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Energy Division

National Information Infrastructure Education Forum: A Summary Report

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MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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NATIONAL INFORMATION INFRASTRUCTURE EDUCATION FORUM

A SUMMARY REPORT

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May 4, 1994

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EXECUTIVE SUMMARY

The National Information Infrastructure (NII) Education Forum was held on October 6-8, 1993, in Arlington, Virginia. The Forum was sponsored by the Office of Scientific Computing, U.S. Department of Energy (DOE). Its purpose was to discuss technology for K-12 education and what role DOE and its national laboratories could play in developing, disseminating, and using technology for K-12. The Forum brought together over 120 people from across the nation. Participants represented six groups: national laboratories; education research institutions; K-12 teachers and administrators; industry; federal agencies; and other institutions.

The Forum consisted of a series of structured presentations from each of these six groups; technology demonstrations; and open, small group discussions. The presentations covered the following: important K-12 education and computing issues, national laboratory capabilities, other federal sector initiatives, and industry perspectives. The demonstration room had over 20 computers networked to the Internet. Workshop participants were shown (1) how to use the Internet to access resources anywhere in the world, (2) state-of-the-art network video teleconferencing technology, (3) multi-media technology, and (4) various other educational software systems.

Four discussion groups were convened simultaneously to consider the topic of K-12 education technology and the role of the national laboratories in development of the technology. Comments fell into five categories: DOE capabilities, the school environment, vision, specific technology projects, and policy considerations. Overall, Forum participants felt that DOE and its laboratories could play a significant role in K-12 technology development, dissemination and use. The comments generated during the group discussions raised important issues and contained creative ideas but did not represent a comprehensive vision of a potential DOE K-12 technology program.

Recognizing a need for consensus, the participants stressed that it was important to continue the dialogue begun at the 1993 NII Education Forum. To this end, an e-mail reflector has been set up: nii-forum@ornl.gov. Also, it was recommended that a working group be convened in early 1994 to identify specific technology for precollege applications that could help define a Departmental initiative meeting Administration goals related to the National Information Infrastructure.

1. INTRODUCTION

The United States Department of Energy (DOE) is a national leader in the areas of computational science and networking. A substantial part of DOE's expertise resides in its national laboratories. First established during World War II to support the Manhattan Project, the national laboratory system is now composed of three types of laboratories: those whose major focus has been on weapons development; multi-purpose laboratories that conduct basic and applied research mainly in the sciences; and special purpose laboratories, such as the Stanford Linear Accelerator Center. In total, these laboratories house an unprecedented array of high-performance computers and other types of computers that are linked together by state-of-the-art networking technology.

As the nation heads towards the 21st century, a national consensus has formed around the idea of building an "information superhighway." Within the federal government, this idea has come to be known as the National Information Infrastructure (NII) initiative. Numerous federal agencies, including DOE, are working together on NII technology and on ensuring that its use fosters the greater social good. The NII is seen as improving U.S. economic competitiveness, being a conduit for new entertainment and communications services, and even as helping to restructure U.S. health care. However, many would argue that its most important use will be for education, with the most challenging tasks arising on how to use the NII to benefit precollege (i.e., K-12) education.

The Department of Energy is in the process of considering how its expertise in computing and networks might be used to further the goals of the NII initiative with respect to K-12 education. To bring more information to its discussions, the Office of Scientific Computing within the Office of Energy Research in DOE decided to sponsor a national meeting to bring together a diverse group of people to discuss DOE's potential role not only with respect to K-12 and NII but also with respect to other computing and telecommunication issues (e.g., supercomputing).

The National Information Infrastructure Education Forum was held October 6-8, 1993, in Arlington, Virginia. Over 120 people were in attendance, who evenly fell into six groups: national laboratories; school teachers and administrators; industry; educational researchers; federal agencies; and other relevant institutions. The Forum featured presentations, discussions, and technology demonstrations. A demonstration room was set up that housed over 20 computers linked to the Internet over a T1 line. Demonstrations covered how to use the Internet, video teleconferencing over the Internet, multi-media, and other specialized education software.

The purpose of this report is to summarize the Forum's presentations and discussions. The report has four main sections and two appendices. The four sections, in order of presentation, cover (1) significant issues with respect to K-12 education in general and technology in particular; (2) resources available within DOE and its laboratories; (3) comments from four open, small group discussions; and recommendations for next steps. Appendix A contains the Forum's agenda. Appendix B contains a list of participants.

