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Paper Session I-D - Internet Science and TechnologyFair

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The Internet Science and Technology Fair:
A Call for the Space Science Community to Meet the Challenge

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> *"Space science can strengthen American education and enhance
> scientific and technological literacy by engaging people's imagination
> and strengthening their interest in science and exploration. The results
> of space science missions have literally revealed the universe through
> new eyes and opened up new worlds to explore and understand. The
> awe-inspiring missions, rich data bases, and creative talents of the space
> science community can have a powerful and positive effect on science,
> technology, and mathematics education for all students and on the public understanding and
> appreciation of science."* [1]

This excerpt was taken from "Partners in Education: A Strategy for Integrating Education and Public Outreach into NASA's Space Science Programs". It indicates the importance and value NASA's Office of Space Science places on education and the public's understanding of science.   It also represents a challenge to the space community as a whole that the quality and quantity of future space leaders is directly dependent upon their collective ability to revitalize science education.

The following begins with a discussion about technology literacy, its value in the marketplace and its relationship to our K-16 educational system. It then focuses on the impact and importance of educational partnerships with the science community as a means of bringing real world science and technical resources to the K-12 classroom. And finally, It takes a look at a new partnership oriented, Internet based program, the Internet Science and Technology Fair. It is designed to nationally stimulate technology literacy in the classroom thereby encouraging students to pursue technical professions.

Technology Literacy and Higher Education:

> *"The Nation must put absolute priority on educating and training all
> members of society in mathematics, science, and engineering so
> they may be productively employed in an increasingly sophisticated
> global economy. This educational process is a lifelong endeavor, an
> opportunity that U.S. colleges and universities can revitalize, in
> cooperation with Federal agencies, by promoting the integration of
> research and education at all levels."* [2]

Commerce and industry, especially in fields requiring technical literacy, place great value on students who graduate with science and engineering degrees. This is because of the correlation between technological superiority and international market competitiveness. Living in a global economy, we must remain cognizant that our economic future is only as secure as our ability to maintain an educational system capable of producing a technology literate workforce.

To remain competitive in the global marketplace, space industry will need a constant supply of workers, technical managers, business persons and entrepreneurs from which the future industry leaders will emerge. <u>They will need to be educated in science, mathematics and engineering, be conversant in the use of technology in the workplace and have a broader understanding of the implications of technology to make informed decisions regarding their lives, economy and the world in which they live</u>. This same theme is echoed in a White House report entitled, "Science in the National Interest". Producing the finest scientists and engineers for the 21st century and raising the scientific and technological literacy of all Americans are national goals.

Our nation's postsecondary education institutions have to a large degree met the employment demands of space and other technology related industries. This is due in part to the support and technical infrastructure generated through joint research and development with corporations and the federal government. The resultant infusion of equipment, new technical processes, software, technical assistance and funds for student support and course development has a significant impact on the quality and diversity of courses offered in higher education. K-12 education has does not have access to the same resource rich, support system (as higher education) and will be challenged to improve science, math and engineering education.

Technology Literacy and the K-12 Classroom:

> *"Technological literacy—meaning computer skills and the ability to use computers and other technology to improve learning, productivity, and performance—has become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic. Yet, for the most part, these new technologies are not to be found in the nation's schools."* [3]

This quote is not an inditement of the educational system. It is however a realistic portrayal of the status of new technologies in American schools. In 1997, the CEO Forum on Education and Technology produced a report entitled, "From Pillars to Progress, Integrating Education & Technology". The forum was founded, "to help ensure that every child in the United States is equipped with the essential technological, critical thinking, and communications skills necessary to compete in the 21st century." Using President Clinton's Four Pillars of education and technology, the report address the current state of hardware, connectivity, content and teacher professional development in K-12 schools.

Hardware •In the 1996-1997 school year, the average student to computer ratio was 9:1 and the average student to multimedia capable computer ratio was 16 to 1. •In 1995, reports suggest that nearly 60% of school computer purchases were used to replace old and outdated computers, resulting in only a marginal increase in the number of machines available to students.

Connectivity •In 1996, only 14% of classrooms had access to the Internet. •The percentage of schools using local area networks for instruction has increased by nearly 70% every year for the last four years.
Content   •In 1995, schools spent $6 million for online and subscription-based services. This is expected to double by 1998.   •Forty-nine percent of school districts plan to increase spending on instructional software in 1997-1998.

