

**Workshop Summary**  
**U.S. Educational Seismology Network Workshop**  
Baltimore, Maryland, September 13-15, 2003

## General Overview

This report summarizes a September 2003 workshop convened to chart the future course of the U.S. Educational Seismology Network. The workshop took place at the Mt. Washington Conference Center (Baltimore, Maryland), on September 13-15, 2003. The stated goals of the workshop were (1) establishment of a strong community consensus for the USESN initiative, (2) development of a short-term (1-year) management plan and structure for a 1-year pilot proposal for initial USESN activities, and (3) development of a draft a 5-year strategic plan for the USESN. The 2.5-day workshop brought in 46 participants from the research, education, and science outreach communities, included a mixture of oral, poster and discussion sessions, and concluded with formal writing assignments for education and operations plans for the USESN. A detailed description of the meeting agenda can be found at <http://www.indiana.edu/~usesn/workshops.htm>. The list of meeting participants and contributed abstracts can be accessed at <http://www.indiana.edu/~usesn/workshop/Registrants.htm>.

Much of the meeting time was devoted to discussion sessions focused on a series of issues deemed critical to the future of the initiative. Three of the meeting's four breakout discussions focused on the three overarching themes: curriculum issues, professional development issues, and technical issues facing the USESN. The fourth of the breakout sessions, which focused on management issues, divided the workshop into three groups addressing organizational structure of USESN, funding opportunities, and institutional/international linkages. This report summarizes the discussions and principal conclusions of each of these six discussion groups. Additional information about the workshop can be obtained by contacting a member of the workshop organizing committee <http://www.indiana.edu/~usesn/workshop/meetingcontacts.html>.

## Curricular Issues

The discussions of the curriculum breakout addressed a variety of issues surrounding the creation and dissemination of seismology-related educational materials. Below, we address a number of the curriculum-related questions developed by the organizing committee.

### *How can we identify needs and prioritize the development of curricular materials?*

The group began the discussion with an attempt to articulate the fundamental educational goals of the ESN community:

- increasing earth and space science literacy among students, teachers, and the population at large;
- promoting integration of science disciplines through interdisciplinary approaches, i.e., introducing earthquake science across the earth science, physics, mathematics, geography, and computer science curricula;
- developing high-quality educational resources for pre-service teacher-training;
- engagement of student interest in scientific research through hands-on, inquiry-oriented student research experiences;

- bringing state-of-the-art scientific observation and analysis into the classroom setting; and
- using seismology as an exemplar of high-quality application of advanced technology for scientific research.

A fundamental issue, well articulated in Jim Bartholomew's introductory presentation, involves finding the appropriate balance between broadly based efforts aimed at bringing seismology into the K-12 science curriculum through alignment with curriculum reform movement, versus narrowly based curricular efforts aimed at development of a modest-sized cadre of highly motivated, research-oriented participants in a national seismic network. The two approaches imply vastly different use of resources. The former implies a minor role for seismic instrumentation in the schools, and requires that much of the resource base be devoted to development of a broad range of curricular materials. The latter places a much greater emphasis on instrumentation and student research, requiring less in the form of curriculum development. Although this overarching issue was not formally resolved, much of the discussion focused on a narrower interpretation of our role in developing a focused set of curricular materials related to analysis of seismological data.

*How do Educational Seismology topics align with national standards and existing classroom methods and materials?*

It has become increasingly clear that a fundamental requirement for implementation of any new curricular initiative will be the alignment with national and state/local educational standards. Because seismology touches on many of those standards, in areas of physics, mathematics, earth science, and geography, such alignment is not difficult. The responsibility will be on us, however, to demonstrate the applicability of each curriculum module to individual standards, and to provide teachers with means to incorporate the modules into a strongly standards-oriented curriculum.

*Who is our primary audience (e.g., K-6, 7-9, 10-12, college, general public) and how should we allocate resources between the different audiences?*

The group discussed the range of educational arenas that would be most receptive to seismology-related curricular initiatives. These include, in decreasing order of audience size:

- (1) middle-school earth science/physical science classes;
- (2) high-school physics/earth science/physical science classes;
- (3) college-level earth science classes;
- (4) pre-service science teacher training classes;
- (5) clubs, science fair participants

USES N seeks to address all of these prospective audiences. However, given limited resources, many of the participants felt that we should focus most of our resources on addressing the broadest possible audience, i.e., earth/physical science where it is most broadly taught—at the middle school/early high school level. Others, however, noted the importance of attracting high-ability, college-bound students into the earth sciences. Thus, the group sought some combination of broad distribution of accessible classroom materials for many students in elementary level earth and physical science classrooms, while providing opportunities for high-end, science-oriented students.

