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Final Report

Live From Space Station Learning Technologies Project

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1.0 INTRODUCTION

This is the Final Report for the Live From Space Station (LFSS) project under the Learning Technologies Project FY '01 of the MSFC Education Programs Department. AZ Technology, Inc. (AZTek) has developed and implemented science education software tools to support tasks under the LTP program. Initial audience consisted of 26 TreK in the Classroom schools and thousands of museum visitors to the International Space Station: The Earth Tour exhibit (Figure 1) sponsored by Discovery Place museum.

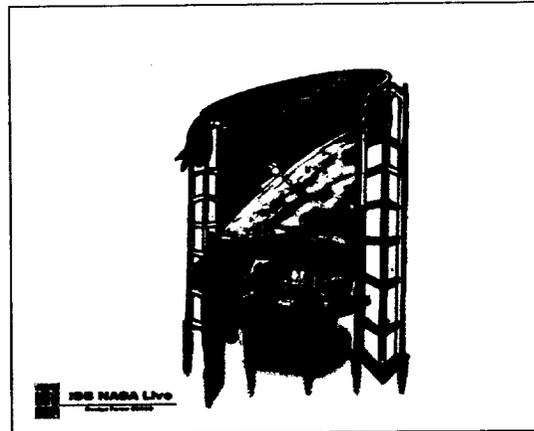


Figure 1: NASA Live! Kiosk

This report will discuss the work performed during the entire contract, March 15 to September 15, 2001. The initial audience for this proposal was the Space Experiment Education Kit's schools based on a National Science Foundation SBIR Phase II award. Instead, we changed focus of the project to reach a broader audience through a traveling museum exhibit. The traveling exhibit opened on June 16 in Charlotte, NC at Discovery Place. It will travel to 17 different museums for the next 5 years with a traveling debut at Maryland Science Center in Baltimore. A partnership of US Space Enterprises (USSE), exhibit designers, AZTek, telescope integrators, and the University of Alabama-Birmingham's Center for Biophysical Sciences and Engineering (UAB), telemetry source, provided a stable foundation for developing the NASA Live! portion of the exhibit.

The work performed by AZTek during this period includes the following:

- Developed concept document and kiosk interface specification.
- Initiated a partnership with University of Alabama-Birmingham's Center for Biophysical Sciences and Engineering to support the telemetry distribution to the kiosk.
- Designed and developed real-time display for museum use.
- Developed EZStream telemetry tool to replace legacy TOPS application.
- Installed museum kiosk computer with Live From Space Station telemetry software.
- Provided update of telemetry display to Discovery Place at the end of July.
- Developed educational resource CD-ROM for "TReK in the Classroom" audience.

2.0 BACKGROUND

The LFSS FY'00 project developed a prototype science education application based on a manifested Space Station experiment. The application was used and evaluated in Spring 2000 utilizing a laboratory prototype since the earliest Space Station experiments were not operational until the 2000-2001 school year. The LFSS FY'01 project has extended this capability to provided educational content in a museum setting. The NASA Live! kiosk inside the ISS exhibit provides real-time telemetry acquisition from UAB (Figure 2).