Professional Development   •Only 13% of all public schools reported that technology-related training for teachers was mandated by the school, district or teacher certification agencies. •When

asked to rate the greatest barriers to integrating the Internet into the classroom, 50% of teachers cited the "lack of time to train." [4]

The availability and use of technology in K-12 schools is on the rise. It is a slow process given the costs of hardware, software, establishing networks, providing on-site technical assistance and training. It is worth the investment as the impact of technology on teaching and learning is becoming well documented. Technology literacy has the capacity to bring the real world to all students while allowing them to learn by doing and at their own pace. At the same time they may work together as in a network environment, analyzing data, comparing results and presenting their findings. It offers parents an opportunity to become active partners in education because of the potential of 24 hour connectivity between home and school. And it enables students to become more proficient in the use of technical tools which will significantly help as they continue their education or should they enter the workforce. The level of expertise attained will become extremely important as employers continue to require skills that involve critical thinking, problem solving, communicating and presenting ideas to others and collaborating with diverse populations

Bringing Real World Science to the K-12 Classroom:

> *"National S&T policies must include a component that addresses the role of science and technology in the development of the Nation's human resource base. This must focus on revitalizing K-12 science and mathematics education at system-wide levels, emphasizing partnerships among diverse communities and all sectors of the economy and encompassing the education and training of S&E personnel in the context of excellence in science, mathematics, engineering, and technology for all Americans." [5]*

Public-private partnerships play an extremely important role in helping to bring real world science and technical expertise to K-12 classrooms. They help to prepare students for today's careers, update curricula in terms of what is current and relevant, and give the community and businesses a chance to better understand local schools' needs and accomplishments. Public and private grant programs have a very successful track record insofar as using partnerships to leverage resources to enhance science and technology education.

> *"Working in partnership - America's success in science and technology depends on the continued viability of a long-standing team effort. NSF (National Science Foundation) investments, including those made in tandem with other agencies, state and local governments and the private sector, directly involve over 200,000 researchers, teachers and students, over 2,000 colleges, universities, and research institutions, including almost 600 businesses. Indirectly, they involve literally millions more." [6]*

Concerning space science education, NASA has taken a leadership role in bringing real world science to the classroom by partnering with educational institutions. Of particular importance is NASA's use of the Internet as a vehicle to convey science using space related data, graphics, audio and real-time simulations. NASA's SpaceLink and Learning Technologies Project (LTP) are examples of programs which continue to fuel the growth of national information infrastructure. Using these resources, students are motivated to research technical topics because they are current and relevant to their coursework. Using e-mail, they

are afforded timely feedback from scientists and engineers who help to explain the science which has made the technology possible. And, teachers can discuss, participate in development efforts and show-case new curricula products.

Creation of the Internet Science and Technology Fair at UCF:

The President of the University of Central Florida (UCF), Dr. John Hitt, established five goals to guide the institution through the year 2000. One of the goals, "Be America's leading partnership university", has helped to shape the services offered through the Partnership Infrastructure Initiative (PI^2). Using information and communication technologies, PI^2 tracks, develops and delivers on-line information services for small community organizations, local governments and educational institutions.

PI^2 originated in Sponsored Research which assists faculty at UCF in their research endeavors. We have witnessed the science behind the research, worked with the faculty who produce the science and have seen tangible results (of research partnerships) which have contributed scientific equipment, and resources for student support and course development. In realizing how public-private partnerships have benefited higher education and having seen the needs of local schools, PI^2 focused their energies on developing a long-term educational resource capable of bringing real world science to K-12 students throughout the country.

Science Fairs have traditionally helped students understand science. They play an enormous role in making science exciting and also offer students of all ages hands-on
opportunities to experience and understand the importance of science and technology in their everyday lives. As teachers and parents become involved, they share in the learning experience. This is especially valuable to teachers as they are exposed to new processes, contacts and resources which may offer new materials and tools for use in the classroom. The only problem is that the science fair comes once a year, due in part to the significant amounts of time, organization, resources and personnel required to support the event.

In realizing the influence science fairs can have on the teaching experience and students' decisions concerning their careers, UCF-PI^2 developed what is becoming an important "electronic hands-on" national science program for middle, junior high, and, eventually, all grade level students . It is called the annual "Internet Science and Technology Fair" (hereinafter referred to as ISTF). The focus for the first year (1997) ISTF was on middle school and junior high students. It was critical to begin with this age group for they are contemplating their careers. If we have any hopes of interesting them in pursuing science and engineering careers, we need to provide programs that will stimulate their interests. If motivated, their interests could be further fueled by taking math and science courses in preparation for high school.
The ISTF has three goals.

  • first, to pique students' interest in science and engineering using the Internet to develop on-line projects which may ultimately impact career decisions and/or begin to build a sense of "technology literacy";
  • second, to give educators an opportunity to learn how to use Internet resources which may later help to enhance teaching of existing science and other technical curricula; and,
  • third, to demonstrate the importance of electronic collaboration through partnerships and the educational benefits which may be derived.

