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**Precollege Science Education:**  
*Development of Distant Learning Laboratory  
and Creation of Educational Materials*

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**Office of Education**

## Abstract

The Office of Education's fundamental goal is to disseminate information, mostly that which relates to science and technology. In this attempt, as I have observed, the Office has many programs bringing both students and teachers to NASA Langley to expose them to the facilities and to teach them some about the scientific theory and about available modern technology. As a way of expanding the audience that can be reached, as the expense of bringing people in is limiting, Marchelle Canright has proposed establishing a center dedicated to researching and producing distant learning videos.

Although distant learning through telecommunications is not a new concept, as many universities, colleges, and precollege level schools offer televised courses, the research in this field has been limited. Many of the standing distant learning broadcasts are simply recordings of teachers in classrooms giving lectures to their own students; they are not aimed at the television audience. In some cases the videos are produced without a Live-lecture atmosphere, but are still only classroom lectures. In either case, however, the full range of capabilities of video production are not being fully utilized. Methods for best relaying educational material have not been explored. Possibilities for including computerized images and video clips for the purpose of showing diagrams and processes, as well as examples in fitting cases, may add considerably to the educational value of these videos. Also, through Internet and satellite links, it is possible for remote students to interact with the teachers during televised sessions. These possibilities might, also, add to the effectiveness of distant learning programs. Ms. Canright's proposed center will be dedicated to researching these possibilities and eventually spreading the results to distant learning program managers.

This is the project I was involved in over the summer. As implied, the center is still at the foundation stages. Ms. Canright has proposed four or five possible series that could be developed, each one aimed at a specific age group of students, or group of teachers. I was involved in the design of the series aimed at the youngest children, the Picture Book Science series. My involvement included proposing and researching topics, writing a lesson for the first show, writing the latter portion of the picture book story (the part including the scientific lesson), and illustrating the story. I also designed and collected the materials for the Learning Center's television studio set as well as finished the painting of the main backdrop panels.

# LARSS Report

Allowing the abstract to be an integral portion of this report, I will not redescribe Ms. Carright's proposed distant learning center, but will instead, lead directly into my involvement with the center as a LARSS intern. My range of involvement covered several areas. To explain these, I will first list them, and then expand each one:

**Design, collection of materials for, and construction of TV studio set.**

**Picture Book Science development:**

- Propose topics that will align with NASA's research emphases along with the National Science Educational Standards curriculum guidelines.
- Create the first lesson- including the fundamental scientific concepts to be covered, a general lesson on the subject, as well as a list of activities demonstrating the principles.
- Integrate the scientific concepts into the children's story by writing the latter portion of the story.
- Visually create the nine characters in the story which Kenneth wrote.
- Illustrate 33 pictures for the children's story.

## **Studio Set Design and Construction:**

The studio set design and construction involved several steps. The first step was establishing what the possible purposes of the set would be; the intended use would dictate the desired features as well as the constraints. The video equipment is currently being assembled in a studio located in the Office of Education's building. The capabilities will include being able to video a large television screen which can be fed by both video clips and computer images. Both prerecorded and live broadcasts will be developed. As part of my set design proposal I included this report:

*Learning Laboratory Set Design Proposal July 5, 1995*

*The following video studio set design was created with the goal of meeting the Office of Education's diverse needs. By presenting a strong visual background that can easily be altered in both imagery and mood, the set will be useful for situations ranging from formal lectures on educational theory, to active demonstrations of scientific principles, to recorded conversations between two experts on a certain topic.*

*- Bold design adds a sense of sculpted space.*

A backdrop should serve the purpose of defining a space for the lecturer, or group of people being recorded. It is important that the set reflect the content and purpose of the program, but that it not distract the audience from the information being presented. For this reason, I have designed a bold, interesting set of lines and spaces, but kept the overall picture uncluttered, free from permanent images and visual business.

The presented set's colors and spaces are designed to support a variety of topics and presentation styles

including:

- *outer space*, for lectures on space topics
- *the atmosphere*, for lectures on aeronautics or atmospheric sciences
- *abstract architectural setting*, for less formal discussion groups on various topics such as approaches to dissemination of scientific and technological information.

**- Free standing panels.**

The backdrop will be made of free standing panels. This allows for:

- mixing and matching of the panels to create desirable visual effects.
- portability of the set; it can be set up on stages in schools or other facilities such as the H.J. Reid Center.
- sizing of the overall set; two or three of the panels can be used to create a backdrop for presentations including live seminars or prerecorded narrated introductions to informational videos.