A common point of discussion—and occasionally dissent—throughout the meeting was the balance between low-cost, education-oriented instruments vs. more expensive, research-grade instruments. The majority of the group agreed that highest priority should be given to widespread engagement of teachers and students through the use of an inexpensive, easy-to-operate seismic instrument such as the AS-1. A smaller-scale deployment of research-grade instrumentation should be encouraged in appropriate circumstances. The group agreed that in any case, easy access to global seismic network data is essential to the success of data-intensive curriculum exercises. We also discussed alternatives to actual seismograph station operation: for instance, some schools can operate 'virtual seismograph stations' that provides high-quality real-time seismic displays without the requirement of actual station operation. A possible connection to the EarthScope initiative might be an 'Adopt a Seismograph Station' program that links participating schools with a neighboring USArray or ANSS seismograph station. Many of the participating teachers, however, agreed that a physical instrument provided very valuable features that could not be obtained by simply sharing a regional instrument, or by operating a 'virtual station'. They stressed the importance of a sense of "ownership" by participating students and teachers. The presence of a physical instruments also serves to "hook" students' interest through direct observation of instrument operation. Operation of a seismograph in the classroom also provides a solid basis for understanding what a seismogram is and therefore the appropriate background needed before using Internet-based sources of high-quality seismic data.

*How do we prioritize the development of a few simple exercises for a broad distribution versus a range of in-depth exercises? How can we assess the pedagogical quality of current and new materials, their impact on learning and their use in the classroom?*

The limited time available did not allow the group to address these issues in great depth. There was a consensus that an essential component of curriculum development is the creation of an effective needs and gap assessment that will help define the areas of greatest need. Of course, a large number of seismology-related curricular modules already exist; an important first step is the creation of a clearinghouse of existing materials and some assessment of the effectiveness of those materials. Many existing materials have been developed and implemented with little or no effort to assess their educational impact. It was noted, however, that many new curricular initiatives (e.g., materials developed through the IRIS E&O RFP) have some sort of formal assessment incorporated into the development/implementation plan.

*What are the best mechanisms to disseminate materials and encourage the creation of new materials?*

Two end-member approaches exist for curricular dissemination: remote access through web-based dissemination mechanisms and more direct introduction through pre-service teacher training, professional development workshops, and teacher-to-teacher interaction. The former approach requires the creation of very robust, easy-to-incorporate materials that require a minimum of teacher training. The latter requires less formal curriculum development, but relies on a cadre of education-outreach specialists, acting as an intermediate layer between the research community and the educators. Possible candidates for that role include science educators, master teachers, and 'volunteer mentors' (e.g., retired earth science, physics, or engineering professionals).

*How do we develop general curricular materials that are readily adaptable to diverse audiences?*

Although the mechanism was not defined in detail, the group agreed that core concepts in seismology are applicable at many levels. We should seek in developing new materials to allow for applications at a number of different levels, perhaps using the same data and analysis tools but providing different questions for each of the different target audiences.

**Action Items.** The group identified a number of projects for focus on for year 1 implementation. These include:

- development of a clearinghouse for existing curricular materials related to educational seismology;
- preliminary needs assessment of curricular materials that will address the prospective value of new curricular modules to a range of USESN audiences;
- development of prototype curricular materials intended for two primary target audiences—middle school earth science and physical science classrooms, and high school advanced earth science and physics classrooms;
- identification of sources of seed funding to support initial development and pilot deployment of curricular materials; and
- development of tools and resources to make seismology research accessible to high-school and undergraduate student researchers.

Issues critical to the successful development and dissemination of these materials include the following considerations:

- (1) that the curricular materials be strongly aligned with national, and ideally state, standards for science education;
- (2) that curricular development involve a close collaboration between researchers, education developers, and practicing teachers;
- (3) that dissemination of curricular materials be coordinated through a well trained cadre of 'outreach specialists', perhaps including experienced 'master teachers';
- (4) that the materials be strongly interdisciplinary, linking earth science with physics, mathematics, computer science, and other disciplines;
- (5) that dissemination be closely coordinated through professional development workshops and follow-up teacher-training activities; and
- (6) that impacts be carefully assessed in a small number of pilot school districts, preferably in a number of contrasting geographic and educational environments.

