internationally), and/or analyses of seismic data in a lab setting (for example investigations of Earth structure, earthquake sources, seismic hazards). Each project provides students with ample opportunities to:

- conduct research with state of the art geophysical data and leading researchers at IRIS institutions
- develop an understanding of scientific inquiry, including designing and conducting scientific investigations, defending scientific arguments, and preparing publications
- gather, manage, and convey information, using various skills, strategies, resources, and
- learn, use, and evaluate technologies for the collection and study of geophysical data

To bring closure to the summer, interns and their hosts collaborate to develop and submit an abstract of their summer’s work to a national scientific meeting. Thus, each internship culminates in the stimulating atmosphere of a professional meeting, where interns present results from their summer work.

The eight-year-old IRIS Undergraduate Internship Program has successfully placed 46 undergraduate students at 28 different IRIS member institutions plus the USGS. To measure the impact of the program a survey of all alumni was conducted in early 2004. The results found that over 83% of the alumni pursue advanced degrees (largely PhDs) in a range of geoscience fields, with the majority in seismology or geophysics and smaller numbers in geological sciences, petrology, geochemistry, and mineral physics. 43% of these students attend graduate school at the institution where they spent their internship. All the students agreed that the internship was one of the best learning experiences they had ever had. 50% of our interns have been female in the past 3 years, and 13% of the interns identified themselves as African-American or Hispanic.

**Website**

The E&O web site provides the primary means of distributing seismic data and resources, including both timeless information such as answers to frequently asked questions and timely information about recent seismological events. There were over 1 million visitors to the IRIS web pages in the past year. The IRIS E&O web page provides (1) information on the programs, activities, and opportunities of IRIS E&O; (2) tools for the non-specialist to access and manipulate seismological data (earthquake statistics, maps and seismograms); (3) links to E&O efforts in seismology and the Earth sciences at IRIS member institutions and other organi-
zations; (4) background and topical earthquake information; and (5) instructional materials. The IRIS website represents collaboration between the Data Management System (DMS) and E&O to enhance the profile of IRIS and provide greater access to IRIS resources. The website provides the means to respond to events of interest to the public and the seismological community. An example is the set of Sumatra earthquake pages which allowed the scientific community to share short-term results. A very different example is an online interactive exercise called the “Earthquake Simulator” which was developed in response to the TV mini-series “10.5”. A lesson plan and resources were developed to accompany the Earthquake Simulator and the lesson plan was trialed in a classroom.

**Educational Seismographs and the Use of Seismic Data**

Collecting and distributing seismic data products to the research community is the mainstay of IRIS. As advances in seismology are frequently data driven, this data is frequently the foundation for making advances in our understanding of Earth. However, sharing those data and the excitement of discovery that they offer with a general audience requires effective tools and an understanding of seismology. People want to know how a seismometer works and how it can detect earthquakes on the other side of the planet. They want to know what each wiggle on a seismogram means. While not all of these questions are easily answered, providing non-specialists tools to begin investigating these questions and illuminate the basic scientific research process is a valuable contribution to society. To address this need, IRIS E&O in collaboration with the DMS and GSN have developed products ranging from web data viewers to school seismograph software. The Seismic Monitor is a web-based tool that provides a quick global view of recent earthquake locations, with links to the IRIS waveform database. The Seismic Monitor and associated pages are by far the most popular of all IRIS web pages. Data access is also provided both through DMS tools on the IRIS website and through the Global Earthquake Explorer (GEE) software, which has been specially designed for the non-specialist audience. GEE software and associated instructional materials, have been developed in part via a subaward to the University of South Carolina, and includes built-in teaching modules as well as free exploration options. GEE development is ongoing through an independent NSF grant.

In 2000, IRIS initiated a program to distribute educational seismographs to schools (the AS1), and developed new display software written by Alan Jones (AmaSeis). Over 100 schools now are operating the systems and using educational modules developed specifically for the systems. Over twenty of these schools are now displaying real-time views on the IRIS web site of the last 24 hours of activity at their schools. Schools share waveform data via the SpiNet web site maintained by Science Education Solutions. IRIS is also leading the effort, via the US Educational Seismology Network (USESN), to aid and coordinate a number of primarily regionally-based seismology outreach projects. Educational seismograph stations, now numbering in the hundreds, are situated at schools, museums, and colleges across the country. Notable among these efforts, other the IRIS AS1 program, are the University of Michigan’s ‘MichSeis’ and the Ohio Geologic Survey’s ‘OhioSeis’ projects, the Princeton Earth Physics Project (PEPP), the South Carolina Earth Physics Project (SCEPP), Nevada Educational Seismic Network and the amateur-oriented Public Seismic Network (PSN).