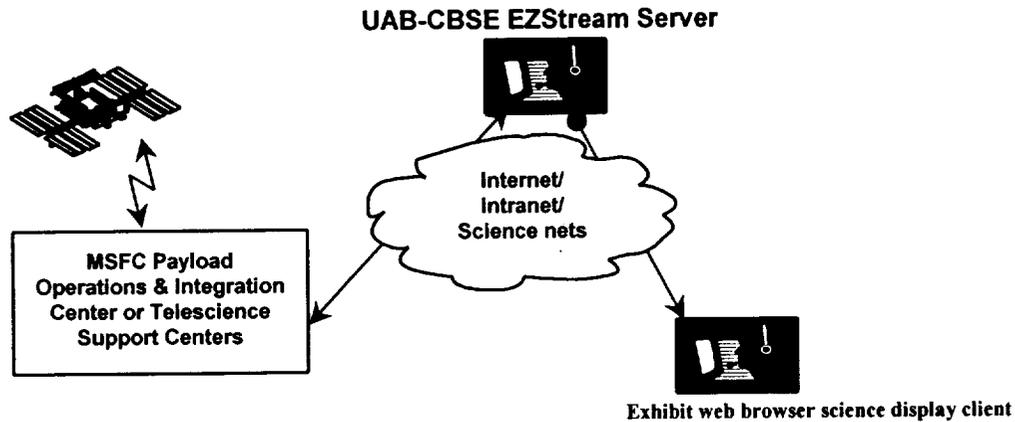


Figure 2: Live From Space Station Data Distribution

Timeline

- March
 - Develop Concept Document
 - Develop Design Interface Specification
- April
 - Research a viable replacement for legacy TOPS application.
 - Develop NASA Live! display
 - EZStream Phase I development
- May
 - Installation and Integration of EZStream tools onto kiosk computer.
 - End-to-End testing with UAB and Discovery Place networks.
- June
 - Exhibit opens to the public
- September
 - Educational activity with TReK in the Classroom schools.

The education/public outreach program is based on the Telescience Resource Kit used by International Space Station experimenters. TREK was designed for use by experiment developers and operators. We have provided the museum with the same telescience tools that the scientists use. Our goal was to provide space science awareness in schools and to the general public.

3.0 TASKS

3.1 Task 1: Developed concept document and kiosk interface specification

AZTek provided USSE with a computer design specification that defined the computer hardware, software, network and museum interface (power, bandwidth, etc...) requirements. This specification was based on the amount of telemetry being sent from UAB to the remote location and described the interfaces (data, power, etc...) that the museum needed to support.

AZTek worked with USSE to develop a computer concept definition document. The concept document was used as a guideline for development and project management, as well as a starting point for future enhancements to the telescience portion of the kiosk.

3.2 Task 2: Partnership Agreement

AZTek developed a partnership agreement with UAB-CBSE to provide the telemetry stream for the museum display through December 31, 2001. For periods of Internet loss or lack of telemetry flow UAB provided a TReK archive to drive the science display so that the museum kiosk will always be active. AZTek will look for a new experimenter to provide telemetry data to the kiosk, this will help keep the display updated and keep the public informed to other scientific discoveries on board station.

3.3 Task 3: Designed and developed real-time display for museum use

AZTek developed a science web page (Figure 3) to display the telemetry data in real-time. The combined experimenter and ISS ancillary data display provides a broad picture of the ISS science. AZTek worked with UAB to determine "interesting" parameters that could be tied into the rest of the exhibit.

