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Apr 29th, 1:00 PM

## Paper Session III-C - The World Wide Web as a Science and Engineering Educational Tool

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### Scholarly Commons Citation

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## **The World Wide Web as a Science and Engineering Educational Tool**

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### **ABSTRACT**

Since 1992, the internet evolved from a means to share information between university and government computers to a world-wide total information community open to every human being. The World Wide Web, WWW, or the Web as it is popularly known, has taken on a whole new dimension in human culture. We can now share any known fact in a single moment with everyone else, on and off-planet. Education can be as broad as the human imagination. Obfuscation is no longer possible. Repression can only occur when openness is unavailable, and the oppressors are on the run. The Free World has become the entire world on the Web.

Given this wonderful metamorphosis, the opportunity to vastly enhance scientific and technical education is at hand. Access to virtually every scientific and technical discovery ever conceived and documented becomes the enabling force.

For the next century, enhancements in technology will provide instantaneous dissemination of new ideas to the entire world. NASA, in its quest to develop technology for the conquest of space and the understanding of the laws of nature, has provided many of the tools

that have brought about this revolution. NASA support to the creation of *Mosaic*, the forerunner of *Netscape* and *Internet Explorer*, to high speed network design, to advanced software for real-time information sharing, embedded microprocessor control, and to the development of integrated circuitry design, clean room technology, and image processing techniques have paved the way for the second industrial revolution.

This paper shall discuss some of the new technologies, both hardware and software, that are changing the world, and make some suggestions as to how to put it to good use in education.