**Posters and One-page Handouts**

IRIS produced the first educational poster (“Exploring the Earth Using Seismology”) in 1998 and continues to give out thousands of copies of that poster each year. The poster shows how seismic waves from the 1994 Northridge earthquake propagated throughout the Earth, and is used by teachers to illustrate Earth science concepts. IRIS continues to de-
velop new posters such as the “History of Seismology” poster that is aimed at high school and college students and the most recent poster highlighting the GSN recordings of the Magnitude 9 Sumatra earthquake (published in both English and Spanish). In total, over 50,000 posters have been distributed to 22 countries worldwide. The one-page educational handout series covers topics related to our posters and to our museum displays. The series has expanded to six topics and has been translated into Spanish, as has the Exploring the Earth poster.

**Educational Affiliate Membership**

In 2001, IRIS established a new Educational Affiliate membership category for 2 and 4-year colleges and universities that teach seismology but are not sufficiently involved in seismology research to become full consortium members. The objective of this membership category is to cultivate a base of institutions committed to excellence in geoscience education through the co-development of E&O activities designed to address their needs. By becoming an EA member of IRIS, institutions gain entrance into a community of educators that is closely connected to the research community and shares a common set interests and goals, as well as benefits such as discounts on seismometers and access and input to special E&O programs (see example below). The first Educational Affiliate members were accepted in 2002 and the initial members are assisting IRIS in developing E&O activities to address their needs. A workshop to discuss these needs was held before the IRIS annual workshop in 2005.

The Sabbaticals in Seismology (SIS) program, is a new IRIS Education and Outreach initiative designed specifically to address the needs of the Educational Affiliate community. This effort strives to promote high-quality geophysics instruction and research opportunities for undergraduates by supporting collaborative geophysical research efforts involving faculty at IRIS member institutions and Educational Affiliates. Beyond enabling opportunities for undergraduates, a geophysics research experience for EA faculty will greatly enrich faculty’s background knowledge of geophysics, which in turn, would greatly enhance their ability to present geophysics topics in the classes they teach at their home institutions. The first sabbatical of the program began in January of 2005 and was a partnership between Eckerd College and the University of Texas Institute of Geophysics.

**Current Educational Affiliate Institutions**

Arizona Western College  
Bridgewater State College  
Dine College  
College of Charleston  
Eckerd College  
IslandWood  
Moravian College  
Trinity University  
University of Missouri, Kansas City  
University of Portland  
Waubonsee Community College

**Distinguished Lecturer Series**

IRIS initiated the IRIS/SSA distinguished lecture series in 2003 as an additional way to reach the public through informal learning institutions. Two speakers are selected each year, based on their ability to convey the excitement of seismology to a general audience. In the first 3 years of the program, speakers presented over 30 lectures at major museums and universities throughout the country to audiences of up to 400 people. The responses from the museums have been very positive, with many arranging additional events in conjunction with the lectures, such as webcasts, radio interviews, teacher workshops and IMAX films.

**Past and Present Distinguished Lecturers**

2005  Michael Wysession: Earthquakes, Tsunamis and a Modern Journey to the Center of the Earth  
Susan Hough: The Very Long Reach of Very Large Earthquakes

David E. James: Revealing the Mysteries of the Earth’s Deep Interior: Plates, Plumes and the Birth of Modern Seismology

2003  Walter Mooney: The Discovery of the Earth: The Quest to Understand the Interior of the Planet  
Roger Bilham: Death and Construction: Earthquakes on an Urban Planet
Collaborations with other organizations

Additional audiences are reached via collaboration with local, regional and other national geoscience programs. For example, 15,000 copies of the “Exploring the Earth” poster were provided in 2004 for AGI’s Earth Science Week packets, and we provided exercises for the GSA CD “Explore Earthquakes”. IRIS partnered with the Colorado School of Mines (CSM) in 2002 to provide content for part of CSM’s Engineering Practices Introductory Course Sequence. As the lab segment of the course, 350 freshman engineers were given the task of designing an inexpensive seismometer for use in schools, culminating in a judged competition at the end of the semester (Hubenthal et al, 2003b).

