

**WORKSHOP REPORT**  
**NEPTUNE PROJECT -- EDUCATION & OUTREACH**  
July 24-26, 2001, Chinook Center, Whidbey Island, Washington

Workshop Conveners

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**Summary**

A small group of educators, scientists and engineers gathered for a workshop on Whidbey Island to distill the ideas generated at the first (and much larger) workshop held last November at the Sleeping Lady Conference Center, Leavenworth. The goal was to develop the basic "kernels" of 2-3 proposals for submission NSF in spring 2002. The fourteen attendees first discussed and generated an overall vision of how NEPTUNE can transform learning and teaching while ocean and earth sciences are changing with this new mode of investigation. They then addressed specific topics drawn from an initial distillation of those conceived at the Sleeping Lady conference. These discussions were detailed and written up into two proposal kernels by the end of the workshop. The resulting ideas include 1) a program teaming scientists and teachers quite closely to bring NEPTUNE related education to middle-school classrooms (a pilot for the NEPTUNE Institute), 2) a program to create a "sea-floor" experience that could be use in both informal science settings as well as for formal school groups. The next steps in the process of turning these kernels into something of NSF proposal quality are many and vary with the individual concepts. However, each depends on a adequately identifying partner institutions for the programs and researching models from other sciences and places. Lastly, all agreed that a third workshop be held specifically to develop more ideas for informal education and general outreach as general exposure to the NEPTUNE concept is important on a broad range.

**The NEPTUNE Project** (see [www.neptune.washington.edu](http://www.neptune.washington.edu) for more information)

*Background:* Ocean and earth sciences are on the threshold of major changes driven by the need to study these systems differently and new enabling technologies to do it. Traditionally, oceanographers have gone to sea in ships to collect in-situ data for short periods of time: an expeditionary mode. Missing from this approach is crucial information on the fourth dimension of natural processes: time. Now, by combining advances in several technologies, we have the ability to observe and interact with the whole dynamic ocean-earth environment for long periods of time.

*The NEPTUNE Network:* A network of about 30 undersea "laboratories" connected to shoreside power and computers will enable unprecedented real-time observations of, and experiments within, dynamic earth-ocean systems. By laying 3,000 kilometers of fiber-optic and power cables on the seafloor around and across the Juan de Fuca tectonic plate and North American continental shelf, a suite of in-situ observatory and experiment nodes spaced about 100 kilometers apart will be created. This tectonic plate in the northeast Pacific Ocean (off British Columbia, Washington, Oregon and California), is one of a dozen or so that make up the planet's surface, and is an ideal location that offers a representative spectrum of global earth-ocean processes.

*Full-time, Interactive Science:* In contrast to the traditional expeditionary mode of science, NEPTUNE will operate full time ("24/7") for at least a quarter century. Plans call for the project to begin operations in 2006. Data from the NEPTUNE network will flow in real time via the Internet to

land-based laboratories, classrooms, and living rooms around the world. Scientists, students, decision makers, and the general public can use the NEPTUNE network to gain a new understanding of earthquakes, tsunamis, fish stock assessment, marine mammal populations, metal and hydrocarbon deposits, and human influences on ocean and climate systems. If an event occurs that demands a change in sampling or a different type of observation, the NEPTUNE system allows scientists to do so from their desks via instrument command and control. No ship and crew will need to risk themselves on the sea surface to discover what's happening below.

*Education and Outreach Potential:* Opportunities exist to couple this scientific and technical revolution with entirely new approaches to educating learners of all ages. NEPTUNE's capabilities, which include access to a wide variety of sensor packages and robotic vehicles via the Internet, will be significantly more engaging than turning the pages of a textbook. By capitalizing on real-time communication with an entire earth-ocean system, NEPTUNE could be used to develop fundamentally new approaches to education by scientific inquiry and encourage new forms of creativity.

