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PLANET X PROBE

A Fresh New Look At An Old Familiar Place

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ABSTRACT

PLANET X PROBE will utilize a G.A.S. payload to provide a large student population with a remote Earth sensing experimental package. To provide a cooperative as well as a competitive environment, the effort will be targeted at all grade levels and at schools in different geographical regions. "Landsat" capability will allow students to investigate the Earth, its physical makeup, its resources, and the impact of man. This project will also serve as an educational device to get students to stand back and take a fresh look at their home planet. The key element will be to treat the familiar Earth as an unknown planet with knowledge based only on what is observable and provable from the images obtained. This will allow for critical and analytical thinking, imagination, and add the excitement of new discovery to that which is well known. It will also provide a format for competitive defense of ideas.

Through participation in the project, students will take an active part in the whole range of experience including:

1. Mission planning, selection of specific goals and priorities, selection of equipment and formation of task groups and teams
2. Research and pilot projects to train the teams, development of a system to handle and analyze the data
3. Identification and recruitment of scientific mentors and dialogue with those mentors before, during, and after the mission
4. Selection of a student advisory team to be available during the mission for necessary decisions caused by changes in conditions
5. Analysis of data and compilation of findings to answer selected questions and to exploit unplanned incidental findings
6. Preparation of final reports, constructed along sound scientific principles with findings supported by specific evidence; logical speculation based on available evidence supported by a close adherence to the principles of critical thinking
7. Presentation and defense of findings before a meeting of competitive student groups and distinguished scientists in the field

EDUCATIONAL GOALS

The educational potential for this project falls into two major areas: the specific science lesson which can be derived from the payload itself and the scientific methodology, teamwork, and the forensic and critical thinking skills that can be taught by the preparation and defense of the findings.

Because the remote sensing of the Earth cuts across many disciplines and scientific skills, any grade level or science course can play a role.

Some examples:

ASTRONOMY - planetary science, a "Voyager"-type analysis of a planetary body based on remote imaging techniques

BIOLOGY/LIFESCIENCE - logical predictive modeling of likely animal forms, pollution effects on plant coverage, infrared studies of plant health

CHEMISTRY - Atmospheric analysis, prediction of likely compounds of minerals and fluids based on temperature and basic spectographic data provided by the astronomers

ECOLOGY/ENVIRONMENTAL SCIENCE - pollution impact studies, climatic and geographical effects on plant coverage, land use studies

EARTH SCIENCE - includes all of the disciplines on this list modified and targeted for the appropriate grade level, emphasis on the broader overview as opposed to the highly specific

GEOLOGY - study of landforms, analysis of the geological history of the planet as evidenced by observed landforms. Special studies, if available, of recent volcanoes and earthquake zones.

CARTOGRAPHY - orbital tract plotting, construction of overlay maps from sequential photographs

METEOROLOGY - weather pattern studies over the duration of the flight, cloud coverage studies, tracking of particular storms or other weather phenomena

TAXONOMY - selection of names for land masses, oceans, specific geological structures, and the planet itself

OCEANOGRAPHY/MARINE STUDIES - studies of major currents, studies of the coastal environment, and silt pollution problems

PHYSICAL GEOGRAPHY - the mapping and study of land areas and types of major structural features such as rivers and mountains

PHYSICS/PHYSICAL SCIENCE - orbital track analysis, electromagnetic spectral wavelength propagation and atmospheric absorption studies

Activities associated with each topic will be modified to meet the educational level of the students.

"On the way to the moon, man discovered the Earth."-- Norman Cousins

In addition to the scientific data derived from remote images, the structure of the project will be designed to teach indirect lessons in methodology and thought patterns. The fact that the students will have to take an unprejudiced, fresh view with limited data of an already well known planet will force them to analyze data critically and to base findings only on that which is demonstrated by the actual evidence. This is one of the most vital and most difficult techniques of scientific inquiry. The necessity of defending all conclusions before an audience of competitive student investigators will quickly detect any failure to document conclusions or to adequately consider alternatives.