We also leverage our resources by providing materials for workshops organized by other organizations, with ten such workshops in 2004. Many of our resources are available through the Digital Library for Earth System Education (DLESE). We are a partner in the Electronic Encyclopedia of Earthquakes project led by the Southern California Earthquake Center (SCEC) and are working closely with EarthScope, UNAVCO and the Network for Earthquake Engineering Simulation (NEES) as they establish their Education and Outreach programs. The success of the E&O program is directly attributable to those who have volunteered their time and energy. In particular we acknowledge the extensive contributions of current and past members of the E&O Standing Committee.

The Next Five Years

Over the past 7 years the E&O Program has developed a range of products and activities that balances the desire to reach multiple audiences with the need to remain focused on activities that relate to IRIS strengths, particularly the use and explanation of seismic data. In that time IRIS E&O has become a well-respected program in the Earth science education community and it has taken a role in the planning and/or development of new E&O programs for NEES, UNAVCO, JOI and EarthScope. In the next 5 years the E&O program will continue to improve the quality and expand the reach of our successful activities, as quantified by our internal evaluations, as well as adding new products designed to reach wider audiences with innovative and engaging educational material. We propose to implement an external evaluation of the program during the next 2 years, similar to the recent evaluation of the GSN program to assess the balance and quality of the E&O Program. A major focus will be providing E&O products that make use of, and help promote USArray and EarthScope. Existing programs that will be continued include distinguished lectures, educational affiliates, 1-pagers, posters, creation of classroom modules, and the dissemination of materials and data via the IRIS Web site. We will continue to collaborate with a wide range of institutions to maximize the reach of our activities.

Some of the expansion of the existing activities is planned to occur via funding sources outside the core IRIS funding from NSF. NSF EHR is one place we will apply for additional funding and we will also pursue funding opportunities through other government organizations and private foundations. The first example of this is the recently funded proposal to expand our summer internship program into a NSF REU (Research Experiences for Undergraduates) program.

Expansion and improvement of existing programs

IRIS/USGS Museum exhibits

We propose to continue to work with major museums (more than 1 million visitors per year) to develop new displays based on the exhibits at AMNH and the Smithsonian. We expect to develop new partnerships with 2-4 major museums over the 5-year period. We will also make the new Museum-Lite display a major focus of our museum program. The Museum Lite display is a simple to implement and low cost way to provide high-quality, real-time seismology and other information to a wide audience. It can be easily customized for regional and local audiences in numerous ways. The project evolved out of the online Seismic Monitor and the IRIS/USGS large-scale earthquake displays. The museum display is too expensive and takes too much maintenance to be practical for small museums, schools, visitor centers, etc. The Seismic Monitor allows for interactive or preset use for such venues, and its capabilities are very flexible.

Museum Lite provides a customizable set of web pages that can be viewed either via an interactive touch screen or an automatically cycling display. An individual venue will be able to select from a menu that includes such choices as:

- Maps of current seismicity at various scales (global, regional, local) with touch-screen capability to get information on individual earthquakes
• Online helicorder displays of nearby seismic (e.g., USArray) stations
• Static maps of long-term seismicity and seismic hazard
• Other local information or graphics as desired by the client.

The full museum display requires a dedicated staff and costly hardware. A number of good web sites exist supplying a variety of pertinent information, but none are customizable and as easy to use (Museum Lite requires only a networked computer running a browser). The initial response to the Museum-lite displays has been encouraging and there appears to be a significant market for a web-based, customizable, real-time display. For example, the recent evaluation of the IRIS museum display carried out by the IRIS E&O program highlighted broad public fascination with real-time earthquake monitoring information. Museum-lite is particularly well-suited to EarthScope/USArray outreach, as new results and discoveries can easily be added as they become available and the display can be customized for a particular region. E&O proposes to develop a customization system and associated web resources to support up to several hundred such systems.

The existence of established partnerships with major museums and a careful evaluation of the displays, combined with the demonstrated potential of the Museum-Lite display provides the basis for a considerable expansion of the program. The Museum-Lite display is also of significant interest to IRIS members and Educational Affiliates and thus will serve our membership as well as the general public.