Longer term goals include the following:

- widespread implementation of USESN curricular resources into schools nationwide;
- development of a densely spaced network of educational seismographs at schools and public institutions across the country ("A Seismograph in Every Starbucks!??")
- broader integration of up-to-date seismology curricular materials into high-school and middle-school science textbooks;
- some significant scientific discoveries that have been aided by the efforts of the USESN community;

- greater public awareness and understanding of earthquake hazards leading to improved mitigation;
- eventual broadening of curricular coverage to cover a range of current seismological topics; and
- to leave a legacy of educational seismograph stations in the aftermath of EarthScope deployments.
- greater awareness of the professional job opportunities in the earth sciences and increased diversity in the work force.

### **Professional Development Issues**

The professional development breakout section began by prioritizing the most important questions for discussion during the limited time available. Based on input from all participants and a brief discussion, the breakout group spent its time focusing on the following two questions.

*Who is our primary audience (e.g., K-6, 7-9, 10-12, college, general public) and how should we allocate resources between the different audiences?*

The group quickly concluded that at least some professional development effort must be targeted to all audiences (K-6, 7-9, 10-12, college, informal [i.e., museums, home school, etc.], and general public). Each of these audiences has a specific significance in science education under the broader concept that good science outreach programs should reach as many people as possible. We should aim to meet a broadly stated goal of "science for ALL students". For example, it was recognized that many students are attracted to a science career at an early age, so it is important to provide them with quality science experiences, including, of course, earth science and particularly an exciting and relevant earth science topic such as seismology.

Within K-12 education, earth science is often included or emphasized in the middle grades (5-9) so it makes sense for USESN to focus significant professional development efforts toward that audience (with materials and resources and through professional development for in-service teachers). Grades 10-12 represent opportunities for more in-depth coverage and student research in seismology and connecting to earth science as well as physics and mathematics courses. Effective professional development for these audiences would not only enhance science education for a broad audience but also have the potential to interest students in a future career in earth science or even in seismology. The college audience is significant because many students take introductory earth science courses and our efforts to enhance earth science education would therefore reach a large audience. Further, professional development aimed at colleges could reach pre-service teachers and also provide an additional opportunity to attract students to careers in earth science. Professional development focused on the general public is important in order to reach a large audience, to contribute to science literacy, and to help generate public understanding, acceptance, and support of science. In summary, the group favored addressing all levels in some way but suggested an initial focus (and an initial investment of resources) on grades 5-9 professional development (materials, opportunities, in-service teachers) followed by professional development aimed at pre-service teachers. For this effort, it was noted that including both college science and education departments was important. For the K-4 level, it

was noted that few seismology activities are available and that it would be beneficial, for addressing this age group, to develop 1-2 simple and effective exercises in seismology.

*What are the most effective structures for professional development programs and the most important and effective topics and educational materials for use in these programs?*

The discussion of this question focused on some general issues of effectiveness of professional development programs, and then examined workshops more specifically as mechanisms for this goal. The structure/characteristics discussion provided a list of suggestions including:

- Building of a stronger sense of community among scientists and educators, providing reinforcement and motivation for ESN participants;
- Pairing of researchers and instructors (scientist-mentor/teacher-learner), maximizing opportunities for face-to-face interaction;
- Immersion of teachers in the research process;
- Construction of state and local alliances, enhancing advocacy for science education;
- Development of on-line courses with built-in assessment;
- Use small colleges as resource agents for dissemination of professional development activities; and
- Development of a cadre of well-trained education specialists, who can serve as intermediaries between the scientific and education communities.

Most participants favored workshops as a primary mechanism for professional development. At the same time, it was recognized that they also require significant follow-up effort, such as virtual meetings, online resources, and additional contacts. In many cases, a second follow-up (advanced) workshop is highly desirable to maintain and expand the professional development experience, respond to teacher or participant needs, and maintain involvement. Other concepts that were mentioned as being important in the design of effective workshops were recruiting teams (pairs or more) of teachers to provide a built-in support system and using 'master teachers' to teach new participants, where appropriate.