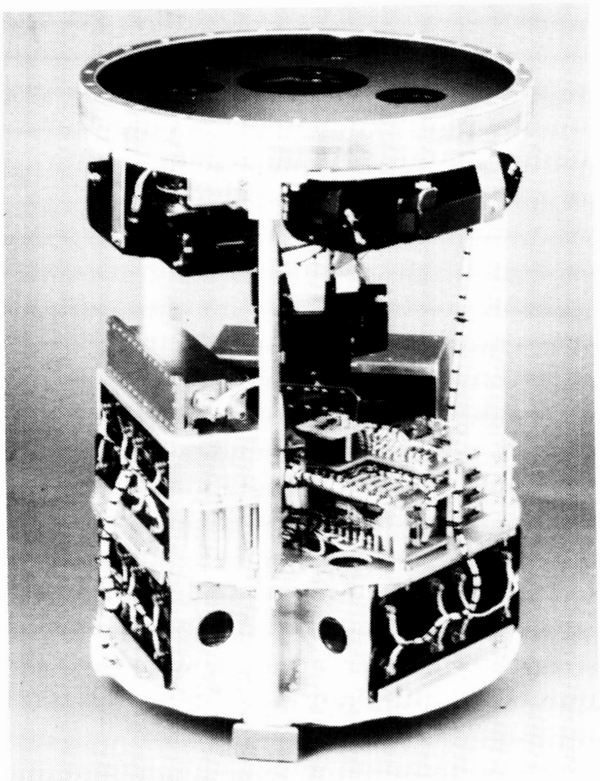
The planning of the mission will teach the necessity of setting priorities and making trade-offs to maximize data. The limited number of cameras, lenses and film types available on a single flight will require the students to carefully select a package where equipment choices for one inquiry will not eliminate data collection in a different area. This type of decision is common in scientific inquiry where, for example, the Voyager team had to decide how much time to devote to a particular moon, while sacrificing available time to study the planetary rings. The preparation of reports for presentation will involve language and communication skills as well as scientific skills. In a competitive environment, the team able to make the best presentation will have the best expectation of having its findings adopted in the final report.

HARDWARE REQUIREMENTS

PLANET X PROBE can utilize the Charleston County Public School District CAN DO payload in its present form without major modification. The major addition would be a passive sensor to detect when the payload is pointed towards the daylight side of the Earth. The payload has the capability to mount four 250 exposure Nikon cameras. Lenses can be selected from any focal length from extreme wide angle up to a 500 mm telephoto lens. This would seem to cover any likely requirements for angular coverage.

Film selection can be made from a wide variety of black & white film and filter combinations to cover any particular wavelength from infrared through visible light and including the near ultraviolet. Color films can also be used for true color, true color minus ultraviolet, or false color infrared. This essentially covers all the capability of Landsat instrumentation except for thermal infrared and microwave which both require elaborate scanners.

Image quality should be excellent and fully comparable to that provided by Landsats and previous space flights. Depending on the orbital track, available Earth viewing time, and weather conditions, significant numbers of high quality images containing a large amount of useful data should be returned. Because the payload has been fully tested for vibration, shock, and thermal conditions and the cameras have proven totally reliable in the harsh environment of the Kuiper Airborne Observatory, there is every reason to expect a successful mission.



The CAN DO Payload

THE PAYLOAD

CAN DO is designed for a 5 cubic foot G.A.S. canister outfitted with a motorized door assembly, a 0.92 inch fused silica window, and sealed for flight with one atmosphere of dry nitrogen. The payload utilizes a 3-strut 6061-T6 aluminum design with the control electronics located on an intermediate plate which forms the top of the battery compartment. Power for all operation comes from redundant Duracell alkaline battery stacks that are electrically and thermally insulated in the lower compartment.

Four Nikon F3 35mm cameras with 250 exposure film backs and motor drives are mounted on the top plate with enough clearance to accept a variety of lenses, from the wide angle 16mm to a 500mm reflex telephoto. The 35mm format has an impressive line of films from which to choose, covering the spectrum from false-color infrared to ultraviolet. In addition, multiple switched optical filters greatly enhance the detection capability of a camera and film. Each camera is controlled by an independent intervalometer which is programmed to take a series of photographs while switching optical filters and returning to a clear calibration shot at the end of the series. A separate day/night sensor can inhibit operation as desired, while a manual control loop from the GCD control can be selected up to the time of integration. In addition, an auto-failsafe override capable of taking a simple exposure series will take control in the event of an intervalometer failure. To advance film reliably at low mission temperatures, and to avoid any stress which could tear the film stock, an exponentially-ramped motor control voltage starts all film movement slowly.

The payload is insulated with a nitrogen gas circulation containment jacket of Rubatex EVA which is covered with a low emissivity surface of aluminized kapton to reduce thermal radiation. The dead air space between the mylar surface and the canister wall forms an additional thermal barrier. All thermally-conductive pathways are isolated with G-10 glass epoxy barriers, and thermal radiation from the payload face exposed through the window is reduced by a series of EVA layers and baffles. A stable thermal environment is maintained by separately switched and interlocked thermostatically-controlled heaters and low-volume fans. As a result, an operational mission temperature of -20°C can be held for up to ten days.