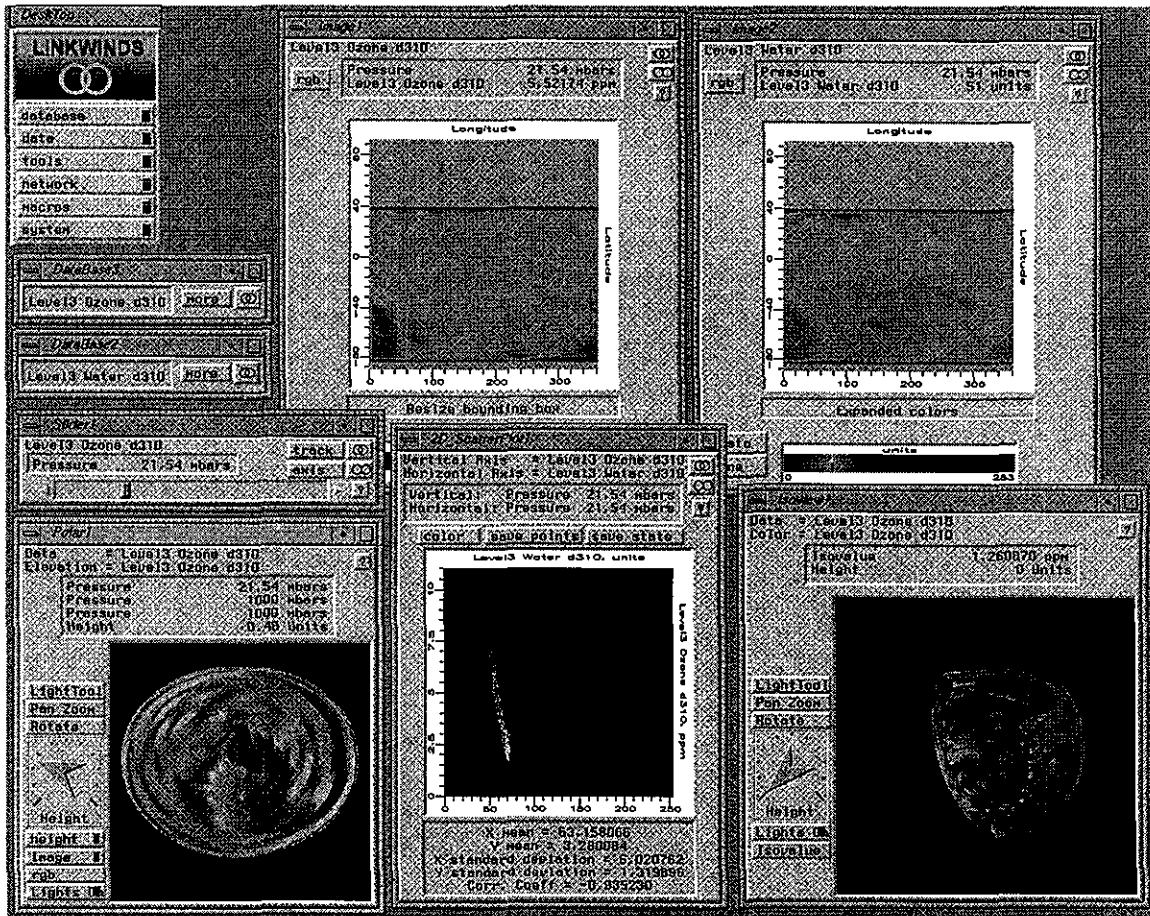
### **INTRODUCTION**

Beginning in the late 1980's, NASA, NSF, DARPA, NIST, DOE, and NOAA formed a consortium to focus research on means to exploit the potential of the Internet. Relatively small grants to research institutions such as University of Illinois at Urbana-Champaign for the creation of *Mosaic*, the first Web browser, had unforeseen impacts on the world today. The creation of the Web browser and hypertext markup language, Web servers, and high-speed telecommunications devices and interfaces, along with the explosion in the personal computer hardware and software markets has transformed the world as we enter the new millenium. NASA has made significant seed money investments in these new technologies to assist us in our mission to conquer the frontiers of space. New technologies spring forth each day which may further transform society, and with it, our entire perception of the world.

## WEB TECHNOLOGY

NASA has developed several new technologies that are already having a significant impact on scientific education and research activities. One of these, a co-winner of NASA's 1996 Software of the Year competition known as *LinkWinds*, allows users to collaborate over the Web as they view large, complex data sets, such as world ozone data (below).

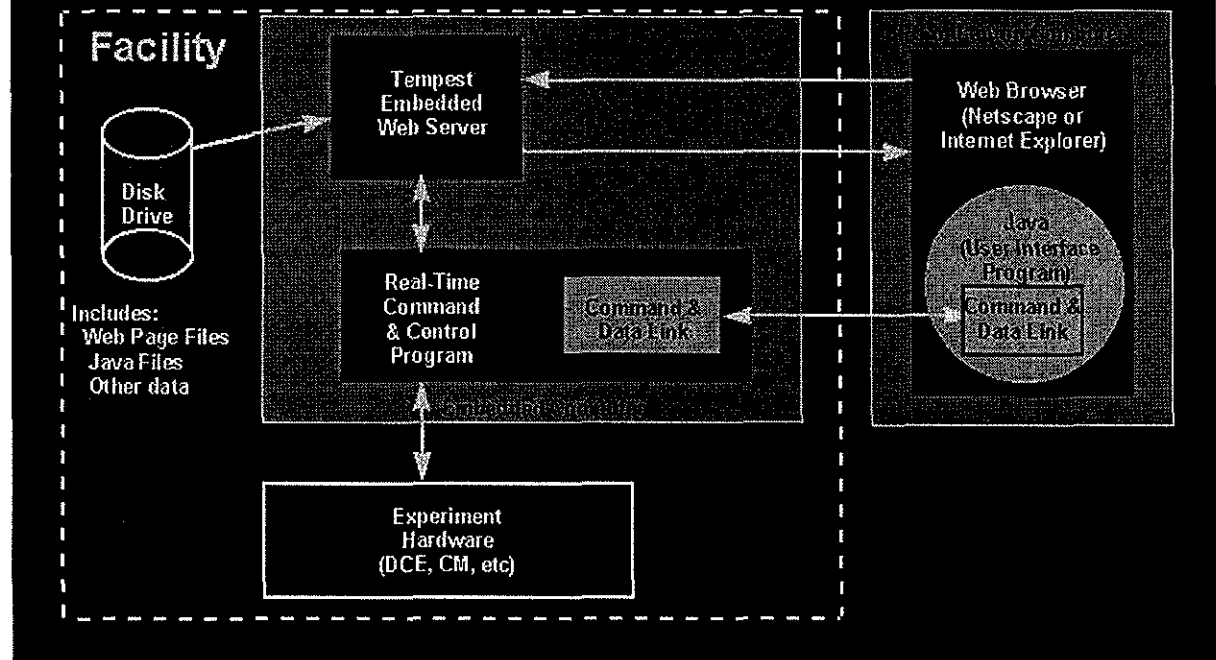
Another NASA software package, known as *Tempest*, co-winner of the 1998 competition, developed originally for the Space Station program for remotely controlling experiments, has the ability to actually control microprocessors using an embedded Web server and any conventional Web browser over an Internet connection. One can literally control anything that has an onboard computer and a Web