**Action Plan.** This group tried to produce a defining vision for the ESN community for the next five years. The vision is based on the concepts of appropriateness of the objective for the largest audience and cost-effectiveness, resulting in a "pyramid" of educational seismology goals. The long-term vision of an ESN network might look like this:

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

An ESN initiative of this scale could result in a 'sea-change' of earth science education, in which inquiry-oriented learning using state-of-the-art technology becomes a normal part of student learning. Participants discussed concrete indicators of ESN activity, including student presentations at national conferences (based on USESN data), and a formal USESN Certificate for students who complete a research program.

The group discussed possible next steps for the national effort. These include:

- (1) Development of a 1-year management plan for ESN and a 1-year pilot proposal;
- (2) Undertaking a formal needs assessment for ESN, defining the highest priority issues for professional development activities;
- (3) Identification of a cadre of workshop leaders and other researchers and science education specialists to develop an effective professional development plan;
- (4) Creation of focus group workshops
- (5) Identification of existing and development of new professional development Internet resources;
- (6) Working to expand awareness of freely available data (through workshops, web pages, e-mail communication, etc.)
- (7) Documentation of implementation experience of existing networks for replication elsewhere (most/least useful, what is needed, models for distribution/archiving)
- (8) Identification of existing Internet resources and workshops for use nationally or as models

The group also tried to address realistic goals for in three distinct time sales:

Year 1 Goals	Year 2 Goals	Year 3-5 Goals
<ul style="list-style-type: none"> <li>• Management plan adopted</li> <li>• Existing Internet resources promoted</li> <li>• Workshop designed for each user group</li> <li>• Focus on use of seismic data</li> <li>• Pilot train-the-trainer workshops for 10 teachers each</li> <li>• 100 new schools involved</li> </ul>	<ul style="list-style-type: none"> <li>• 10 Workshops offered to 30 teachers each</li> <li>• 1000 new schools involved (mostly use of seismic data, a few new schools with seismometers)</li> </ul>	<ul style="list-style-type: none"> <li>• Expansion of seismometers (PEPP &amp; AS-1) in classrooms</li> <li>• Explore possibilities for distance learning opportunities</li> <li>• Assessment</li> <li>• 8660 new schools involved</li> </ul>

Although there was limited time devoted to exactly how this vision could be fulfilled, it was clear that both professional development workshops and available, quality online data and resources would necessarily be a large part of the professional development program.

**Technical Issues**

Discussions of this group followed the format of questions posed by the steering committee. These questions were arranged into categories in groups. The discussion questions are given below along with a summary of the discussion these questions generated.

*What is the relative value of stand-alone systems (e.g., AS-1), online networked systems, and use of data from global, USNSN, and USArray stations?*

The primary consensus was that all three approaches were important, but each probably had different contexts where they were most applicable. The varying options, in fact, provide a mechanism to extend involvement to a broader audience of prospective participants. In general,

a passive participation mode is a good entry point in combination with appropriate curriculum materials to teach key concepts. A simple system (e.g., AS-1) is a good entry point for teachers to experiment with the idea of a seismograph in school. The more advanced systems are most appropriate for advanced teachers with a solid background in seismology and with an ability to handle the technical problems these systems pose. Physics teachers or teaching college professors are the best candidates for operating these high-end systems.

*What is the best way to ensure that the technical elements of USESN maximize the educational value of the program?*

There was a strong consensus that the most important technical issue to address this questions is that the software to access the data archive needs to be rock solid, intuitive and easy to use, and reasonably efficient. Curricular materials are needed that are well integrated with these access methods. Finally, it was noted that instrument procurement delays can have a devastating effect on a fledgling program. Initial interest can disappear if it takes months to obtain instrumentation. This means that it may be necessary for IRIS to have a stockpile of educational instruments that can be used to ramp up startup programs.

*Who is our primary audience (e.g., K-6, 7-9, 10-12, college, general public) and how can we meet the diverse technological needs and skills of these audiences?*

A general consensus was reached that the primary target was from middle school through college level. The general public is important but would need to be approached with very different methods. Experience of the group has shown that subsets of people within this age range and the associated teaching staff are best served with different approaches. Some identified groups were:

- Middle school and early high school earth science courses are the best educational targets for introducing seismology into the curriculum. People interested at this level are probably best served initially by a low-cost instrument in combination with educational materials that combine local data with IRIS data from the DMC.
- High school physics teachers and teaching college faculty represent the ideal group for operation of the highest quality instrumentation. Both can be expected to have better technical expertise and have the motivation to operate a station from a personal interest level.
- Amateur seismology could grow dramatically, but it depends upon a readily available consumer product sold in places like museum stores.

