

**FINAL PROJECT REPORT**

**Proposal to Develop Guides for High School  
Teachers on Global Systems Science**

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*for*

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# Proposal to Develop Guides for High School Teachers on Global Systems Science

## FINAL PROJECT REPORT

By Cary Sneider and Richard Golden

### Project Goal

“The Lawrence Hall of Science requests funding for development of trial versions of five guides for high school teachers on the topic of *Global Systems Science*. The guides will reflect the guided-discovery approach for which the Lawrence Hall of Science has gained an international reputation. They will include a wealth of materials already developed as well as new materials, organized as a comprehensive program on global change. The guides could be used together for an entire one-semester course, or integrated individually into existing high school courses in the sciences and social studies.”

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### Achievement of Project Goal

As described in the original proposal, the sum of \$170,000 was awarded for the development of five teacher's guides to support a one semester course in Global Systems Science. We are very pleased to report that the original award was stretched to include development of an entire year's course, including not only five teacher's guides, but in addition, five student textbooks, each of which includes several laboratory activities. Thus, the scope of work has expanded to the development of ten documents—five for use by students and five for use by teachers.

Drafts of six of the ten documents in the *Global Science Systems* course have been completed; and two of these have been revised, illustrated, edited, and printed for broad dissemination as National Trial Editions. These two documents—the text and the teacher's guide for *Volume I A Planet Under Siege*—will soon be field tested by twenty-five high school teachers, and at least 750 students around the country. These two documents are enclosed as appendices to this report.

Also as stated in the original proposal, we have obtained additional funding from the National Science Foundation to conduct a three-year program that will enable high school teachers who test these materials with their students to attend a three-week summer institute in Berkeley, where they will provide feedback and additional activities to improve the *Global Systems Science* course. The grant provides for one institute for 25 teachers this summer, two institutes during the summer of 1994, and two more institutes in 1995, for a total of 125 teacher-leaders. These individuals will become the national corps of leaders who will help to disseminate the *Global Systems Science* course throughout the United States in the years to follow.

### **Reasons for expanding the scope of work**

The need for student text and laboratory materials became apparent as we discussed the project with high school science teachers and school district science coordinators. Unlike hands-on science classes for the elementary and middle school levels, which can be entirely organized by teachers using teacher's guides, high school courses demand carefully written textbooks.

Although some text materials on earth systems were available, our evaluation of these materials showed that they did not sufficiently ground students in the scientific methods, results, and controversies surrounding research on global climate change, nor did they deal adequately with the economic, political, and ethical issues involved in global environmental decisions. Consequently, we undertook the development of five volumes designed for use by students, in addition to the five teachers' guides.

During staff meetings early in the project, we discussed the concepts that were fundamental to student understanding of the global climate system, and problems such as ozone depletion and global warming. It soon became clear that "a comprehensive program on global change" could not be completed in a single semester. We therefore decided to expand *Global Systems Science* into a full year course. The course outline included student text materials and laboratory activities. The course would be suitable for high school science or social studies classes, or might be taught by a team of teachers.

The first draft of student materials for *Volume 1, A Planet Under Siege*, was distributed to forty science teachers scattered across the country. We received detailed comments from 22 of the teachers. Overall, response was very positive. Many of the teachers told us that they had been trying to develop such an integrated science and social studies program in response to national calls for reform, such as Project 2061 from the American Association for the Advancement of Science, or the Scope and Sequence Project from the National Science Teachers' Association. The teachers made many useful suggestions which were evaluated and incorporated into the text.

Also, during the first year of development it became clear that in order to test these materials with student, a black-and-white draft would not do. In order to hold student interest, a strong text design, color, and humorous illustrations were needed. Consequently, we contracted with a designer, illustrator, and editor to help us create a finished product that would be attractive to high school students.

We were also advised by teacher educators that a teacher's guide must provide a clear and compelling vision of the guided discovery method, with respect to each chapter of the student materials. Consequently, we completed a 90-page teacher's guide for *Volume 1* that provide suggestions for preparation, teaching, and follow-up of each lesson.

Copies of *Volume 1 A Planet Under Siege*, and the *Teacher's Guide for Volume 1* are enclosed with this report. Although drafts have been written for the other four sets of student materials, they have not yet been submitted to teachers for comment, nor illustrated and edited. We felt that allocation of our resources towards the completion of *Volume 1* was essential so that testing with students could begin as soon as possible. What we learn in testing *Volume 1* with students could then be applied to the completion of the other four volumes.