*Project Progress:* In June 2000, the NEPTUNE Feasibility Study concluded that the project is technically feasible and scientifically desirable. Now in Phase 2, the infrastructure design and testing is underway, as is identification and development of the scientific and educational user base. As part of that effort, a series of workshops is being put on to explore potential linkages between NEPTUNE and the informal and formal science education communities. The first of these workshops was held November 17–19, 2000 at the Sleeping Lady Conference Center in Leavenworth, Washington and entitled *Technology, Science, and Education: A Sea of Opportunities*. The 60+ participants focused on the use of NEPTUNE as an evolutionary test-bed for using real-time data products in education. The workshop created a large number of good ideas (see report at <http://www.neptune/pub/education/wkshp.rep.html>). The second workshop was held July 24-26, 2001 at the Chinook Center on Whidbey Island, Washington and is the subject of this report. It was attended by 14 educators, scientists and engineers and sponsored by the University of Washington NEPTUNE project office.

### **Workshop Structure and Activities**

The 14 participants were drawn largely from those who attended the Sleeping Lady workshop and represented a cross section of science and educational fields: teachers, researchers, and engineers. The goal was to have this small group distill ideas from the first workshop into the basic "kernels" of 2-3 proposals for submission in spring 2002 to NSF. This was done after first envisioning an overall plan of how NEPTUNE can transform learning and teaching while ocean and earth sciences are changing with this new mode of investigation.

The meeting began with dinner Tuesday evening, followed by a presentation by G. Ross Heath, Science Chair of the NEPTUNE project. Heath brought the group up to speed on new developments in the project since November, including recently funded plans to develop technical test-beds and science projects. These include projects to lay short cable sections into coastal waters, one in Monterey Bay (codename MARS) by MBARI and one around Victoria BC (codename VENUS) by the IPOST consortium. He also talked about a five year project just funded by the W.M. Keck Foundation to investigate microbial life and seismicity at two places on the plate: the Endeavour segment of the spreading ridge and the Nootka fracture area in the subduction zone near the continental shelf (off Vancouver Island). The Keck project (codename PLUTO) doesn't involve laying a cable to get high-bandwidth data, but it will provide the science experiments and instrumentation a necessary kick-start in development.

On Wednesday, the participants divided in half to work in smaller groups. The morning activity consisted of defining the larger vision of NEPTUNE education programs, first separately in small groups, then all together. The result of this discussion is detailed below. In the afternoon, each team took up two of the "topics" on the agenda (see Appendix A) and worked it up through discussion and writing to a point where the other team could read it, discuss it and suggest improvements or talk about issues left unaddressed. The written output of those groups is attached as Appendix B. After dinner Wednesday evening, Fritz Stahr gave a short talk on NSF funding (with lots of handouts from NSF web-pages) and led a short discussion regarding which NSF divisions are most logical to fund NEPTUNE education proposals.

Thursday the small groups started by reading and discussing the other's draft proposal "kernels" for an hour. We then reconvened as a large group and conducted a feedback session on each kernel with further discussion of possible improvements. The notes from this are in Appendix B with the individual proposal kernels. We concluded with lunch and adjourned.

### **The NEPTUNE Education Vision**

As a whole, the participants agreed on a number of ideas about what is "NEPTUNE education" should be, i.e., a larger vision. First, it should be *multidisciplinary*, and not just sciences, but also arts, culture, and fusions of all three, as related to ocean-earth systems. Communicating the excitement and art of scientific discovery is often best done by integrating writers, visual artists, musicians, philosophers, and science historians into the process of discovery. Second, it should be a *knowledge building community* where people work together to advance the forefront of science, education and knowledge in an intertwined way, with scientists, teachers and students all working toward common research and development goals. Third, it should be *multilayered* in the levels of exploring the environment, investigating the processes, and using the archived data. One goal of this multilayering is to move non-scientist members of the community toward better understanding of the ocean-earth systems.

Some features of NEPTUNE that make it unique and lend it to education by inquiry are:

- 1) real, ongoing scientific explorations in which students can participate, make hypotheses, engage in authentic learning where real questions may not have an answer.
- 2) real data is available in a variety of formats that can be accessed and used in some way
- 3) real-time monitoring and control on the seafloor over long periods of time: remotely change an experiment and adapt it to maximize knowledge.

These features are uncommon now, though as more full-time earth observing systems are created, they will become more common. NEPTUNE can make a significant contribution to science education by pioneering useful techniques and curricula.