2. SIGNIFICANT K-12 ISSUES

Three sessions were devoted to discussing K-12 education and technology issues. Speakers discussed the need to engage students, to develop ways to foster true understanding of subject matter, and to create learning communities. To successfully compete in the global economy, students need to learn how to learn. Barriers to achieving these goals include inadequate school budgets, out-dated school bureaucracies, and numerous societal problems. Educational equity, involvement of parents, and a focus on the quality of life for youth were also mentioned as important issues.

Technology was seen as having great promise. Indeed, many participants are actively engaged in using, managing, and evaluating technology in the schools. Several participants are also conducting research on new technologies, such as the Jasper System, a video-disk, multi-media system that is being developed at Vanderbilt University. One teacher from Alabama described her work in teaching students and teachers how to use high-performance computers as part of the Adventures in Supercomputing program, and a high school student from New Mexico described his active and rewarding use of the Internet.

However, technology has not reached its promise for numerous reasons. The budget problem is one such reason. Even if money is not a problem, a school administrator from Illinois explained that habit and inertia, combined with a lack of teacher training in technology, a lack of understanding of technology by school boards, and the fear of not knowing whether change will be effective all work to inhibit the use of technology in classrooms for more than word processing. Additionally, it was pointed out that it is difficult to fit new subjects into the school day, which is often planned out by the minute and as many schools today are required to stick to strict curriculum designs.

Technology is still not as user friendly as it needs to be. Schools typically do not have technology specialists on staff to set up and maintain hardware and software, for example to configure PCs or manage local and wide area networks. Also, there is a lack of electronicly-based material to support more than small parts of any one class. Lastly, it has been found that many of the numerous technology projects being pursued around the country that are prototyping new and interesting educational technology are not producing technologies that can be cost effectively scaled-up for national implementation.

3. NATIONAL LABORATORY RESOURCES

The national laboratories have two major resources to contribute to the improvement of K-12 education: technology and technological expertise; and broadbased knowledge in science, engineering, mathematics, science education and assessment.

The national laboratory system possesses unmatched computing resources. This resource base encompasses the largest array of production systems of any federal agency. Included in this resource base are serial-based supercomputers, parallel processors, numerous mainframes, workstations, graphics mini-supercomputers, and thousands of state-of-the-art microcomputers. Part of this resource base could be made available to K-12, as is already being done with a dedicated Cray supercomputer at Lawrence Livermore National Laboratory. It should also be mentioned that the resource base also includes the world's most powerful parallel processors, such as the Thinking Machine Corp. Connection Machine-5 at Los Alamos National Laboratory and the Intel Paragon at Oak Ridge National Laboratory.

The national laboratory system has also been in the forefront of computer networking. Historically, this came about because of the need to share high-performance computing resources throughout the system. As a result, several national laboratories are served by the world's most advanced packet switching telecommunications systems. This resource base could also be shared with the K-12 universe.

Even more important than its hardware resource base, it the national laboratories' human resource base. Researchers and other staff who have expertise in computers and networks could be put to the task of using their expertise to advise K-12 professionals about technology and even to develop new technology. This is an intriguing prospect because the national laboratories have expertise in more than high-performance computers and networks.

An exhaustive list cannot be provided here, but the following are some other computer-based resources available at the labs: audio-video teleconferencing over networks; multi-media systems; data storage; very large database system design; computer graphics; interface design; distributed computing; expert systems and artificial intelligence; code and algorithm libraries; geographic information systems; hundreds, if not thousands, of applications models (e.g., in the areas of global warming and other environmental problems); and virtual reality. In addition, the labs have the ability to fabricate chips, design and develop advanced materials of any sort, and design and develop electronic instrumentation.

The national laboratories also have active education programs, part of which encompass K-12 activities and part of which also encompass computers and networks.

The following list is not complete but illustrates the kinds of programs being pursued at the laboratories. Examples of relevant educational activities are Lawrence Berkeley Laboratory's Hands-on-the-Universe Program; work by the Princeton Plasma Physics Laboratory to assist the state of New Jersey in providing Internet access to K-16 schools; Stanford Linear Accelerator Center's work with the Public Broadcasting System's Learning Link; Sandia National Laboratory's New Mexico school administrators workshop on technology; Los Alamos National Laboratory's Supercomputing Challenge Program; Ames Laboratory's program to make a 128-node parallel processor available to K-12 schools; Oak Ridge National Laboratory's education network; Fermilab's nationally recognized Saturday Morning Physics program, which is part of a larger program that reaches 9,000 teachers and 40,000 students annually; Idaho National Engineering Laboratory's water quality project; Pacific Northwest Laboratory's ESNET server to local schools; and Lawrence Livermore National Laboratory's National Energy Research Center, which provides Cray supercomputing resources to over 100 classes and 3500 users annually. Lastly, three national laboratories—Oak Ridge, Ames, and Sandia—are collaborating with K-12 schools and universities to run the Adventures in Supercomputing program.