In addition to the primary photographic goal of CAN DO, the payload will house up to one hundred passive student-designed and built research experiments. These experiments are housed in medical cryogenic storage vials which take up very little space and add less than five pounds to the total payload weight. The participating students will file with the Charleston County School District CAN DO team an abbreviated version of the P.A.R., Safety Matrix, Preliminary Safety Data Package, and a Final Safety Data Package, which will not only give them a sense of involvement from the beginning, but will be essential to payload paperwork.

Death Valley, California

MISSION PLAN

1. PRE-FLIGHT

The first step will be to identify regions for the development of research teams. One suggestion might be to form teams in partnership with NASA centers. Each participating school district will be responsible for recruiting students and structuring them into a unified team. Each team will identify local scientific advisors and set up a mentor system to fully involve these advisors at the onset of the project. Adequate means (newsletter, computer bulletin board, etc.) will be set up to facilitate communications between the school districts.

Each team will independently decide on specific areas of inquiry and questions to be addressed. They will select representatives to attend the pre-flight planning meeting. Team representatives will present their agendas at the pre-flight planning meeting and, along with the scientific advisors and the CAN DO Engineers, will select appropriate instrumentation and design the mission plan. Films, lenses, and cameras will be selected at this time, and the CAN DO Engineering Team will be responsible for preparing the payload based on the requirements of the student investigators.

The teams will then prepare themselves by research, interaction with mentors, and pilot studies to interpret the data when available. Airborne studies of the local region can be used to practice interpretation of remote images.

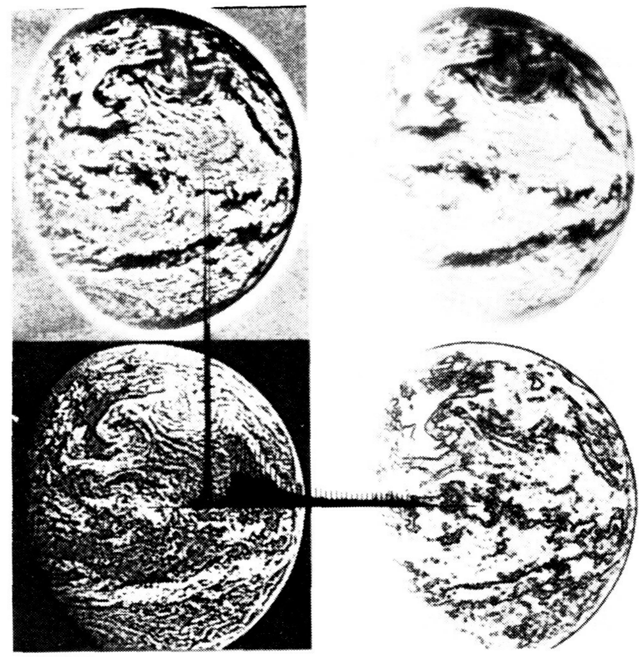
OPERATIONAL

This type of payload precludes much active involvement during the Shuttle flight. However, an advisory group of team leaders would be available to make decisions if required. For example, a change in mission duration might require certain decisions to be made regarding payload activation and firing rate or schedule. Most activities during the flight will be aimed at allowing the students to enjoy the excitement and national attention the flight will create. Students will be encouraged to witness the launch, and arrangements will be made to allow selected representatives to monitor the flight from the control room. Other students can follow flight activities by radio (as relayed by the Goddard Amateur Radio Club and others) and by television (NASA Select). Each team will want to take advantage of the publicity and public relation possibilities of the flight through support materials and press kits generated by the CAN DO team and by NASA Public Affairs.

POST-FLIGHT

After retrieval of the payload and the processing and printing of the resulting images, the material will be distributed to the teams. According to their individual plan, each team will circulate the material, analyze the pictures, and draw their conclusions. The results from each study will be coordinated so that each regional team can draw up a single unified report summarizing their findings. They will then select their representatives to carry these findings to the national symposium.

During the symposium, the findings will be presented in individual research topic meetings where each team will be required to defend their own conclusions. Each topic group will then prepare a joint report which will be delivered to the entire group as a scientific presentation. These presentations will be criticized by the scientists from the various fields. A final report will be written and distributed to all participating schools along with the comments of experts in the field.



Digital image processing will provide more information and more education.

