SMALL PASSIVE STUDENT EXPERIMENTS ON G324
261 INDIVIDUAL QUESTS FOR STUDENT KNOWLEDGE

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ABSTRACT

The Charleston County School District **CAN DO** Project payload on **STS-57** had a primary goal of photographing the Earth with the **GeoCam** camera system. In addition, the payload carried 261 passive student experiments representing the efforts of several thousand students throughout the district and in four other states. These experiments represented the individual concepts of teams ranging in age from pre-school to high school. Consequently, a tremendous variety of samples from collard green seeds to microscopic "water bears" were flown. Each prospective team was provided a simple kit equipped with five vials. Each student team submitted five coded samples, one for space flight and four control samples. The control samples were exposed to radiation, cold and centrifugation respectively while one negative control sample was passively stored. The students received the samples back still coded so that they were unaware of which samples were flown. They then investigated their samples according to their individual research protocols. The results were presented in poster and platform form at a student research symposium.

Space Trees grown from tree seeds flown in the payload have been planted at all district schools, and at many guest schools. These seeds represented another way in which to involve additional classes and students.

Both the passive experiments and the space trees were housed in what otherwise would have been wasted space within the payload. They extended the **GAS** programs worthwhile ballast concept to another level. The opportunity to fly an experiment in space is too precious not to be extended to the greatest number of students possible.

EXPERIMENTAL RATIONALE

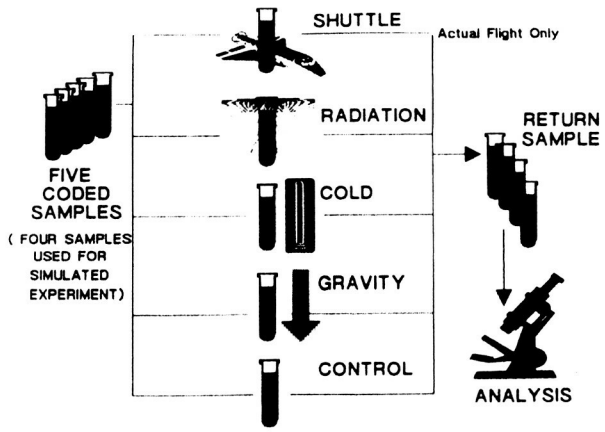
To be successful, a payload should actively involve many students working at their own level. This suggests some possible criteria in the design of a perfect experiment. One is that it should be applicable to as many grade levels as possible and require a minimal amount of expertise, equipment and expense. It also should require a small enough time commitment to allow it to fit into already crowded curriculum schedules. It is important that the experiment teaches some fundamental, solid scientific principles and uses sound scientific methodology. Most important, the activity should be as fail-proof as possible, provide active participation, and be fun.

A good example of an activity that comes very close to meeting these criteria is the inclusion of small passive student experiments in the G324 payload

CONCEPT DEVELOPMENT

When the G324 payload was originally scheduled to fly in 1986, the criteria for student designed experiments was very open for both size and weight. In spite of this, almost all of the experiments submitted fit quite easily into small 5ml cryovials. These cryovials are designed to survive freezing in liquid nitrogen and provide a positive gasket seal. The vials are inexpensive and meet safety requirements for positive containment.

One problem with many of the materials that students might choose to fly in space is that they will be unaffected by the relatively benign environment aboard a vehicle designed to fly fragile humans. Also the normal handling procedures for GAS payloads include long storage times that preclude most living materials.



Our main goal was not to teach just the effects of low Earth orbit but to teach scientific methodology. It was apparent, especially to those who judged science fairs, that many students had a poor concept of what constitutes a valid scientific experiment. Fundamental principles, such as blind studies, and the use of controls were mostly unknown. It was decided to use the small passive student experiments as a vehicle to teach these important principles.

EXPERIMENTAL PROCEDURE

Each student team was provided with a kit composed of an envelope and five color coded 5ml cryovials. The envelope also served as the experimental registration form and was filled out with all the information necessary to handle and track the sample. The students filled each vial with an identical sample of their material and wrote their experiment number on the vial with indelible pen.

One of the five vials was placed in a special aluminum housing inside the G324 payload and flown aboard STS-57. A second vial was exposed to extreme doses of radiation in a laboratory gammator. The third vial was frozen in two separate cycles in liquid nitrogen. The forth vial was spun on a laboratory centrifuge to approximately 600g. The fifth vial was passively stored to serve as a negative control. At the completion of the flight, all five vials were returned to the student teams. The teams were not informed as to which color vial experienced which condition so that all research would be conducted "blind".