### **Specific Proposal Kernels**

The proposal write-ups and comments on them from the workshop are attached as Appendix B. What follows are shortened versions specifically designed to fit on a single page. There are only two, despite the fact that at the workshop, the group that discussed the "Experience NEPTUNE Project" specifically broke it's work into two parts, one informal and the other formal education using the same installation.

*Name:* Experience NEPTUNE Project (ENP)

*Who -- does it:* UW NEPTUNE, NEPTUNE partners -- especially IPOST, MBARI  
*-- funds it:* NSF-Informal Science Education or a private foundation

*What:* Create a physical, tactile, interactive experience of going to, or being in, a seafloor environment, similar to the space shuttle experience. This may be one or more 3-D caves with multiple interacting individuals. It could also be or include a submersible environment, such as an enlarged rendition of Alvin and/or the Jason control van. When the NEPTUNE cable is on-line, real-time data and command and control could be used in this experience.

*Why:* Ocean/earth science needs an experiential tool which can be used for both informal and formal education. Learning by experience is a powerful technique for most people. Public exposure is important to NEPTUNE's success.

*How:* NEPTUNE can provide many components of such an experience, especially direct interaction with the environment once the cable is laid. Before cabling the plate, the NEPTUNE science teams can provide the necessary data and expertise to create such an experience.

*Where:* This could be a temporary or permanent installation in any aquarium, science museum or visitor center. Victoria is planning to have a "visitor center" type facility at the end of the VENUS cable that could house it. Alternately, it could be in a large truck trailer (i.e., 60'x10') which has the advantage of more control by the NEPTUNE partners and mobility to under-served communities or schools. The Los Angeles Natural History Museum operates several of these, including a "Sea Mobile", see <http://www.nhm.org/seamobile/home.html> which are funded by a private foundation (Maxwell H. Gluck) that restricts use to the LA public schools.

*When:* The work on this could start immediately, given identification of personnel and funding. Depending on what physical form is chosen (in-house vs. in-trailer), a system could be up and running in a year, well ahead of cable laying.

*Issues to resolve:*

- If the "experience" is to be an in-house type exhibit, then a location must be found either on campus or at a partner institution (e.g., science center, aquarium, visitor center). If it's a truck-trailer system, we need to glean as much as possible from the Natural History Museum folks in Los Angeles about what works and what doesn't.
- Separate scenarios and /or modules will need to be developed for formal and informal group use. Duration of the experience should probably be something ~20min for general public, and ~90min for classes. The language and detail used in each may be different too.
- Technical challenges: inventive physical interfaces for groups need to be designed and tested; hardware and software to generate the environment is key; networked database system needs development too.
- Neither a stationary nor mobile "experience" unit spreads NEPTUNE nationally, but associated media such as a CD-ROM or web version can. (see Sea Mobile example)

*Name:* NEPTUNE Science In Schools (or NEPTUNE Institute, phase 1)

*Who -- does it:* NEPTUNE partners -- especially UW, WHOI, MBARI, IPOST  
*-- funds it:* NSF-Teacher Enhancement, Geosciences Education

*What:* Create a program which actually integrates the work of scientists (and engineers), teachers and students in three connected activities. The target audience is 12-14 year-old students. A suggested model is "Project Astro" (<http://www.astro.washington.edu/projastro/>).

*Why:* To bring teachers, scientists, and students together in an international knowledge-building community centered around the NEPTUNE observatory. To develop, implement, and assess the effectiveness of a program that is like a full-scale NEPTUNE Institute.

*How:* First, we provide scientists' guided observation time and activities in classrooms to learn how to communicate their ideas and enthusiasm effectively in a school setting. Second, we organize and deliver summer courses/workshops for teachers on NEPTUNE's science content and methods led by NEPTUNE scientists and engineers. The workshop will:

- Provide teachers with science content of the undersea environment.
- Provide teachers opportunities to use remote sensors, learn the fundamentals of experiment and instrumentation design, and understand time-series analysis.
- Provide opportunities for teachers and scientists to collaborate on research questions and design problems for the students to investigate.
- Map the physical/biological/geological science concepts in the middle school curriculum to the science investigated by NEPTUNE scientists.