*How should USESN data be stored and distributed?*

There are two established models for moving educational seismic data to an archive. The first is manual uploading of event-segmented data. Many teachers have used this as a valuable educational experience for a select group of interested students. The responsibility assigned to them to make this happen gives them ownership of the data and can help them learn basic academic skills. Currently the best operational model for this approach is probably the system developed at Arizona as part of their SPINET program. The second model is continuous telemetry via the Internet. This is model is currently being used by PEPP (Princeton Earth Physics Project), SCEPP (South Carolina Earth Physics Project), and the NESN (Nevada Educational Seismic Network) programs. This approach requires the operator to get past more

technical barriers (mainly network setup and firewall issues) that can be a major barrier to instrument operation.

Downloading data to users for educational applications is a different issue. A fair consensus was reached that developments in the GEE (Global Earthquake Explorer) software were promising and that this is likely to become the standard tool for delivery of data for most educational applications. Nonetheless, there was also a strong consensus that in the short term, there is a significant need for a parallel effort to make a user-friendly (simplified) Wilber data access method available to educational users. Several reasons for this were articulated including: (1) a user base already familiar with this approach using tools like WinQuake to work with seismic data; (2) a general need for a simple front-end based on a browser that would not require a special tool to be installed; and (3) concerns about possible performance problems with GEE in low-end computers and/or slow networks. This led to a discussion about the need for a suite of "special events" for educational purposes that have key features labeled described. It was suggested these could be used as building blocks for teachers to improve their knowledge of seismic data interpretation and for the demonstration of a concept being taught (e.g., "This seismogram shows ScS and illustrates some of the evidence for Earth's core... ")

*Should resources be spent on quality control?*

It was universally recognized that school data could not be subject to quality control at the level of standard research equipment. However, the discussion clarified that there are two primary QC issues in educational data: (1) lack of consistent recording of timing information for most data and (2) difficulties in obtaining and passing on station metadata. The former is largely an instrumentation problem as none of the common educational systems have robust systems for tagging information about timing accuracy with the raw data. The second is pervasive in all of seismology and is even worse in the educational realm. Few to none of the existing educational stations have the full metadata required for a standard SEED response definition. Community developments in simplifying metadata definitions may improve this problem, but it will likely be a problem for some time unless something is done to streamline the process of metadata definition.

*What kind of hardware developments are needed? How can this be jumpstarted? What software developments are needed?*

On the hardware side the discussion focused on the general desire for an inexpensive system with high-precision timing that was self-describing in setup. It was recognized, however, that this is unlikely in the near future unless seismometers become a consumer item at a scale that is unlikely in the short term. It was noted, however, that having seismometers in museum stores could improve the market for education and amateur-quality equipment. Discussions on software highlighted the importance of software at many levels, but the group did not converge on any details during the initial session that discussed these topics. The group did come to some specific recommendations for action, however, during day two of the workshop (see below).

Several people noted that we should not rely on large software packages that require the presence of a high-bandwidth network for installation in schools. A related issue is that for the same reason there remains a need for media-based data sets (e.g., data and software on a CD).

*What is needed to complete the buyer's guide and installation/operation guide?*

Although this question was raised it generated little discussion. The conclusion is that what exists is a good start is worth maintaining as a component of basic material on the web in support of USESN.

*Should ESN resources be used for the installation and maintenance of seismic instruments in schools? If so, how can this be supported? How many different hardware and software platforms should be supported? How should we decide which to support? What does it mean to support a hardware or software platform?*

The group reconfigured these questions to focus on three different issues: purchase of hardware, installation of hardware/software, and maintenance of stations. The discussion reviewed the USESN white paper model wherein equipment acquisition was best done "locally" with support being "regional". There was a strong consensus that one of the great strengths of the USESN idea was as a means to set up partnerships between university groups and secondary schools. Some felt national level distribution of hardware was problematic while others argued it could be useful in some project depending on how a program based on the USESN concept developed.