These and other educational programs at the national laboratories constitute a broad base from which to work with schools on technology issues. As mentioned at the Forum, the challenge is enormous. There are approximately 50 million K-12 students, yet the current DOE programs reach maybe only a fraction of a percent of these students. One message conveyed by the K-12 participants at the Forum is that "the mountain needs to go to the schools." Combining technological knowledge and access to expertise in education to achieve this mandate is the key to success.

4. COMMENTS FROM DISCUSSION GROUPS

The Forum participants were assembled into four small groups to discuss K-12 technology and the role of the Department of Energy in its development and dissemination. Participants were assigned to the groups in a balanced fashion, i.e., each group contained representatives from the six groups mentioned earlier. Each group had a discussion leader and, in a couple of cases, a separate recorder.

The results of the small group discussions represent only the beginning of dialogue on these issues. Comments fall into five general areas: DOE capabilities, the school environment, vision, specific technology research and development suggestions, and policy considerations.

The Department of Energy and its laboratories clearly have valuable capabilities that could be focused on K-12 technology and mathematics and science education. DOE possesses systems engineering skills, a large number of highly trained technologists, a prodigious high-technology base, expertise in computational science, expertise in networks, and experience in developing advanced computer applications (e.g., using very large databases, developing interfaces, etc.). Educators also emphasized that DOE researchers possess a wealth of expertise in mathematics and science that could be harnessed for K-12 purposes independent of DOE's K-12 technology programs.

In each group, discussants raised numerous issues about schools that must be kept in mind as people consider how best to use DOE resources to improve K-12 technology. Many of these issues have already been mentioned above (see Significant K-12 Issues). Teacher training, cost of technology, complexity of technology, and lack of computer-based materials were emphasized as important issues.

Comments about DOE's capabilities and the needs of the schools combine to focus attention on the need for DOE to develop a clear vision for its technology efforts. Several participants suggested that a big picture is needed, one that incorporates the entire suite of advanced computer and telecommunications technologies (e.g., computer networks, cellular services, cable, etc.). The vision needs to articulate the roles of the various players, including federal agencies, state education offices, schools, companies, and partnership relationships. The vision also needs to be compatible with the kinds of activities that DOE can effectively support.

It is necessary for the vision to be developed through extended dialogue amongst the players. DOE people versed in technology but not in education need to become more familiar with education issues, which can be accomplished by attending conferences, reading journals, and spending time in schools (e.g., one participant suggested one workday per month). Also, the vision needs to be implemented through structured partnerships, such as Cooperative Research and Development Agreements and Requests for Proposals.

Only the beginnings of a comprehensive vision arose during the discussions. With respect to technology development, one group recommended that DOE consider developing a school-compatible computing device that costs under $100. Others felt that DOE could take the lead in developing software "tools" or freeware useful for K-12. For example, tools are needed to manage large educational networks and to provide network administrators with the capability to oversee networks to ensure that they are used in ethical and appropriate fashions. Also falling under the rubric of tools are user friendly interfaces to the Internet, databases, and other software; software to manage students academic portfolios; and intelligent software to provide students with continuous feedback on their learning progress. One participant suggested that DOE explore ways of tapping into the large base of Nintendo technology for use in K-12 education.

In addition to tools, DOE could consider taking on the role of technology demonstrator. In this role, DOE labs would build prototype systems, presumably at various levels of complexity and within the educational environment, using existing technology and software. The systems would be evaluated, documented, and the results transferred to the larger community if the evaluations were positive. One proposal along these lines is for DOE to create a K-12 research and development laboratory to allow people from K-12 and national laboratories to jointly develop software tools to support computational science as a mode of inquiry.

Several policy issues were mentioned during the discussions. Intellectual property is an extremely important issue as schools and school teachers consider whether and how to custom design "electronic" textbooks using material that may or may not be copyrighted. Concern was also expressed over the possibility of joint ownership of both the telecommunications conduit of information and the information itself.

Several policy issues relate to controlling the costs of new technology. There is interest in the establishment of standards and protocols if they could lead to lower costs for hardware, software, and systems development and administration. Several participants felt that telecommunications costs (e.g., for installing phone lines) are too expensive and that a review of Federal Communications Commission and state regulations might be beneficial. Lastly, there was concern amongst school teachers and administrators that the pricing of Internet services would change from its current access fee approach to a use-based approach. Because of very tight budgets, schools much prefer a known expense (e.g., a specific access fee) to a more uncertain and variable expense (e.g., user fees).