**- For use with or without TV screen.**

The TV screen can be used to show a stationary computer generated logo or image, used instead of a flip-chart or over-head projector, and can be used to show video clips during a presentation. The TV can show images loaded from the computer or the video equipment. However, when the TV is not desirable in a presentation, or the set is taken somewhere out of the studio, the panels are simply moved closer together.

**- Modular Furniture for versatility.**

Using light weight, interchangeable pieces, furniture such as display tables and benches, a podium, and a conference table will be easily built to suit the specific needs of each show produced in this studio.

**- Multi-purpose studio set.**

The topic of the video will be specified or emphasized by the imagery added to the set by hanging "cut-out" logos or images, projecting images on the TV screen, and displaying models or demonstration materials.

The intended purpose or mood of the video can be specified or emphasized by the geometry of the panels, as demonstrated below, the TV images, the cut-out images, the choice and positioning of furniture, as well as other set accessories such as plants or flags.

As described in the report, free-standing, interchangeable panels are what I proposed. As part of this proposal a complete set materials list and an estimated cost were included.

Upon acceptance, I consulted with a man from Engineering and Construction Services, Ralph Angel, who offered advice on the design of the panels as well as help in the construction of them. His help is greatly appreciated. After the panels were built, I proceeded to paint them. The furniture is still under construction but the materials are collected and the plans are drawn.

## **Picture Book Science Development:**

Ms. Canright's Picture Book Science series was at the beginning of the design stage when I entered the project. All that was written is that the series would consist of eight half hour shows, each featuring a children's story, a science lesson, and an introduction of an activity which the children could pursue after the video at school or at home. This left a lot of room for creativity.

I spent the time during the first weeks of my LARSS internship brainstorming topic ideas and preparing the fundamental content that would be included in those. The following is a list of the topics I proposed:

## TOPICS FOR PICTURE BOOK SCIENCE SERIES:

### AERONAUTICS:

#### PROPULSION OF AIRPLANES:

- propellers: pushing on the air, (friction required)
- jets: expansion of compressed gases, (conservation of momentum)

#### LIFT & DRAG:

- forces involved in flying; discuss both flat plates and airfoils
- discuss similarities and differences
  - both deflect air downwards and conservation of momentum requires, then, that they go upwards.
  - they send air downwards by different methods.
    - flat plates: push air downwards from the bottom
    - airfoils: suction redirects air downwards by keeping it attached to the curved wing surface
- other possible features to include in lesson:
  - shape of wings, friction on wing, attached flow of air across wing, speed of air flow, pressure differential
  - conservation of energy, (how kinetic energy and rotational energy are both involved in lift)

#### CONTROL SURFACES and CENTER OF MASS:

- note historical challenge this posed to the development of flight
- discuss flaps, rudders, and other control surfaces
- discuss how the center of mass can change the pitch

#### HISTORY OF HUMAN FLIGHT:

- human fascination in flight throughout the world and history
  - myths, art work, folk lore
  - why humans can't strap on wings and fly (distribution of musculature of birds vs. humans)
- first attempts at flight (balloons)
- first attempts at heavier than air flight
- first successes: Lilienthal, the Wright Brothers, Langley
- how fast flight has taken off (grown in popularity and availability) compared to the time it took to get off the ground!

### SPACE:

#### ROCKET PROPULSION (Expansion of mass vs. the use of friction):

- describe the physics of propellers, that they push on the air much as a tug boat pushes on water, or you push on the pavement when you run.
  - friction required for this type of thrust
- explain that in space there is no air to push on; there's nothing!
  - if rockets can't push on anything, how do they go forward?
    - have to burn fuel
    - the expansion of compressed gases sends them forward
    - actually relates to expansion of mass
    - this is conservation of momentum

#### GRAVITY and ORBIT:

- gravity as a force
  - relative factors
    - distance between objects
    - mass of each object
- orbit: (a balancing of the involved forces)
  - inertial tangential force vs. gravitational force

### ATMOSPHERIC SCIENCE:

#### CLOUDS:

- what they're made of:
  - particles on which they form
  - water vapor
- effects on climate:
  - HUGE cooling effect:
    - reflecting sunlight back into space
  - (reflecting high energy radiation back to space)
  - HUGE heating effect:

- trapping heat given off by the earth
  - (reflecting low energy radiation back to the earth)
  - the NET effect is a SLIGHT cooling one
  - effects of pollution on clouds:
    - spewing more dust particles into space allows more cloud droplets to form; (cooling effect)
    - particles also trap heat which causes evaporation of clouds; (heating effect)
- HOW DO WE KNOW WHAT WE BREATHE? (Spectrometry)**
- explain how tall the atmosphere is and that it is hard to collect samples going all the way up to space
  - introduce a method used to collect information about our own atmosphere, spectrometry:
    - a device (spectrometer), from the ground, looks up into the sky and records the exact "color" (wavelengths) that it sees coming from the sun
    - an orbiting satellite with this same device also looks up into space and records the exact "color" that it sees coming from the sun
    - the two "colors" are compared
    - the difference is due to the gases in the earth's atmosphere
    - in labs, the color of gases can be recorded
    - then you can tell which exact gases and how much are in the air.

I focused my efforts on studying the fundamentals of lift, which would be the topic of the first book. I studied from Naval Aviator's Aeronautic Textbook as well as other books from Langley's technical library. I also discussed the principles at length with a NASA scientist, Geoffrey Considine.

Pulling out the fundamental ideas of something as complicated and subtle as lift proved to be the most difficult part of the process. I am now convinced that the reason lift is not taught until college level, and even then only a mathematically modeled version, is because the actual physics is so subtle. Explaining the *physics* in a manner that would reach even K-3 graders became my goal. Brainstorming for demonstrations accessible to all teachers and children was also a central part of this process.

Another part of the process of science lesson design, was to study the National Science Educational Standards. This book gave me a sense of what the children were capable of as well as what their teachers would be focusing on in their lessons. The goal for the videos should be to present different material but at an appropriate academic level.

In searching for the pre-published children's books that would lead into the science lessons by sparking the children's interests in flying, space, or clouds, we realized that none completely suited our needs. This led the other LARSS student, Kenneth Smith, and I to writing and illustrating our own. Kenneth wrote a story about eight children which brought up questions on the similarities and differences between kites and planes. I decided to write an ending to the story that would answer the questions on the mechanisms of both kite (flat plate) and plane (airfoil) lift.

I also illustrated story. The illustrations took me a large part of the summer as the eight children and their teacher were of widely varying ethnic backgrounds, which required some time learning to draw in an obviously differentiating manner. Upon visually creating the eight children and the teacher, I did 33 illustrations for the story. The drawings are black ink on white paper, a technique chosen for a several reasons. For one, the technique is relatively fast compared to such techniques as paints or pastels; children's books of this length would tend to take a year to illustrate if these more drawn out techniques were used. Also, the images can be easily scanned into the computer, which will be ideal for making a video out of them. The studio, with the silicon graphics computer, will have the capability of digitally editing the illustrations into the video. The

coloring of the illustrations also proves to be ideally done on the computer. To get extremely vivid colors, transparent ink is the best option. The visually smoothest way to apply ink is through a printer. By coloring the scanned black and white drawings with the computer, and then printing them, truly bold illustrations will be created if hard copies are desired. As I will mention further on in this report, publishing a book out of the story and including the science lesson as an insert or integral part of the book would allow teachers to create this lesson live in their classrooms, or more deeply instill the lesson by reviewing the material with the children multiple times. Examples of the black and white illustrations are included as an appendix.

The science lesson following the story will elaborate upon the ideas which were briefly explained in the story. Demonstrations of the principles will allow the children to relate the principles involved in such phenomena as lift to occurrences that are visible in their everyday lives; the demonstrations will help the children to assimilate the ideas. Also, activities which the children can pursue afterwards in school or at home will be presented and explained.

I have prepared a general lesson on the similarities and differences of lift between kites (flat plates) and planes (airfoils). The lesson still needs to be modified (simplified) for the use of it at the K-3 grade level. I have, however, already gathered ideas for the demonstrations of the principles of lift for airfoils and flat plates.

Now that the prototype for the Picture Book Science series is nearing the polishing stages of the content, I can see two other possible uses of the created material, uses that would align with the Office of Education's goals. For one, as mentioned, the story and illustrations could be published in book format with the corresponding expanded science lesson, demonstration ideas, and activity ideas included either as an insert or as an integral part of the book. Another use of the prepared material would be to share it with the teachers who visit Langley's Office of Education every summer as a way of preparing them to teach the material to their students.