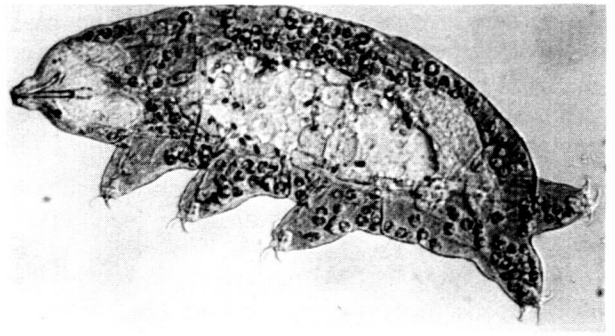
SAFETY

Safety rules were developed both to protect the shuttle and the student experimenters. Forbidden items included: flammable, pyrotechnics, human pathogens, body fluids, disease causing organisms, corrosives, radioactive material, lithium batteries, oils, and soda. Students were not allowed to taste or consume any test material. Radiation safety officers at the Medical University of South Carolina confirmed the safety of the irradiated material. A volunteer pathologist reviewed all submissions for disease hazard. The cryovials performed well with no incidents of breakage or leakage in either space-flown or control material.

Bear Hunters NGS Photo

WATER BEARS

It is impossible to describe all 261 experiments in a short paper but one experiment serves as a model for all. Microscopic tardigrades (*water bears*) live on lichens. These unique little creatures can live for years in suspended animation when dried. They begin to re-animate in as little as 20 minutes if placed in water. Students in a biology class at Wando High School in Mt. Pleasant SC decided that this made *water bears* prime space candidates. At first they ordered specimens through a biological supply house, but discovered that they could collect them locally. Although Charleston has none of the limestone rock that tardagrades prefer, the students discovered that they could be found on old limestone tombstones. By flushing water through collected lichens, *water bears* could be concentrated under a microscope. Once carefully dried, the tardegrades were flight-ready having gone from a 19th century graveyard to an ultramodern spacecraft. Because the water bears were easy to see under a classroom microscope, other classes became interested. Wando High's "Bear Hunters" became mentors to first grade scientists at Goodwin Elementary School and supplied them with *bears* and training.



Water Bear Can Do Photo

Planting Space Trees Can Do Photo

SPACE TREES

Smaller lenses and a reduced requirement for heating batteries brought G324 down in weight. This opened up the possibility of more secondary experiments. The Timberlands Division of the Westvaco Paper Company offered to supply seed for the first ever "space trees". With the forester's advice, students selected Loblolly Pine and Sycamore as representative South Carolina trees. The devastation to local forests from the August 1989 visit of Hurricane Hugo made this project even more appealing.

With the help of students enrolled in a forestry intern program, seeds were gathered from selected prize trees and carefully prepared for space flight. They were supplied in bulk packages for housing in the aluminum experiment box in the payload. In addition, Westvaco made seeds available to any classes who wished to use them for small passive experiments.

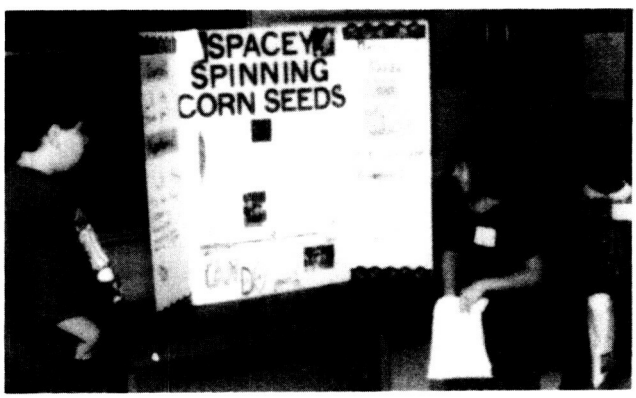
After the flight, the seeds were returned to the care of the foresters who grew them into seedlings suitable for transplantation.

On Arbor Day 1994, a pair of seedlings was supplied to all the schools in the district. Additional trees were supplied to guest schools in neighboring districts and four other states as far away as California. Several schools in the Houston, Texas area received trees to plant for the children of the STS-57 crew. Complete care instructions and classroom materials were enclosed with all of the trees. Most schools scheduled ceremonies to commemorate the planting of the Space trees. Many students wrote poems and songs for the occasion.

Space trees spread your roots
Reach to the far corners of the Earth
Drink water
Spread you limbs, grow your leaves
Grow to touch the stars
Michael Grade 4

CAN DO RESEARCH SYMPOSIUM

In April 1994, a research symposium was held at James Island High School with over 85 of the small passive experiment teams attending. Modeled after the format of scientific meetings, the results were presented as either platform or poster presentations. In addition to giving their experimental results, most students identified which vial had actually flown in space. At this symposium, the color codes were finally revealed. Interestingly, most teams correctly identified the space flown vial even though the sample rarely if ever showed significant change. As expected, the radiation and cold control samples were much more likely to show change due to the extreme nature of the treatments.