Finally, we implement a "scientist in the school" program in which a NEPTUNE scientist will work with teachers and students on questions of genuine scientific interest, through face-to-face or telepresence classroom visits, perhaps for a short intense period (one week) or for a whole semester. The same scientist/teacher teams will persist through the first and last activities and could be complemented by graduate student team members, particularly those getting science education degrees.

*Where:* In several locations at once, probably starting in NEPTUNE partner cities first. It would be best to find places (like Seattle) where NSF is already investing in systemic change in science education and places where the Internet2 backbone will be available when the NEPTUNE cable comes online. Leveraging off these already NSF funded activities will help.

*When:* Ideally there will be a six month planning period after the grant starts in which the participants are identified and the summer workshop is set up. All other activity can happen within one calendar year thereafter. This will make a good adjunct to the test-bed projects.

*Issues to resolve:*

- Compensation for scientists & engineers in both salary and recognition of effort.
- Compensation for teachers in credit (clock-hours), as well as stipends for the workshop.
- Assessment of educational effectiveness, perhaps as masters project of education students.
- Perhaps need a starting conference for first participants to meet each other and talk— chance for scientists to find teachers they want to work with and vis-versa.
- Need to integrate humanities somehow to match grand vision of NEPTUNE education.

## Next Steps

This workshop created the nexus of two proposals upon which to build the NEPTUNE education program. They are appropriate in time and scope to complement the upcoming testbed installations and, ultimately, the major cable installation. Full proposal development may proceed based on these results and with collaboration from those who attended the workshop and volunteered to help.

NEPTUNE needs to further explore the possibilities of using the project's full-time data feeds in informal science settings. We will invite a selected set of representatives from aquaria and science centers in the U.S. and other countries for another workshop that will focus exclusively on this issue. The goal will be similar to that of this workshop, that is to develop the kernels of 2-3 proposals that can be used to prepare requests for funding.

Following these workshops, we will form an Outreach (and Education) Implementation Team of five to seven members, which will function within the NEPTUNE organization on the same level as the two other major NEPTUNE teams: Science and Engineering. A NEPTUNE Outreach Coordinator will be hired to oversee this component of the project.

## Participant List

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## **Appendix A: *Workshop Agenda***

### **Goal:**

Develop the basic "kernels" of 2-3 proposals for submission in the spring 2002 round of NSF submissions (Jan-May). These kernels should address significant issues in enough detail to satisfy ourselves for completeness. They should also fit within a larger vision of how Neptune can transform learning and teaching while ocean and earth sciences are changing with this new mode of investigation.

### **Topics (i.e., proposable?):**

1. Teacher training workshops and/or awareness sessions - (range of material? - curriculum created?)
2. Neptune Institute - (how to organize? how to start without cable & data? how to expand?)
3. Neptune "project modules" for specific grades (e.g., 4-6, 7-9) - (on-line? CD-ROM? text?)
4. Sea-floor "experience" - (like Space-Shuttle mission? Virtual reality? Summer camp? Sub project?)
5. Communication of currently available vent/ridge info - (text book sections, special web-site?)

### **Issues:**

- How to build & spread enthusiasm through teachers & students with limited resources?
- How to spread Neptune education/outreach widely in US and internationally?
- How to reach underrepresented groups with these new initiatives?
- Timing - what is valuable in stand-alone mode now? MBARI cable 2003? Keck buoys 2004?
- What are needs of users at different levels? - what are wants? Non-computer curriculum?
- Need large scale survey of teachers & students re: current knowledge of sea-floor & deep ocean?
- Reviewing new Neptune curriculum, web-pages, etc. re: science, state & national std.s - who? when? how?- panel of scientists, education researchers, and teachers?
- Neptune education web-pages - what should be there? how structured? especially "kid" friendly?
- Developing analytical thinking vs. providing streaming data, does Neptune do it all? how?
- Organization of people? creating, training, refining, supporting which parts? - priorities?
- Organization of available resources for students & teachers? - interpretation, teacher training, reviewed curriculum, data stream
- Assessment plan for curriculum - built in? plan for other resources (e.g., web page)?
- Create separate groups for packaging & disseminating data/info vs. for teacher-scientist-student interactions? - relation of informal to formal education?
- Archives - how set up & maintained? - data (proprietary?), student projects, teacher training, curriculum?
- Students need to understand failure is part of science process - discovery involves both
- What will be connection, if any, to possible PNW Center for Ocean Science Educational Excellence? - or National COSEE?