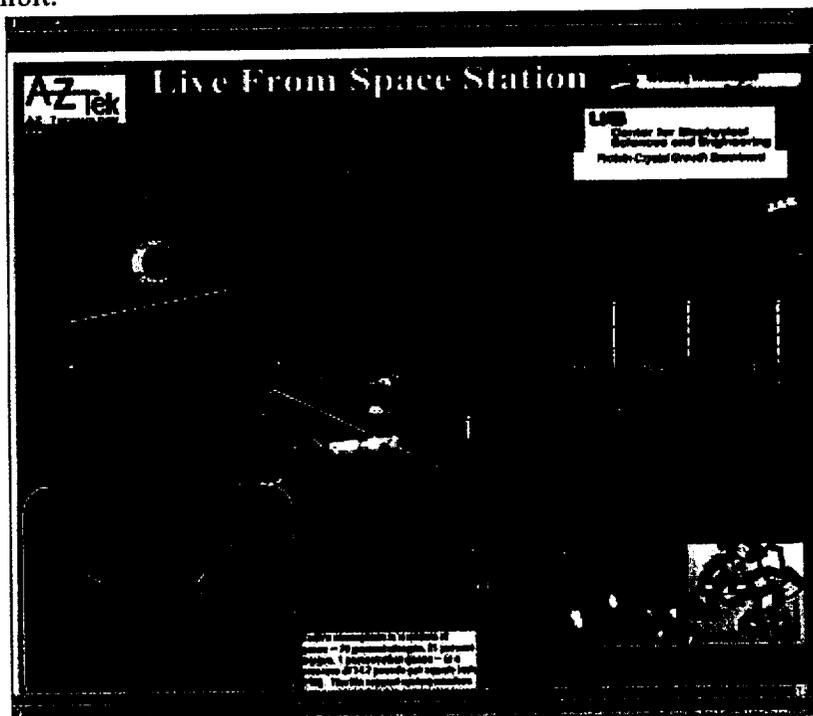


Figure 3: Live From Space Station Display

The display was built in Microsoft Visual Basic using ActiveX controls. The ActiveX controls

allow the display to be updated in near real-time with dynamic controls instead of static controls. The dynamic controls allow the integration of controls, dials and strip charts that illustrate the data in a graphical format.

3.4 Task 4: EZStream Development

This task was intended to replace the legacy TOPS system that was originally used for the TReK in the Classroom project. Technological advancements have far surpassed the primitive structure of TOPS and in order to make this a viable tool for education/public outreach activities a more sophisticated tool was needed.

EZStream software interfaces to TReK via a Front-End process utilizing the TReK Application Program Interface (API) and the TReK database. The Front-End process generates metadata and telemetry Internet Protocol packets processed by the EZStream server located on the TReK or other PC. The EZStream server process distributes the telemetry data to EZStream Client processes and Web browsers connected to the IP network. For this project, the Live From Space Station display is an EZStream client process running in a web browser on the kiosk computer.

AZTek implemented a beta EZStream version to provide a mechanism for the museum and schools to receive the telemetry data via the Internet. A full version will be developed for International Space Station Principle Investigators and experimenters to use during mission operations. AZTek has pre-sold a copy of EZStream to an ISS experimenter, IBC. IBC's tentative launch data is January 2005. EZStream Version 1.0 will be available to the IBC team in January of 2001. More enhancements and features have already been discussed for EZStream and it is already proving its worth to the small payload developers and ISS experimenters.

3.5 Task 5: Installation and testing

AZTek provided installation and integration of telescience tools on the kiosk computer. Before the computer moved to the museum end-to-end testing was conducted between AZTek and UAB to verify EZStream's operation for telemetry streaming. More testing was completed after the computer was set up inside the museum to verify network settings were appropriate. To keep the display from becoming inactive during periods of Internet loss or during UAB's payload inactivation periods an archive of live data was created to stimulate the display. Setup manuals were created to aide the museum staff in setting up the display for live or archived data.

After the exhibit had been open for one month, AZTek worked with Discovery Place to provide more intuitive graphics on the science display. The slight redesign of the display aided the public in understanding and learning more about the function of the ISS during an orbit. Providing historical data over the life of an orbit instead of showing just the current data points allowed the visitors to get a clearer picture of what effects the Sun has on the ISS.

3.6 Task 6: TReK in the Classroom school activity

The original audience for the Live From Space Station project was the TReK in the Classroom schools that participated in the NASA MSFC Ground Systems Dept. remote TReK testing and SEEK, the prototype course developed during a previous LTP project. Of the original 26 schools assembled from the NASA Educator's Workshop during the summer of 1999, we were able to reach and provide educational resources for 15 of them. After working with this magnificent

group of teachers for two years, we have maintained a level of excitement and innovativeness that keeps over half of the teachers coming back for more. Their students have received access to LIVE International Space Station provide by the University of Alabama-Birmingham. They were provided a CD-ROM with resource material about protein crystal growth and ISS experimentation as well as an instructional link to the Live From Space Station web site hosted at the UAB-CBSE lab. The teachers are integrating the use of the materials and the live data display in their science courses to teach a myriad of lessons: temperature conversion, current and batteries, as well as basic crystallography. The teachers have shared their resource CD's with other teachers in their schools as a way to provide knowledge across all subjects and age groups.