5. CONCLUDING REMARKS AND RECOMMENDATIONS

The strongest concluding observation is that the 1993 NII Education Forum only represents the beginning of an important dialogue involving the DOE and its laboratories, the education community, and industry on the topic of technology for precollege education. Without question, DOE and its national laboratories have exceptional capabilities to bring to bear on this problem. More discussion is needed to determine what should be done and by whom.

As a start, an e-mail reflector has been established to facilitate the exchange of ideas among Forum participants and other interested individuals. The reflector address is nii-forum@ornl.gov. Requests to become part of the distribution list can be sent to Ed Oliver via electronic mail at oliverce@ornl.gov.

As a next step, it is recommended that a working group be convened in early 1994. The purpose of this meeting will be to set guidelines for several (i.e., four to five) areas of K-12 technology and associated policy research that can be pursued by the national laboratories in partnerships with schools, other research institutions, and industry, where appropriate. Example areas include freeware, development of low cost computing technologies, technology use instruction, and important policy issues. National laboratories would form partnerships among themselves and the schools to write research project proposals with respect to these guidelines. The proposals would then be funded based on their merit.

And finally, the authors wish to acknowledge Dennis White and Jane Loftis, both of the Energy Division, for their review and comments on this report.

APPENDIX A: FORUM AGENDA

National Information Infrastructure (NII) Education Forum.

October 6-8, 1993

Marriott, Crystal City
Arlington, Virginia
703-413-5500

Draft Agenda (revised 9/30/93)

Wednesday, October 6, 1993:

7:00pm to 10:00pm	Conference participants hospitality center, registration, and reception. (Will have 15 Macs set up for participants to explore the Internet; plus, we will have 5 Suns set up for demo).

Thursday, October 7, 1993:

7:30am to 8:45am	Registration and Continental Breakfast
8:45am to 9:00am	Welcome: *A. Trivelpiece*, Director, Oak Ridge National Laboratory
9:00am to 9:45am	Keynote Address: ***Richard Stephens,*** U.S. DOE
9:45am to 10:00am	Break
10:00am to 11:00am	State of American Schools (readiness for technology) Chair: ***Gwen Soloman***, New York City Public Schools -***Jan Hawkins***, Center for Children and Technology -***Robert Tinker***, TERC -***Linda Roberts***, Department of Education
11:00am to Noon	Approaches to Learning (role of technology) Chair: ***Pam Keating***, University of Washington -***Joe Walters***, Project Zero, Harvard University -***Louis Gomez***, Northwestern University -***Nancy Vye***, Vanderbilt University

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Thursday, October 7, 1993: (Cont'd)

Noon to 1:00pm	Working Lunch
1:00pm to 2:00pm	Case studies of schools and technology Chair: ***Sharon McCoy-Bell***, New Orleans Public Schools -Adventures in Supercomputing Experience, ***Sharon Carruth*** -Local case study, ***John Kaltsas***, Arlington Heights, IL school district -Students' perspectives, ***Agbeli Ameko***, Albequerque Academy
2:00pm to 3:00pm	Overview of National Laboratories' Capabilities Chair: ***Ed Oliver***, Oak Ridge National Laboratory -Hardware and networking capability, ***Bill Lokke***, LLNL -Software and technology capability, ***John Rowlan***, ANL -Education programs, ***Rich Stephens***, DOE
3:00pm to 3:15	Break
3:15pm to 3:45pm	Education Networking Technology Overview -***Pat Burns***, Colorado State, Overview of INTERNET -***Stu Loken***, LBL, Workstation applications
3:45pm to 5:30pm	Hands-On Demonstrations
5:30pm to 6:30pm	Cash Bar, Hors d'oeuvres
8:00pm	Informal Discussion Groups

Friday, October 8, 1993:

7:30am to 8:15am	Continental Breakfast
8:15am to 9:00am	Overview of related federal activities Chair: ***Fred Howes***, DOE -***Nora Sabelli***, NSF, NAS workshop report -***Gary Johnson***, DOE HPCCIT Education -Subcommittee, Report on Activities

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Friday, October 8, 1993: (Cont'd)

9:00am to 10:15am	Comments from Industry Participants, Sign up for Slots to discuss company, industry, etc. Chair: (TBD) -Ben Martindale, Sybase -Bruce Nelson, Novell -Linda Glessner, USAA -Others TBD
10:15am to 10:30am	Break
10:30am to 12:30pm	Small Group Meetings: Recommendations for DOE four groups, will discuss options for the development of education technology
12:30pm to 1:30pm	Working Lunch
1:30pm to 2:30pm	Group Reports
2:30pm to 3:00pm	Summary and Closing Remarks *-Dave Nelson*, DOE/ER

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