*How can the USESN become involved in EarthScope/USArray deployment and EarthScope EON local alliances?*

The group discussed this only briefly with no significant results. This was primarily a problem of a lack of time.

#### **Action Items:**

The technical issues group met the second day of the workshop to formulate a set of action items. The results of that session were the following recommendations:

##### *USES N Web Site*

- There is a need to consolidate as much information as possible into the new USESN web site. Get feedback from community to maximize material in this site.

##### *Data transmission:*

- Set up an upload system (probably building on SPINET system) to allow AS-1 and other manually uploaded data to be transmitted to IRIS DMC.
- Continuous data transmission has multiple working solutions that we need to just build on to make it easier to plug a new station into a current network.

##### *Data delivery*

- A simplified Wilber needs to be set up for educational users. A working group needs to be set up to define and refine how this interface should be set up and to define the look and feel of the system.
- Long term: GEE seems to be going in a good direction – but will require continued close communication between IRIS DMC and E&O to keep the development on track.
- Long term: IRIS/USES N should work to evolve the national system for USESN data to simplify and automate the process of both contributing data and receiving data from the DMC.

*Hardware*

- We need to set up a pool of loaners and/or trial instruments that can be used to jumpstart new programs. This essentially already exists with the AS-1 instruments, but a small pool of other instruments (e.g. PEPP-V's recovered from inoperative PEPP schools) would be useful.

**Linkages Breakout:***Do all schools need to be affiliated with a regional center or university?*

The consensus was that regional centers were desirable, though not necessarily essential. Experience to date has shown that linkages between university groups and teachers are essential ingredients to build the human relations network that makes a program effective. Programs with an emphasis on teacher professional development will absolutely require a strong connection between university and school groups. On the other hand, programs like the IRIS Seismographs in Schools program do allow a teacher to work with these instruments in relative isolation. It was also noted that "regional" is a definition that depends on population density. Distance is more of a factor in sparsely populated states like Arizona or Alaska, making direct contacts more difficult in many cases. In contrast, the ability to travel to a school and return in the same day is important for the success of programs in Indiana and South Carolina.

*What is the ideal relationship of research-oriented and teaching-oriented institutions?*

Some suggested that teaching institutions could provide a valuable layer of support between active research groups and schools, but most felt that introducing an additional level hierarchy could be damaging to the development of direct university-school relationships. A stronger consensus was that IRIS could and should build on its Educational Affiliates program to build up a community for USESN. Educational affiliates could provide a core nucleus of people to expand USESN and are the best candidates for operating higher-quality stations. Mechanisms were discussed to promote this with three concrete suggestions a person is needed at IRIS to (1) coordinate this effort, and (2) promote the program at meetings attended by individuals we want to reach (GSA, AAPT, etc.).

We considered these the following series of questions together: *What is the best way to encourage international collaborations? Can USESN provide funding for international groups or just access to software and data? How can exchange of data, software and classroom activities be improved? Could international data be stored at the DMC? Are there special opportunities for collaboration with other disciplines (e.g., foreign language teaching) in international collaborations? How can we extend ESN activities to the developing world?*

Several items emerged with varying levels of endorsement by the group:

- USESN needs a mechanism to interact with Project GLOBE
- USESN needs a mechanism to share software and technical developments between programs across the globe.
- Formal links between schools need to be encouraged. The natural link between science and foreign language classes is a clear opportunity. A 'seismic pen pal' concept was discussed.

- European version of USESN is developing rapidly and we need to collaborate with them. An opportunity to make this happen is at upcoming international meetings like the IUGG.
- Linkages to next-door neighbors in Canada and Mexico should be an immediate concern for USESN and EarthScope.
- Explore funding options for international connections possible through State Department or NSF International Programs.
- Getting college international programs and foreign language departments involved in programs could be a way to promote international collaborations.
- Seismographs in schools is likely to be a low priority for developing nations, but as part of a national hazards effort could be a useful way to help developing nations build a national network. Middle East and Central American countries are obvious targets.

*How can we develop a formal relationship with USGS/ANSS, DLESE, or other earth science education organizations?*

The group quickly added another important category here. Museums and science centers are an important potential partner for USESN activities. They have staff with a mission in outreach and are natural partners for running seismic instrumentation for local consumption. University of Alaska has an active partnership with the Denali Foundation that is proving very fruitful for them. Support for educational programs is a big problem for them due to the large travel distances. Similarly, national and state parks would likely be valuable collaborators for local educational displays at visitor centers.