## **Appendix B: *Individual Group Proposal Kernel writeups***

### **Part 1:**

Development of one component of NEPTUNE Institute idea  
Whidbey Workshop, 7/26/01

We propose to develop the first of XX modules that will lead to the creation of the NEPTUNE Institute (NI). NI will ultimately become a physical plant that is a public showcase for the entire project. NI will include informal education, classes for students, teachers, and the public, using the most effective instructional and communication technologies, including virtual reality. It will also provide a working lab for research scientists and technology developers. The NI will engage a diverse group of learners in science through compelling questions regarding recent discoveries that hold keys to the history of life on earth and the possibility of life on another body in our solar system. The Institute will be the organizing vehicle to build knowledge and learning communities for NEPTUNE research and real-time data gathering..

The NI will expand the boundaries of science education and offer a transformational approach to the development of knowledge-building communities, prompting deep understanding of science fundamentals through the study of the real-time and archived data generated by the Neptune Network. In the earliest stages, before the cable is deployed, the NI will develop a prototype for interfacing scientists with teachers and students and provide a model for the development of a learning community, around archived data, that involves middle school classrooms.

This first module, or prototype, entitled "NEPTUNE science in the schools," will be an international knowledge-building community for scientists, teachers, students, and through students, their parents (and the public?). This innovative multidisciplinary program will enable students to effectively engage with research scientists in authentic scientific inquiry while at the same time learning core curriculum concepts. Students will be engaged in the excitement of the process of scientific discovery, providing them with the opportunity to collaborate with and be inspired by a scientist, as well as the opportunity to participate in shaping investigative questions.

Using the existing vent/ridge data, scientists and middle school science teachers will develop possible questions that might be answered through analysis and modeling of data that has been collected in the various projects investigating the vent/ridge systems, and, eventually, NEPTUNE's real-time data as it becomes available from testbeds and the Keck project.

Students will learn basic physical/biological/earth science concepts through investigating data or designing instruments that might be used on the Neptune array. Ultimately, as the Neptune Project progresses the Institute will expand to include a global community of scientists, teachers, students, and parents engaged in sharing discoveries of this frontier on the ocean floor.

In 2002-2003, we propose to conduct a proof-of-concept by developing a prototype of the first module that could be successfully replicated at schools throughout North America. The target audience will be 12 to 14 year-old students.



The purpose of the module proposed here is to develop, implement, and assess the feasibility and effectiveness of a program that brings teachers, scientists, and students together in three connected activities.

First, we will provide support for scientists' guided observation and other activities in science classrooms to learn how to communicate their ideas and enthusiasm effectively in a school setting. Volunteer scientists will be matched with middle school teachers from a diverse geographical distribution, including non-coastal states and provinces. Scientists will be in-serviced in the nature of inquiry and teaching methods that engage students in reflecting on their own thinking. They will spend a period of time in the classroom of their partner teacher in the Spring to familiarize them with the nature of the classroom environment, the pedagogical approaches appropriate with middle school student, and the cognitive development of the students.

Second, we will organize and deliver summer courses/workshops for teachers on Neptune's science content, methods and instrumentation, led by NEPTUNE scientists. During these summer courses, teachers and scientists will be immersed in a 4-6 week institute. The purposes of the institute include:

- Provide teachers with science content that is needed to investigate the undersea environment
- Provide teachers with opportunities to make use of remote sensors and analysis of large data sets. Provide fundamentals of instrumentation design, if appropriate.
- Provide opportunities for teachers and scientists to collaborate on possible questions and instrumental design problems for the students to investigate.
- Map the physical/biological/geological science concepts in the middle school curriculum to the science investigated by Neptune scientists.

Finally, we will put in place a "scientist in the school" program in which a NEPTUNE scientist will work with teachers and students on questions of genuine scientific interest to NEPTUNE scientists, through face-to-face, telepresence, and online classroom visits. Scientists will spend a week in the classroom, engaging with students, teachers, parents, in the scientific discoveries for which the Neptune project provides potential. Over the course of the school year, students will investigate their problem and maintain contact with their scientist.