The UAB science display link was not made publicly available because UAB can not handle the amount of overwhelming Internet traffic that would swamp it. NASA has strict requirements on how much bandwidth experimenters must maintain in order to receive data from the ISS and large amounts of extra traffic could not be afforded. In future phases, Live From Space Station will be hosted at science web portals that can maintain large amounts of web traffic. Providing a permanent location for LTP and the science that they are helping teach.

4.0 AUDIENCE REACHED

4.1 Museum Visitors

Live From Space Station is part of a museum kiosk in a traveling exhibit, International Space Station: The Earth Tour. The exhibit debuted at Discovery Place in Charlotte, NC in June of 2001. Discovery Place has determined that it has received 106,000 visitors between June 1, 2001 and September 1, 2001. This does not include the educational and group programs that Discovery Place sponsors throughout the year to promote Space Science education. The exhibit will remain at Discovery Place until January 1, 2002. From there, it will take a 5-year tour to 17 different museums starting first with the Maryland Science Center in Baltimore. Each museum has approximately 40,000 visitors per month during the summer and about 25,000 visitors per month during the off-season. The number of students, teachers, and the science interested public that will see Live From Space Station over its lifetime could far surpass 2 million.

4.2 Number of schools served

The Live From Space Station project worked specifically with 17 geographically sparse schools (see Table 1). However, we know that these teachers shared their information with co-workers and colleagues so the actual number of schools reached is much more than just 17. If each teacher shared their resource CD with one other colleague in another school this estimate could easily be determined to be 30 or more schools.

Table 1: TReK in the Classroom participating schools

School Name	Location
Ottawa County Juvenile Detention Center	West Olive, MI
LaJunta Middle School	LaJunta, CO
South Iredell High School	Statesville, NC
Sandy	Lexington, NE
Seven Hills School	Cincinnati, OH
Ruffin High School	Ruffin, SC

Upper Sandusky High School	Upper Sandusky, OH
Red Bank High School	New Bethlehem, PA
Kelloggsville Middle School	Grand Rapids, MI
Sherwood Githens Middle School	Durham, NC
Dumas High School	Dumas, TX
Rainbow Middle School	Rainbow City, AL
Mackinaw Trail Middle School	Cadillac, MI
National Cathedral School	Washington, DC
Sherwood Middle School	Baton Rouge, LA

5.0 EXPANDING LIVE FROM SPACE STATION

During the course of this program, AZTek has sent out numerous correspondences inquiring for new experimenters to participate in the Live From Space Station (LFSS) program. We have had favorable responses for participation in future activities. LFSS has many applications and can be used to teach and learn thousands of fundamental principles. New science displays can be built that focus strictly on the ISS and its core data, arboretums could be interested in showing a Live From Space Station display that focuses on how plants are grown in space and the things that we learn from microgravity exposure, or an exhibit about the human body could use a Live From Space Station display that deals with the health and monitoring of the astronauts. The ISS is a wealth of information and it can be tapped in hundreds of venues: space and science web portals like science.nasa.gov or space.com, museums, science and technology centers or educational facilities.

For LTP FY '02 funding, AZTek plans to explore the addition of more experimenters and venues as well as adding interactivity to the current display used in the ISS traveling exhibit. The current display does not support any keyboard or mouse inputs from the visitor. The next generation version would allow the user to select an area of the screen and be given a "pop-up" window that provides in-depth resources about that particular object, whether it is a cabin temperature or the power being generated by the solar arrays. AZTek would also like to investigate the addition of 3D animations to help students/viewers visually understand the data being presented. For example, as crystals are being grown on board the ISS students would be able to see (and rotate with a mouse) a 3D representation being driven by the data from the ISS of that crystal.