*How can we foster collaboration (sharing of data, classroom activities, collaborative science experiences) between students in schools? What web resources can be used to foster collaborations, including sharing of data and classroom activities and interactions between students in different schools in the same or different regions and networks?*

A current problem is that students in schools have no easy, sanctioned way to communicate with other students. Furthermore, although progress has been made, access to computer technology in most schools remains problematic for both economic and political reasons. There are serious issues about school liability for minors and access through the web of “inappropriate” materials. The best way to get around these problems is probably to set up formal relationships to “sister schools”. This type of mechanism can reduce liability concerns and open more channels of communication.

Another idea advanced was that contests and awards provide a motivational force to get students and teachers involved. A small cash prize for best ESN project could be considered. The “ask a seismologist” experience was discussed. It was noted that this approach only works for small workloads. If the number of people asking gets large, answering the questions can become too burdensome for volunteers and paid staff are required. A FAQ for technical issues associated with the AS-1 seismograph would be a good first step.

*What is the optimum role for USESN in EarthScope activities—particularly during the deployment, operation, and post-deployment stages of USArray?*

Some items discussed were:

- A media kit needs to be developed to precede USArray arrival that can be distributed to schools with initial suggestion of working toward ESN participation.

- A backend kit is needed to provide a mechanism to allow a school to continue to participate in USArray as an ESN participant.
- PBO also has similar connections but without the backend element. Schools could be more natural hosts to some types of instruments (e.g. GPS).
- Could use instrument siting as a way to teach geography in school (map reading and exposure to modern GIS concepts)

## Funding Breakout

*Funding for which activities should be provided by the national organization and for which activities should local and regional networks be expected to independently seek their own funding? What should long-term funding cover (e.g., central office, technical support, new equipment, professional development, curriculum development)?*

The consensus of the group's discussion was that there exists a suite of core ESN-related activities that would benefit from a centralized facility. Probable activities that could be provided by a national organization include:

- Administration: A centralized administration for ESN could provide essential coordination of regional networks' activities, funding, communication, and a wide range of community activities.
- Instrumentation: Although many participants argued for local 'ownership' of equipment acquisition, some argued for the cost and coordination benefits of centralizing purchases, and allowing schools to get equipment at no direct cost (e.g., PEPP, SCEPP, or IRIS Seismographs in Schools model). There was also considerable discussion on the number and type of instruments needed for school deployments, as well as the appropriate level, ranging from low-cost demonstration-style instruments to higher-end research-grade instruments.
- Technical support: A centralized facility could coordinate technical support, develop manuals for installation and operation of instruments, and some level of email or telephone support. Direct support for station operation would need to come from regional/local network operators.
- Professional Development activities: A centralized facility could provide high-quality materials for professional development activities, as well as direct training at national/regional science teacher meetings. Most direct professional development activities, however, would probably continue at the regional/local level.
- Curriculum Development: One of the major benefits of centralized ESN facilities would be the development of high-quality educational materials to accompany educational seismographs. This would avoid duplication of effort and allow for the development of higher-quality, standardized curricular materials. Dissemination and assessment of curricular materials might occur more logically at the local level.
- Software development: A central ESN facility could act as an interface between software developers and the user community. The major commitment of resources needed for high-quality software development would probably only be available through a well-funded, centralized ESN facility.
- Data management: There will probably be growing efforts to centralize data management activities, primarily through the IRIS DMC and regional data management

- facilities. A central ESN facility could help to coordinate data management issues with IRIS, and could act as an interface to educational users.
- Community activities: An important contribution of an ESN facility would be the development and coordination of community activities, including workshops, teacher-training programs, teacher- and student research symposia, and developing websites.
  - Assessment: Much assessment activity would, by nature, take place at the local level, but a central facility could provide resources to make assessment accessible, by providing standards, standardized assessment tools, and collecting and disseminating results of assessments.