Promoting the collection and use of seismic data
IRIS E&O seeks to promote the installation and effective use of educational seismographs and seismic data, to disseminate high-quality curricular materials and educational services that promote the use of seismology in science education, and to provide an organizational framework for coordination and advocacy of educational seismology across the country. This promotion can take place on at least three levels:

• Broad use of regional and/or global data via Internet tools
• Simple student seismographs in schools
• Networked research-quality seismographs in schools

To reach a large number of students and provide sufficient educational and technical support, it is necessary to work at both the regional and national levels. A goal of the US Educational Seismology Network (USESN) is to provide such a structure and to work towards the long-term vision of:

• 100s of research grade (e.g., broadband) instruments
• 1,000s of instruction-quality (e.g., AS-1-type) instruments
• 10,000s of schools using freely available seismic data via the web

Teacher professional development
The IRIS 1-day workshops have been very successful as measured by post-workshop surveys (same day and 1 year later) and will be continued. Additionally, IRIS E&O plans to begin working with partners (such as McREL, NEES, UNAVCO) to offer more comprehensive teacher professional development. An important audience we don’t currently reach is pre-service teachers (i.e., school of education students getting teaching certificates). Working with pre-service teachers would help us cross the science department/education department divide that exists at some universities. As described previously, a major new initiative begun in the past year is the development of partnerships with entire school districts to help achieve long-term, systemic reform. In the next 5 years we propose to continue to work with Yuma High School District and to apply the model we are developing with Yuma to at least one other highly diverse school district. This could become a major part of our professional development and could be funded by an external proposal.
The USESN will become a federation of universities and other groups who are promoting seismology education in their region, with IRIS leading the federation. IRIS is already taking a lead role in facilitating the base for the above pyramid via web-based software and is providing professional development for teachers to ensure that the AS-1 seismographs are being used effectively. IRIS will provide overall national-scale coordination and will focus on widely-applicable software, classroom exercises, simple stand-alone seismographs and the teacher professional development needed to support these products. Local teacher education and technical assistance, particularly for networks such as Indiana PePP, South Carolina (SCEPP) and the Nevada K-12 network, will be best carried out on a regional basis. As part of its leadership role IRIS E&O will continue to focus on providing web-based tools such as the Seismic Monitor and the new Rapid Earthquake Viewer (REV) (project led by University of South Carolina with separate NSF funding), and will continue to work with USC and DLESE on improving the educational capabilities of the Global Earthquake Explorer (GEE), which is a platform independent seismic analysis tool that is designed for student use and accesses IRIS data via the Internet. IRIS E&O will also continue to support improvement to software and classroom modules related to the AS1 seismograph. We plan to initiate a redesign of the AS1 electronics and to explore other simple seismograph options to further expand the availability of classroom seismographs. If a lower-cost seismograph can be developed, a partnership with the international GLOBE may be possible.

USES N-related development is currently being seeded using IRIS E&O funding. That seeding has included development of software and educational modules, support for the creation of a seismograph buyers guide for teachers, and support for the initial stages of coordinating the groups that comprise the USESN (including an NSF-funded USESN workshop in September 2003). An important seed effort over the next year will be to work with one of the regional groups to develop an improved model for the educational aspects of regional programs. We expect the scalable model will include partnerships with local schools of education, teacher professional development, modification of existing classroom exercises (using existing data collection and analysis software) for state standards and local curriculum. The planned expansion of the program will require an external proposal to NSF EHR or another government agency or private foundation.

Increase outreach (“inreach”) to IRIS consortium members

We propose to provide overviews of E&O and other seismology resources for the future seismology professors (i.e. graduate students) to assist them in teaching seismology and Earth science in general and to build future associations with E&O efforts. These would be conducted as 1-day workshops for graduate students, probably the day before the annual IRIS workshop. One way to considerably expand the reach of the IRIS E&O program is to provide more structured assistance to PIs in outlining ways their research projects can address the need for broadly disseminating their research and its implications. For example, IRIS E&O can provide an avenue of dissemination through its partnership in AIP’s Discoveries and Breakthroughs Inside Science (DBIS) program, which produces short science research stories for local TV news broadcasts. IRIS can also facilitate the creation of distance learning courses in seismic techniques applications. A course that is developed and used only at one IRIS institution may have too small an audience to be viable, whereas if the course can be offered to students at a number of institutions, teaching it becomes cost effective. As a pilot course, IRIS E&O is sponsoring a seismic reflection short course, which uses processing software that is supported by IRIS (SPW).

Diversity

We will continue to place a priority on reaching diverse audiences with all our activities. For example we target students at HBCUs for summer internships and teacher in urban school districts for professional development. An important approach will be to continue to build partnerships with groups that are already engaged in successful activities. To be effective, programs need to be sustained for many years and a smaller number of well-supported programs are likely to be more successful than many small, short-term efforts. Example partners are SACNAS (through a Board member on the IRIS E&O Standing Committee), UT Austin, UNAVCO (through their initiative to expand the SOARS program), and AfricaArray.