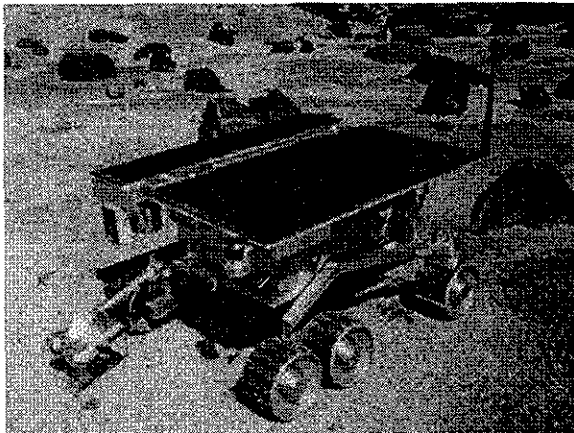
With LinkWinds, and its successor, WebWinds, a student or researcher can explore vast data sets with ease, gleaming the vital information and understanding that only visual examination can provide. The data may be stored on a server and viewed from any machine capable of viewing high-resolution, high-color graphics.

connection from anywhere on or offworld. This is extremely valuable to scientific and technical education, in that experiments can be conducted at remote sites under the control of students and researchers from their homes, offices, or classrooms. A diagram of how this works follows:

## FCF Command & Control Block Diagram



Some probably recall during the Mars Pathfinder mission that it was possible for interested parties to virtually pilot the Sojourner Rover from a Web site at JPL. A NASA software program known as *Web Interface for Telescience*, or *WITS*,



was developed for precisely this purpose. *WITS* allows users to enter the virtual world of the object being controlled, using VRML plugins within the browser, and apply commands with a simple point and click interface to maneuver the object. In some ways, *WITS* is similar to *Tempest* except that direct microprocessor control is not

achieved. Both programs, however, are quite valuable in a classroom environment.

As one can appreciate, there are literally hundreds of different formats for data that is being catalogued on Web servers around the world: geophysical, medical, astronomical, geographic, demographic, and multispectral. NASA has developed a *Common Data Format (CDF)* which allows the data to be converted to a single common format and to be read by any Web browser. This is important so that a student or researcher may use a simple browser and viewing plugin to capture and review the data. Information about *CDF* can be found at:

<http://nssdc.gsfc.nasa.gov/cdf/>  
 Access to NASA's scientific and technical databases is also available through the National Space Science Data Center (NSSDC) at that site.

Some NASA Internet-based software was developed specifically for educational purposes: some of the more

interesting programs and their Web sites are listed below:

Program	Web site
Foilsim	<a href="http://www.lerc.nasa.gov/WWW/K-12/aerosim">http://www.lerc.nasa.gov/WWW/K-12/aerosim</a>
Imagine the Universe	<a href="http://imagine.gsfc.nasa.gov/">http://imagine.gsfc.nasa.gov/</a>
Observatorium	<a href="http://observe.ivv.nasa.gov/nasa/education/edu_index.shtml">http://observe.ivv.nasa.gov/nasa/education/edu_index.shtml</a>
Exploring the Moon	<a href="http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Exploring.the.Moon/.index.html">http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Exploring.the.Moon/.index.html</a>
Space Link	<a href="http://spacelink.nasa.gov/">http://spacelink.nasa.gov/</a>
Quest	<a href="http://quest.arc.nasa.gov/">http://quest.arc.nasa.gov/</a>

### **ENABLING TECHNOLOGY**

NASA has over 2,000 patents in force in new technology, in virtually every field of science and engineering, and publishes nearly 100 computer programs each year. While many of software products from NASA are helping to expand the frontiers of education, much of the hardware and software we produce has enabled the existence of the Web as it exists today. Some examples of these include:

- *Cares/Life –Ceramic Analysis and Reliability Evaluation of Structures Life*, which was used by Intel to repair its 486 production line problems in 1991, making it possible to produce low-cost, reliable microprocessors
- *WINVN – Windows Virtual News*, a simple windows-based USENET news reader

- *Particle Fallout Activity Sensor*, a device that is being used in clean rooms enabling fabrication of ultra-high density integrated circuits
- *Information Sharing Protocol (ISP)*, used to build the new Mission Control complex in Houston, used and expanded the capabilities of TCP/IP communications to allow up to 19 different computer platforms (operating systems) to access and provide real-time command and control of a massive, world-wide network

Information about these and other NASA-created technologies may be found at:

<http://www.hq.nasa.gov/office/codei/90s/best.htm>

### **THE FUTURE**

While it is not NASA's mission to revolutionize education, it is our job to transfer what we have learned to our people so that they can change the world for the better. We are documenting all our new ideas and publishing the results openly (when allowed after meeting security restrictions). NASA patents are available to any for licensing, and our software as well. The rate of change in the fields of technology is now faster than ever before, now that 95% of all scientists and engineers who ever lived are alive today, connected together for the first time in real time over the World Wide Web. Soon, instantaneous access to information may be available to any person as soon as it can be transcribed and documented. Tools for education will be honed and refined to maximize learning and understanding. NASA will continue to innovate and inspire the scientific and technological revolution.