Research Symposium Can Do Photo

THE PRESENT AND THE FUTURE

As a method to develop the procedure, simulated experiments were conducted in the years leading up to the flight. The procedure is identical except that the fifth (space flight) vial is omitted. Teachers found this to be a useful tool for teaching the scientific method and a fun classroom activity. As a result they use the simulated experiments as a part of their regular curriculum in Earth Space Science.

Plans are underway to fly the Can Do payload again. In any future mission, these special little experiments will be an important part.

SMALL PASSIVE STUDENT EXPERIMENT MATERIALS

Acrylic Paint
Alka Seltzer
Batteries (2)
Beans, Navy
Beans, Lima
Biodegradable Bags
Black Bread Mold
Bread Mold (3)
Brine Shrimp (7)
Bubble Fluid
Bubble Mixture
Bubbles
CHEMICALS
- Alum
- Baking Soda (3)
- Copper Sulfate Pentahydrate
- Cornstarch and Water
- Cornstarch and Coloring
- Fluorite
- Hexamethylenediamine
- Oil and Water
- Salt
- Vinegar
- Water, natural (2)

Clinitest Tablets
Clinitest Tape
COLLOIDAL MATERIALS
- Mayonnaise
- Jell-O
- Gelatin

Crystals, Cobalt Chloride
Crystals, Copper Sulfate
Detergents
Dosimeters
Enzyme, Thymosin Fraction 5
Etafilicon-A
Fertilizer (4)
Fertilizer 10-10-10
Film, Exposed
Film, Negative (3)
Food Cling Wrap
Glue
Hair, Human (2)
Hot Dog Buns
Ink Cartridges
Insect Eggs, Spider
Iron Fillings
Killifish Eggs
Latex Paint
Lemon Juice
Lichens (3)
Litmus paper
M & M's
Magnets (5)
Magnets and Salt Water
Metal Strips, Copper
MINERALS
- Magnetite
- Feldspar crystals
- Quartz
- Quartz, Cubic Zirconia
- Sphalerite

Mosses
Paint, Poster
Paper Clips
Pluff Mud
Popcorn (17)
Rubber Bands (4)
Sand Designs
SEEDS
- Acorn
- Bermuda Grass
- Bird
- Brassica Rapa
- Camphor Weed
- Centipede Grass
- Chinese Tallow
- Cleome
- Collard Green
- Corn (2)
- Cosmos
- Cotton (2)
- Coxcomb
- Dandelion
- Dogwood (2)
- Dried Beans
- Four O'clock (2)
- Georgia Collard
- Golden Rod
- Grass
- Indian Popcorn
- Lemon
- Lettuce
- Lima Bean
- Loblolly Pine (39)
- Longleaf pine
- Magnolia
- Marigold (3)
- Mimosa (5)
- Mimosa & Brassica Rapa

SEEDS (continued)
- Okra (2)
- Palmetto (2)
- Pea
- Pine (2)
- Popcorn Tree (5)
- Pumpkin
- Radish (3)
- Red Pepper
- Strawberry
- Sunflower (2)
- Sweet Potato
- Sycamore (11)
- Tomato
- Turnip
- Virginia Pine
- Wild Flower

Semi-permeable Membrane
Silly Putty (2)
Slime (3)
Soil Samples (3)
Spanish Moss (2)
Spices, Cinnamon
Spices, Old Bay
Spores, Dry Penicillin
Steeped Coffee
Super Conductors
Tea Leaves
Teeth (2)
Toothpaste (2)
Trash Bags
V-8 Juice
Water Bears (5)
Water, Ocean (4)
Water, Pond (2)
Water, Rain
Wheat
Yeast (7)
YTLA Ceramics - Type II

261 Dreams Can Do Photo

CAN DO EXPERIMENT PACKAGE

Experiment # 732

School Buist Academy
School Address 103 Calhoun Street Charleston S.C., 29403
School Phone

Teacher Kelly Rudd **Class** 5-B
Home Phone
Student Team Michelle Pages, Nathaniel VanLandingham, Jonathan Brannan

EXPERIMENT NAME
Charlotte Webb in Space

EXPERIMENTAL QUESTION
Will Space affect the way spiders make their web?

Material Spider eggs in cases
Source of Material & spiders found around the local homes

How was material prepared ?
We gathered untreated spider eggs and placed them in the test tubes

How will material be tested after treatment?
Spiders will be grown in incubators

RETURN TO:
Carol A. Tempel, Coordinator
Charleston County School District
Office of Math, Sciences & Technology
3 Chisolm Street Charleston, S.C., 29401
(803) 720-3020

CAN DO

A Standard Small Passive Student Experiment Envelope

Can Do Photo