CURRENT STATUS

At the present time, we have a workable payload, a G.A.S. reservation number, and an experienced CAN DO team. PLANET X PROBE as presented in this paper is deliberately left as open as possible. One of the main goals is the establishment of multiple teams in various parts of the country to allow for maximum input and exchange of ideas. As the teams develop, more and more educators will become involved, and it is they who are the best source of ideas on how to achieve the most educational impact. As students are brought into the program, they will be presented with the widest possible range of options in mission design. The result will be a program that will evolve and develop through the interaction of student investigators, expert mentors, professional educators, and the CAN DO support team. The final PLANET X PROBE program will be the result of the ideas and hard work of everyone involved.

The level of funding support will be based on the size and number of school districts involved. Since the payload itself is already designed, built, and tested, the hardware costs will be minimal. The cost for meetings, publication, and educational activities will be shared by the school districts involved. Additional support will be solicited from public and private institutions who are committed to the improvement of science education in our schools.

FUTURE GROWTH

PLANET X PROBE has the great advantage of being designed to study a dynamic and constantly changing object. Any one shuttle flight will only image a small percentage of the Earth's surface, and much of that will be partially or totally obscured by weather and atmospheric conditions. Additional flight images can be treated as a separate project or added to the existing data base. The program can be repeated with new student teams, and their conclusions will be totally different.

This type of Earth observation could be a highly attractive candidate for the future Space Station. It will require relatively little power and space, but will continue to operate over a long time span. Images will be returned as film, electronically, or a combination of both.

PILOT WORKSHOPS

Preliminary student input on PLANET X PROBE has been obtained through a limited number of workshops at meetings such as the South Carolina Junior Academy of Science. This has proven to be an effective method of testing ideas, assessing areas of special interest, and tapping the invaluable resource of youthful imagination. Already, certain fields have emerged as ones with a high interest level. Many students want to study coastal environmental problems such as erosion, pollution, and the impact of development. This interest is as strong among students living inland as among those living near the ocean. Other forms of pollution also score strongly as areas of interest.

Another important conclusion from the pilot workshops was that the students were fully capable of selecting a suitable compliment of lenses and films with only a brief training period. After one hour of instruction in which the students were shown examples of the coverage of the different focal length lenses and the spectral response of the different films, they designed packages in order to study questions in which they were interested. Each package included four lens/film combinations. Through interaction and compromise, one package was developed that would meet the research needs of all. Within two hours, the student teams were able to arrive at a research design that was well balanced and appropriate to meet the stated goals.

Western Europe at night.

ACTIVE RESEARCH

Although PLANET X PROBE was originally invisioned as a passive observational experiment, workshop students have suggested an exciting active research addition. Fascinated by photos showing the patterns of city lights taken on Earth's night side, the students began to imagine ways in which they could actively change measurable parameters. Basically, the main question was whether students, as a group, could create a significant enough change in their local area to be observed from Earth orbit. For example, if every student in an urban area turned off as many lights as he could, would the city look different? Obviously, each individual light would make only an infinitesimal contribution as to what would be seen from space, but there would be many students. If each student would get several neighbors to cooperate, the effect could be quite dramatic. All students in, say, Washington could turn on lights, while students in Baltimore turned them off...or checkerboard a whole state, county by county...or turn them off at an exact time....

Such an experiment would require a degree of active control and coordination not usually available to a G.A.S. payload. The lesson to be learned would be that students could have an impact, if they worked together. Collectively, they could alter the Earth in such a dramatic way that it could be made visible from space. If the students could create that much change by cooperatively doing something as simple as turning off a light, then it would also be in their power to exert more lasting influence on their environment.

STUDENTS AND SPACE

There is a crisis in American education today. Current figures show that the educational system is failing to interest enough students in science as a career. There will not be replacements for the scientists who will soon retire, let alone provide for the growth that will be needed in a highly competitive and technological future. Unfortunately, circumstances have been unkind to that best of all motivators--the space program. Innovative programs such as the LDEF Seed experiment and the Teacher in Space have been negated by fate at the very time when classroom involvement is so badly needed. Other worthwhile programs such as Young Astronauts and Space Camp do a tremendous job of reinforcing those students already interested in science, but by their natures, are not available to all students. To reach more students, it is necessary to design programs that can be fully integrated into the normal classroom curricula. PLANET X PROBE has the potential to provide teachers with a powerful tool to support the scientific lessons that are being taught every day, and to make them more effective and exciting. To this goal, the CAN DO team dedicates its efforts.