*Where might long-term (5+ years) funding come from? What opportunities are there for foundation or industry funding?*

Although a variety of options are available, probable sources include NSF's Elementary, Secondary, and Informal Education (ESIE) program, the Division of Undergraduate Education programs, the Geoscience Education program, and the National Science Digital Library (NSDL) program. Other long-term funding might come from foundations or industry, particularly those with a strong science or technology focus. Examples include the Exxon-Mobil Foundation, the Keck Foundation, and Intel Foundation. A strong organizational model needs to be in place before long-term funding can be secured. Most likely scenarios for funding would not rely on a large single block of funding, but would rely on the project being funded 'in pieces' through a number of distinct grants. Linkage with other science outreach programs, such as EarthScope Education and Outreach Network (EON), Project GLOBE, the Revolution in Earth & Space Science Education, may be critical to the success of our project. A critical question for long-term funding is the balance between funds coming through the IRIS E&O core funding versus supplemental funds coming from outside sources. For the short term, funding from the IRIS E&O core will be quite limited, due to commitments for ongoing projects.

*What are the high-priority targets for short-term (1-3 years) USESN funding?*

The group discussed a probable three-stage strategy for funding: a short-term funding phase for a ramping-up of the consortium, which would include resources for pilot projects, start-up for community activities, and resources for further growth. Success during this start-up phase would allow for a major growth phase, relying on the identification of one or more major grant sources. Following this a period of major growth, the organization would need to move into a long-term sustainability phase, providing funding for technical, curricular, and professional development support for existing school participants.

*What are the critical elements of the USESN that will be needed for ongoing success (ie. what are the most important structures and services)?*

Critical short-term funding goals include a process of taking stock of existing programs—i.e., identification of the areas of success of current programs, as well as their failures. We need to more formally document the impacts of existing programs, and link findings to a formal needs assessment, in order to decide how best to invest future resources. Critical short-term efforts include

- Development of a national organization for coordination, communication, and identification of funding opportunities
- Expansion of existing programs and replication of successful programs

- Dissemination of educational materials
- Broadening the community of participants in ESN activities
- Development of a cadre of advisory groups, particularly 'in-the-trenches' experience with science education in the K-12 environment.
- Identification of sources for supporting/sustaining local educational seismograph network operation

## Organizational Structure

The breakout discussion on Organizational Structure developed considerable debate. End-member solutions were discussed that range from a loosely linked federation of independent programs to a tightly focused national initiative. The breakout was followed by a wide-ranging discussion that expanded on each of the organizational issues.

*What can a USESN federation provide that individuals or regional networks can't do for themselves?*

The consensus of the group was that most of the resources and efforts involved in delivery of educational products must take place at the local level, and that success of our program will rely on robust local activity, sensitive to the needs in each region. However, a national federation can provide resources to facilitate work that might otherwise not get done. These include:

- Instrument acquisition (bulk purchases of seismic instruments to allow easier initiation of ESN programs and encourage standardization of instrumentation);
- Coordination of technical resources (provision of resources to help schools install, operate, and maintain ESN instruments);
- Preparation & dissemination of shared curricular resources;
- Creation of professional development materials (to encourage local-level delivery of high-quality professional development programs);
- National organizational activities (workshops, symposia, publications); and
- Communications, website development

A national federation can also help to provide support for local projects, in the form of credibility for local efforts (through association with a national effort), by providing a point of focus to build community, and by raising expectations and enthusiasm for a national effort.

One model for a successful federation is the Federation of Digital Seismograph Networks (FDSN), which receives little centralized funding, but provides an important resource for the research seismology community. The FDSN provides critical quality-control criteria for data sharing, site coordination, instrumentation, siting, as well as resources for data centers and software developers.

*How can the federation best provide those resources and services?*

The group agreed that some level of centralized resources are needed, but that many of these resources can be provided through existing programs, e.g., IRIS E&O effort, and through modest expansion of an external funding base for USESN. The conclusion of many participating in the breakout was that we should strive for the minimal level of organizational structure that is needed to sustain a national effort.

A number of critical efforts were recommended for the central organization. These include:

- Continued development of the USESN Buyer's Guide
- Facilitation of data exchange between networks
- Development of high-quality curriculum materials
- Application of well tested assessment instruments
- Needs assessment geared to practicing teachers
- Workshop preparation & notebook guide for facilitation of professional development activities
- Documentation of effectiveness of the approach
- Communication resources for teachers/students (e.g., web resources, web conferencing, on-line publications, etc.)

### **Workshop Organizing Committee**

Michael Hamburger  
Indiana University

John Taber  
IRIS Consortium

Gary Pavlis  
Indiana University

Tom Owens  
University of South Carolina

John Lahr  
U.S. Geological Survey