These activities will take place at three sites, the University of Washington, Seattle, (Simon Fraser University, WHOI). At each site, a selected cadre of teachers and scientists will work together for a period of two years.

We will assess the success of the project by monitoring changes in scientists', students' and teachers' concepts during the project and by formal and informal evaluation of the activities' feasibility and cost-effectiveness.

(N.B. Bill Winn strongly suggests we apply for proposal planning money to invite NSF to a pre-proposal planning workshop.)

## **Feedback on scientist in the schools concept**

*Monologue (i.e., only other group comments)*

Observations:

In whole program, would be useful to include graduate students and perhaps undergraduate students who could be team members with scientists.

Also: include School of Education members to examine effectiveness of process

Where do these things happen: open application from teachers and scientists around the various countries; only requirement: school and institution should be in proximity, open anywhere with some preference given to states that are opening up Internet 2 to K-5 (e.g., Michigan is one)

Summer workshop—4-6 weeks seems like a long time; issue of how to get teachers and scientists to commit to this; way individuals and institutions compensation is important; not only salary, but tuition, stipends—some way for scientists to get recognition from their institutions, some recognition to department—scientists could get course credit for teaching the course—

Credits: undergrads and grads could get credit or earn stipends for their participation

Perhaps add to team: a high-school student from local high school—so middle school students are making a connection to their next level of education.

Discussion of who would attend a planning workshop besides NSF folks:

Include 12-14 year old students in addition to scientists, teachers—so students could give feedback on what they want to learn about the seafloor.

Intermediate step—a pilot school that would use this as a component of their science curriculum—as step toward bricks and mortar

Students aren't actively involved in the process—later on have student directed summer camps—

Involvement of undergraduate and graduate students with summer "camps"

Other locations: don't need to be coastal—could pilot in midwest—

Didn't mention the size of the whole thing—2 schools or 20 schools—would depend on how many people you wanted to have at summer workshop—scaling is an important part of the proposal—how small do you start and how big do you end up—what are the limits to the total number of people involved.

On land side version—want a parallel network of schools to NEPTUNE network

*Dialogue (discussion between groups)*

Scientists would be volunteers—

Concept: students in the classroom are participating in some way in real science—if grad students also are defining real research questions, then grad student participation would be worthwhile.

Didn't think that schools would have to be proximal: travel to schools for scientists part of funding—

Initially: work with institutions and schools that are close to each other, proximity helps generate excitement long-term in students.

Role of high-school student—nurture notion of career opportunity—partner the high school science student with the teacher or team—perhaps a Westinghouse science project; independent project possibilities; also a teaching assistant role.

Why is 4-6 weeks too long? Big chunk of a teacher's summer—  
Group was thinking more of a 4-week course not full time or intensive 2-week full time, particularly for teachers coming from out of town—

Summer classes conceived as a course for the teachers to use as a basis for what to do in the classroom the following year.

Each scientist will be matched with a specific teacher—one on one pairing  
Project Astro is a good model—

Consider broadening this to all the NEPTUNE science, go beyond just the vents—  
this will involve more high-level scientists—

Include engineering, as well as scientists—instrument design—same pattern of paired teacher/scientist would work with engineer/teacher—

Scientist/engineer would write a paragraph describing interests—then teachers apply to work with that person, way to find best fit for classroom—

Maybe—need a mini-expo or conference so that people can meet each other and talk—chance for teachers and scientists to meet and find out about each other—  
includes chance for scientists to find teachers they want to work with—

Teacher—scientists—student relationship: students feed scientist with questions and issues that are perplexing to them—help scientist formulate questions for further investigation—

Need to define goal of what will happen within each phase—third phase, scientist in the classroom, needs much better definition.

Address issue of how to help scientist to learn how to communicate/teach students

Include a technology developer and media arts person in this proposal.

General comment: include art generated by kids in bricks and mortar facility or pilot school—

Could use this proposal's approach and substitute artist for teacher—

How does this lead into bricks and mortar—this is a step toward breaking down the boundaries of science and education, then science and art, science and literature.