In addition, diversity will be considered as an important element in everything we do. For example, we will target HBCU’s for summer internships and as Educational Affili-
ate members, schools with highly diverse student bodies get priority for receiving an AS1 through our seismographs in schools program, we will continue to expand the materials that are translated into Spanish. We plan to have an ongoing relationship with Yuma High School District (97% Hispanic) and we plan to begin working with other large urban school districts. We will continue to work with Kipp Academy, a local inner city charter school dedicated to helping minority students. We will also explore ways to establish a relationship with the National Society of Black Physicists, to encourage more physics students to try seismology.

Internship Programs

IRIS E&O will be expanding its summer internship program over the next 3 years through its newly awarded REU funding from NSF. The program will blend the spirit of a traditional REU site with IRIS’s successful experience hosting students at widely separated institutions. To do this IRIS will first initiate an orientation program to bring the students together as a community of learners, and to begin to bond through a shared experience. While together interns will also participate in a variety of activities designed to: 1) illustrate the exciting research questions of modern seismology, 2) facilitate peer interaction, 3) provide an introduction to effective habits of independent workers and, 4) prepare interns to use a variety communications technologies. Following this, interns will spend 8-10 weeks working on seismology research project with their individual hosts. The projects will be structured to provide interns with ample opportunities to develop successful work skills and an understanding of scientific inquiry, to gather and convey scientific information, and to use advanced geophysical technology.

Though separated from the other IRIS interns by distance, interns’ experiences during this period will not be limited to only the activities at their host institution. Leveraging training provided at the orientation, all students will communicate with each other and participate in a learning community. This communication will include both required, structured interactions via video conferencing and blogs, and relatively unstructured discussion boards. Scientific results generated from the summer research project will be presented at a professional conference to provide the students with the opportunity to interact with the larger IRIS community, and reconnect, face-to-face with the other IRIS interns.

We will also continue to expand internship opportunities through partnerships. Current possibilities include the SOARS program in partnership with UNAVCO, and collaboration with the AfricaArray initiative.

International leadership

IRIS E&O has begun providing seed equipment (AS1 seismographs) and sharing expertise with school seismograph programs at various stages of development in New Zealand, Great Britain, France, Italy and Costa Rica. Students are very interested in sharing seismic data between schools in different countries and IRIS can take the lead in providing the mechanism for the schools to interact. At the undergraduate and graduate level, IRIS can also become more proactively involved with the activities of the IASPEI Commission on E&O.

New Initiatives

On-line graduate level professional development course in seismology for teachers

We propose to develop an on-line course and associated training, “Seismology in the Earth System” targeting formal education (grades 6-12) in-service teachers. The course would help teachers improve their instructional skills in seismology related topics in three key ways; improved content background, learning through the use of pedagogically sound instruction (modeling), and providing high quality related
activities for use in the classroom. This model fits a need of many teachers today by providing a meaningful way for them to get graduate credits for certification. Additionally it fits within the service role of the E&O program, as IRIS E&O would write a proposal for the development of the course, develop it and then give the course, along with training, to any IRIS school who wanted to offer it through their institution (perhaps in partnership with the education department). The initiative is sustainable since IRIS would only seek funding to develop the course. The implementation of the course would be driven by the enrollment at any IRIS schools interested in offering it.

**Video products for major media distribution**

We propose to work with partners to expand IRIS’ involvement in video products for large markets such as Discovery Channel. The goal is to create dramatic stories that are told in a cutting edge documentary television style that targets both primetime and educational audiences. The videos will be entertaining and fast-paced and will capture scientists who are engaging storytellers while they work. 3-D graphics will illustrate the theories they propose and the reality they are discovering. The videos will be supplemented by practical and absorbing curriculum activities that are distributed on the Web. The videos and supplemental material will meet the required educational standards for middle and high school science. Funding for the videos will be pursued outside of the core IRIS funding, in partnership with video production companies.

**Visualization and animation of seismic data and modeling results**

Graphical tools that allow interactive visualization of data and models provide an important way for students to gain understanding of complex data sets. We propose to work with partners to improve and create new ways to combine seismic data and results with other data. Combining the diverse data sets that are expected to be produced by EarthScope research projects is a prime example. The visualizations could include web-based and stand-alone products and 3D technologies such as GeoWall. An example would be a map-view representation of 3-D particle motions across the Transportable Array from a large earthquake. Another example is improved imaging of mantle structure and dynamics via collaboration with UNAVCO and GEON, using the GEON Integrated Data Viewer (IDV), which is an extension of the Unidata IDV. An initial step will be to work with NSF’s animation group on an animation that explains seismic tomography on the scale of USArray.

**References**