The once a year Fair will enable student teams in conjunction with science teachers and technical advisors to develop "Project Homepages" which focus on National Critical Technologies (as obtained from the Office of Science and Technology Policy and National Science Technology Council). The National Critical Technology Categories are as follows.

ENERGY : Energy efficiency, Energy storage, conditioning, distribution and transmission. Topics focused on: superwindows, modular utility components, energy efficient lighting, advanced batteries or power electronics.

ENVIRONMENTAL QUALITY: Monitoring and assessment, Pollution control, and Remediation and restoration. Topics focused on: environmental monitoring sensors, biomarkers, waste elimination, soil washing, composting, recovery of spilled oil (or other hazardous substances) or nuclear waste storage or treatment.

INFORMATION AND COMMUNICATION: Components, Communications , Computer systems, Information management, Intelligent complex adaptive systems, Sensors, and Software and toolkits. Topics focused on any one of the following technologies: high-density RAM, parallel data storage controllers, holographic displays, programmable radios, mobile computing systems, satellite-ground communication systems or hypercubes.

LIVING SYSTEMS: Biotechnology, Medical technology, Agriculture and food technologies, and Human systems. Topics focused on: drug development, mineral extraction, protein sequencing, molecular electronics, biomolecular materials, gene mapping/sequencing, agricultural species modification, AIDS vaccine or tissue engineering.

MANUFACTURING: Discrete product manufacturing, Continuous materials processing, and Micro/Nanofabrication and machining. Topics focused on: computer aided design, factory scheduling tools, computer integrated manufacturing, metal injection molding or gas atomization.

MATERIALS: Materials and Structures. Topics focused on: light weight structural alloys, ceramic coatings, polymer composites, thin-film materials, semiconductor lasers, explosives, road paving, radar-absorbing materials/coatings or high temperature semi-conductors.

TRANSPORTATION : Aerodynamics, Avionics and controls, Propulsion and power, Systems integration and Human interface. Topics focused on: turbulence prediction, noise control, hypersonic designs, glass cockpit technical devices, advanced engine controls, high-efficiency turbines, high efficiency solar cells and remote power transmission.

Scientists and engineers from corporations and federal laboratories are the technical advisors to each team. Each technical advisor will have expertise relating to a specific National Critical Technology. As the third member of the team, these "subject matter experts" will respond to students' questions on-line, suggest useful scientific sites on the net for information sources and provide feedback to teachers regarding technical explanations.

The evaluation will be orchestrated by local and national teachers, scientists and engineers. It will focus on the degree to which guidelines have been followed, the quality of content and presentation of the Project Homepage. Each team member will be responsible for completing the on-line Self-Evaluation Form which will not affect the judging process. It will focus on the value of the Fair as an educational program, assessment of teaming to develop a Project Homepage, what impact the project has had on the student's interest in pursing a scientific career and suggestions for improving the overall ISTF experience.

Teams that have successfully completed Project Homepages and have been judged to have followed the guidelines will receive a "Certificate of Achievement" from the National Medal of Technology program at the U.S. Department of Commerce's Office of Technology Policy. This is the same federal agency which administers the National Medal of Technology Awards on behalf of the President of the United States. The

teams which are judged as the Best of each National Critical Technology Category will receive the "Certificate of Meritorious Achievement" which will be framed in a plaque for their school to proudly display. Each team member will receive a copy of the Certificate.

The First Year of the ISTF:

Between July and October, 1997, there were in excess of 1,000 visitors to the ISTF Website (http://istf.ucf.edu) and over 100 inquiries concerning possible participation. We had a number of requests from High Schools to participate. Some of the e-mails we received were from organizations which we approached to help distribute information concerning the Fair. A faculty member from the University of Southern California who operates a national website for science fairs reviewed our program and said,

> *"This is exactly what I termed a "Virtual Science Fair" a few years ago, so I've added it to that section. Frankly, I'm surprised that there are more _real_ virtual science fairs (which break geographical limits) as opposed to simple school fairs with Web postings which then call themselves "virtual."*

A representative from DoD's Office of Defense Research and Engineering commented,

> *"Visiting your web site made me wish I was back at the (lab) bench and could work with some of your students. I was very lucky to have middle school teachers who spent most of the year leading us through hands-on experiments instead of lecturing to us. Your program will bring science and engineering alive in the classroom. "*

As of the October 17 deadline (which was extended from the original September 15 deadline), 23 teams submitted Concept Papers which met the guidelines. Having received in excess of 100 responses from science educators who were originally interested, PI^2 began to explore why only 23 teams responded. Some of the reasons identified were teachers who initially responded did so from home and did not have Internet access in their classroom, some other teachers were unable to obtain technical support concerning webpage development and there were other teachers who did not have time to integrate the ISTF into their coursework.