Could have specialists: education, artists—roving among teams during the summer institute—

In summer institute: include opportunities for all teaches and scientists to mix, even though pairing is done—

Concept of knowledge-building community—teachers and scientists sharing knowledge, ideas as program goes on.

Extending effect: master teachers, scientists sharing experience with colleagues—

Build in advanced electronic collaboration tools.

Followup with after-the-fact meetings/workshops.

Bring in industrial designers as a resource—part of instrument design—reach students who are less interested in science and technology.

Write in partnerships with middle school and groups for systemic change that are already active on campus—NSF is already supporting these efforts!!! Five school districts are involved.

## **Appendix B, Part 2:**

### **NEPTUNE – Sea-floor experience—(Topic 4)**

#### **Objective:**

Open seafloor environment to families doing science together -- learners of all ages. Create an environment for exploring seafloor via both special location with computer cave and distributed over web.

**Funding Source:** Informal Science Education

**Partner:** Aquarium (e.g., Victoria, Monterey, Seattle) or science museum (necessary to obtain pre-proposal)

#### **Content:**

##### **What concepts are participants going to learn during an experience?**

- Basic concepts from all Neptune science working groups
- Inter-related earth systems – how various science disciplines are connected and affect individuals
- Team dynamics
- Target mis-/ naïve conceptions and challenge them
- Navigation and mapping

##### **What would a sea-floor experience look like?**

- Pattern a dive exploration in Alvin similar to Challenger space center program.
- 3D computer cave environment
- Open exhibit for deep-sea experience combined with mission-type experience for groups
- Use video from actual dives and already available data until real-time data is available.
- Experts to guide people through the experience
- Create both scripted and open-ended mission scenarios
- Other participants are acting out or controlling the environment?
- Participants making choices during trip as to the mission objectives and choices along the way when new discoveries come up (given time constraints). Make choices as to what instruments to take (among many)? What things to investigate?
- Initial information in pre-voyage activities or embedded in experience will guide their choices—preconceptions can be confronted.
- Include other remote sensing data (NOAA, Coastwatch, IRIS, SOSUS, JPL currents, weather data.
- Tie to interplanetary issues —Europa—post mission activities?

##### **Environments represented in scenario**

- Monterey Bay (MARS)

- VENUS (salmon, sediment transport)
- Endeavour (ridge crest processes)
- Nootka (earthquakes, subduction zone processes, fluid expulsion, hydrates)
- Make sure processes match concept standards
- Build scenarios for these 4 worlds then when real-time data becomes available, it can be easily wrapped into the already-existing scenarios.

**Technology:**

**General**

- Computer Cave – no head gear required – wrap-around environment
- View same world via desktop
- Hardware and software to generate the environment is key
- Needs networked database system development
- Need a museum partner for proposal – possible they can provide location and delivery mechanism, NEPTUNE provides content
- Augmented Reality – interaction with environment – either with hands looking at wrap-around screens or robot arms by looking through portholes
- Distribution via web across country – connect to aquarium or museum – same systems developed for mission experience could be modified to work over web – private companies could help fund/develop? Web is a component of the immersion experience.
- Keep duration of experience to 20-30 min for good engagement, but not overextended
- Develop scripts for variable duration for school groups

**Traveling immersion experience (could work for formal education settings too)**

- Semi-trailer with cave– can go anywhere—parking lot of aquarium, science center or school (e.g. Natural History Museum in LA – Earth, Sea, Sky Mobiles , ref. Jim Kisiel, jkisiel@nhm.org)
- Can serve communities that can't get to museum
- Would be reproducible at other locations around the country. Helps reach underrepresented groups.
- private foundation funding to make free?