## **Current Status of Volumes 2-5**

Following is a brief description of Global Systems Science Volumes 2-5, and a statement of their current status. All of the drafts referred to are by staff. Drafts of Volumes 2-5 have not yet been released to teachers.

**Volume 2 A History of Fire and Ice: The Earth's Climate System** (Focus: Earth Science). This volume describes the coevolution of the Earth's atmosphere and living organisms over the past 4.5 billion years, thus providing a broad context within which students may view the problem of global climate change presented in Volume 1. Students are asked to consider how the global community might act to maintain the habitability of Earth's environment for future generations. Richard Golden has completed a first draft of Volume 2. Cary Sneider is currently 50% finished with a second draft.

**Volume 3 Energy Paths: Use and Conservation of Energy** (Focus: Physics). The students learn about the various forms of energy and trace the movement of energy through Earth systems and within human civilizations. They learn about the laws of energy and how they relate to "waste" production and about the needs and benefits of energy conservation. Alan Gould and John Erickson have completed a first draft of Volume 3. Cary Sneider and Richard Golden provided feedback. Gould and Erickson incorporated the feedback in a second draft.

**Volume 4 Ecological Systems: Evolution and Interdependence of Life** (Focus: Biology). The biosphere is treated as an entire system. The students read case studies of vulnerable ecosystems undergoing change, and perform experiments on laboratory ecosystems. They learn how human population growth affects the biosphere and what to do about it. Katharine Barrett and Ted Robertson have completed approximately 50% of the first draft for this volume.

**Volume 5 The Case of the Missing Ozone: Chemistry of the Earth's Atmosphere** (Focus: Chemistry). Atmospheric ozone is the subject matter of the final volume, including its composition and chemistry, and how it protects people from deadly melanoma and blinding cataracts. The students learn about the problem of ozone depletion high in the Earth's atmosphere, caused by catalytic reactions involving chlorofluorocarbons; as well as the problem of low-level ozone pollution and acid rain. They also learn what they as citizens, can do about these problems. A first draft was completed by Sylvia Velasquez. A second draft was completed by Joseph Snider with the assistance of JohnMichael Seltzer. A third draft is currently being completed by Richard Golden and Bernard Finkle.

**Teacher's Guides** Teacher's guides are being prepared for each of the five volumes. The guide for Volume 1 is completed and enclosed with this report. Guides for volumes 2 through 5 have not yet been drafted. Each of the guides will offer suggestions for homework assignments, laboratory activities, and class discussions, recognizing that teachers will make adjustments for their particular groups of students. For example, suggested homework assignments are short, from two to six pages a day, so that less-able readers will not become discouraged. Some teachers may wish to make longer or shorter assignments, or to emphasize different aspects of the material. Also included are data sheets for duplication, and answers to questions and problems. The guide is in loose-leaf form so that it is easy for teachers to remove masters for copying.

### **Inclusion of Field Trips and Interviews**

As described in our proposal, we have traveled to discuss the course with project scientists involved in climate change research, and have included appropriate information in the student materials. Volume 1 (pages 22-43), for example, includes a “field trip” to Mauna Loa on the island of Hawaii, where students find out how atmospheric carbon dioxide is measured. There they “meet” project scientists who serve both as role models for careers in science, and to learn the observational techniques behind James Hanson’s claim that the concentration of carbon dioxide in the atmosphere is increasing. The photographs and interview material was gathered during a trip to Mauna Loa Observatory by Project Director Cary Sneider, during the first year of the grant. Other photos and interview data for use in Volumes 2-8 were collected via telephone.

### **Plans for further development and dissemination**

Under an NSF grant, in March, 1993, we will distribute class sets of *A Planet Under Siege* with a copy of the *Teacher’s Guide* to twenty five selected teachers. Three or four of the teachers will be in the San Francisco Bay Area and the rest will be from different parts of the country. These teachers will use the text and laboratory activities with their students and provide evaluations of each chapter. During the summer they will come together for a three week institute at Berkeley to share teaching experiences, discuss and develop the Global Systems Science project, and receive training to become leaders in Global Systems Science in their home districts.

*Volume 1* materials for both the teacher and students will be revised in light of the trial teachers’ input and these books will be reprinted and distributed nationally. The teacher-leaders trained at the summer institute will introduce the publications to their colleagues. Science teachers will be made aware of the *Global Systems Science* course at science teacher conventions and through professional publications.

We are actively seeking funds to complete development of the *Global Systems Science* course. If we are successful in obtaining funds within the next six to ten months, we expect to complete the entire course by the end of 1995.

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