Another factor which affected the number of participants concerned the requirement that teacher/student teams had to locate their own technical advisors. This became an issue as several teams requested assistance from Pi^r to locate advisors. One additional possibility which may have impacted participation concerned students' inability to locate useful, understandable technical information on their topics using the Internet.

By the December 12 deadline (for the receipt of Project Homepages), 9 teams forwarded their final submissions. Two schools reported,

> *"Of the three groups that originally sent proposals, two dropped out and never got any farther. The third worked quite a bit, exchanged emails with their advisor, but had some technical difficulties because of the school district. We lost our access to email and web for some*

> *time and as a result, just fell too far behind to complete the project.*
> *The group ahas expressed an interest to do this next year as 8th*
> *graders if possible, and hopefully we will have the access we need*
> *throughout the project."*

> *"Sorry about this, but my student team and I just can't get our stuff*
> *together. We have to drop out of the competition. I've been inundated*
> *with things happening so I'm not there to tutor them, and the kids can't*
> *get rides after school, etc., etc. Maybe next year I'll be able to incorporate*
> *it into my actual class and things will go better."*

The student/teacher teams which did submit final project homepages did an outstanding job. Their work will help to set a standard for what will be expected in future years of the ISTF. The following are some of the comments received from the students and teachers who completed the on-line, self-evaluation form at the ISTF website.

> *"Yes the fair was an enjoyable experience partly because I learned*
> *some new things that were both shocking and interesting. I enjoyed*
> *it also because it was a new experience for me, instead of just sitting*
> *in class all day and learning stuff that was mostly the same year after year."*

> *"I wanted an opportunity for my students to do research over the Internet.*
> *Since we study life science, our topic fit in so perfectly. The students*
> *were extremely interested in the human body and how scientists dare*
> *to repair the body. This fair was educational for me and my team because*
> *we learned so much current science on transplantations. Never, in any*
> *way, would we have received so much knowledge so quickly. The challenge*
> *was to evaluate all the information that came in. Thanks for giving us this challenge."*

The evaluation of the ISTF project homepages is in progress. An independent evaluator has designed a questionnaire for a select group of educators to evaluate the 9 homepages.

A focus on Space Science for the next ISTF:

Plans are underway for the next round of the ISTF (scheduled for 10/98). The inclusion of high school students will substantially increase the number of participating teams. Two critical changes are underway to strengthen the program.

1. This year's ISTF has taught us it will be important for next year's program to correlate students' projects with actual technical applications under research or being developed at corporations and federal laboratories. This will help to keep student teams focused on specific technical issues which correspond with the National Critical Technologies. The inclusion of "ISTF Project Sites" at corporations and federal laboratories will bring three important forms of support to student/teacher teams. First, a representative from a corporation or federal laboratory will work with PI[2] to develop a project abstract based upon an in-house technical application of their choosing. Student teams would use this abstract as a basis for developing their project homepages. Second, corporations and federal laboratories will identify one or more in-house scientists or engineers who will serve for a two month period as on-line technical advisors to students. Third, each corporation/federal laboratory will provide some suggested addresses on the net

and from their organization's data files where students can locate additional information to help understand the technical application.

2. Partnering is critical to the ISTF. In order to raise the consciousness of students nationally, each year a special focus/theme will be identified which cuts across the National Critical Technologies. This same theme will be used to identify a critical mass of industry and federal partners to help us meet the challenge. The theme for UCF's 1998 ISTF will be Space Sciences. PI^2 will be therefore be recruiting corporations and federal laboratories which have the expertise to host "project sites" regarding space science and aerospace programs.

The ISTF as a recruitment tool for future space industry leaders and advocates:

To remain globally competitive and economically strong, we are dependent on a workforce which is technically literate. The space industry, like many other technically dependent industries, relies on the educational system to produce future scientists, engineers, support personnel, technical managers and administrators. These persons comprise the workforce pool form which future space industry leaders will emerge. Higher education is able to build technology literacy into their curricula through support from student fees and through the technology infrastructure created as a result of research and development. K-12 education does not have the same support system to afford the increasing costs of technology infrastructure. Therefore, K-12 education cannot accomplish technology literacy alone.

Through partnerships with Corporate America and the federal government, K-12 education can build the tools, expertise and resources needed to stimulate students early in the educational process to consider technical careers. The Internet Science and Technology Fair is one such partnership opportunity that offers students and teachers a real world science challenge.

As of the date of this publication, the ISTF website is receiving in excess of 100 hits a week. Although this may pale in comparison to other high traffic websites, it indicates there are teachers and students looking for opportunities to integrate technology literacy (using the Internet) into the classroom. With the help of the space community, we can build the ISTF into a long term national program capable of reaching hundreds of students and increase the size of the technical workforce from which tomorrow's space industry leaders will emerge.

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