**Time Line:**

4 years total

**Year 1-2**

- choose hardware for generation and delivery
- scripts written
- purchase equipment
- data visualization experiments
- prototype distributed participation system
- technology evaluation
- Use undergraduates/interns to help develop programs – education in development side – during REU or special summer camps for CS students
- Test-beds for distributed program could be summer camp

**Year 3-4**

- full scale use – expand to other sites
- assess programs – could be through science camps also
- add environments and new scenarios
- Connect assessment to school of Ed study of impact on informal experience via pre-post interviews, plus follow up months later for concept and implication

**NEPTUNE Formal Education Modules (Topic 3)**

**Objective:**

- Create curriculum packages that complement and use sea-floor experience proposed above.
- Provide opportunity of students to use their existing knowledge to construct own understanding of science concepts.
- Provide curriculum to address different learning styles and levels of cognitive development

**Funding source:** one of formal education divisions

**Content:**

- Research what misconceptions NEPTUNE can address, create curriculum to address/challenge
- Evaluate standards to see where NEPTUNE can integrate different topics
- Look at basic subjects like chemistry physics and earth science and how NEPTUNE can address those concepts
- Look at what gaps in existing curriculum NEPTUNE can fill in.
- Science content as both separated-subject and thematic approaches—cross-cutting concepts
- specifically connect to land-based (e.g., Earthscope, IRIS)
- archived via DLESE (Digital Library for Earth Science Education)
- Tie content to different Neptune Science working groups
- Create curriculum specifically around Neptune engineering issues and work
- Sample mission to decide what to place on a node, how to lay them out—lots of pre-planning in classroom to decide objectives, design components, etc.
- Include career options and science and engineering mentoring

**Technology:**

- CD's
- Web presence
- LEGO kits (or other building blocks) (MBARI connection?)
- Bound/hole-punched paper packets (like NASA)

**User Interface for NEPTUNE**

- How is a scientist doing exploration different from a student doing exploration? Does it need to be different? Both need a user-friendly way to look at data stream
- Keep as similar as possible – students learn how to be scientists and analyze real data, Have different levels of streamlined data available for different age levels.
- Collaboration between science interests and education interests – mutual benefits during user-interface development.

**Time Line:**

- Approximately 2years
- attempt to coordinate with Seafloor Experience

**Distribution:**

- Conferences, mailings, catalogs
- tie to publicity from Seafloor Experience / Cave
- Special articles in education journals, NARSST, AERA, NAAEE
- link to REVEL teachers and NMEA network, NSTA
- Informal institutions

**Collaboration:**

- Undergrads
- Scientists
- Teacher experts
- Students teaching students (upper level teaching younger...)

**Feedback on Seafloor Experience Concept**

*Monologue (10 minutes of Group A listening to feedback)*

Lots of good ideas

Organization needs more punch; basically two separate purposes: public and for schools.

Include in objective more about why we're doing this, what is the learning experience

What's missing for a proposal: idea of engagement, excitement, familiarity with the ocean environment; to encourage general support for ocean science

Parallels to NASA's programs: we lack that kind of infrastructure support; but what we want to do is similar—infrastructure helps justify goal of educating the public

Need to define the urgency of capturing the public's imagination for earth and ocean systems.

Content: different programs for different groups; public vs. students groups

State something about how curriculum would change

Mention real-time data much earlier in proposal—

Duration of experience: day-long experience for school groups; shorter for public

Issue of basic concepts of what will be learned: need some concrete examples

Comparison of content with the purpose that unit within list of content to be covered, i.e. justify content by how it meets the purpose

Become a tube worm, magic school bus concept—doesn't have to be human scale; what if scenarios—what if the temperature of the ocean went up 2 degrees?

Idea of making it mobile is splendid, although lots of logistical problems—would be exciting if NEPTUNE could make itself mobile in this way.

For actual proposal: pick one module and flesh it out—e.g., concentrate on public or students.

*Dialogue:*

Formal section is to address needs of school group;

Thought: to get hardware, public stuff funded and functioning and then apply to a formal education environment

Janice D.—says may be easier to get informal education \$\$\$\$ than formal ed. \$\$\$

Need to establish a partnership with a museum or an aquarium—would be a big hurdle to this proposal.

Informal ed and getting public excited vs. educating them—where is the line drawn.

Another possible source of funding for this portion: investigate what technology innovation funds might be available.

Questions of intellectual property and who will own the exhibit—NEPTUNE vs. informal science ed partners???

People from Disney Imagineering group have visited HIT Lab—possibility of interest in the seafloor experience—what about getting Disney interested in this concept?? EPCOT center would be perfect setting--

Schools: start out with concepts they need to master; will guide scenario development

General public: scenario will depend on what you want to do to grab them.