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# EDUCATION OUTREACH

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## Abstract

Recognizing the benefits of education, the Hydrogen Program conceived of an Outreach effort that would position hydrogen and hydrogen related technologies for current science study, formal and informal. Such study is intended to produce contemporary understanding and future adoption and use of hydrogen and related technologies.

The effort has produced high school and middle school versions of a curriculum (working title *Clean Corridor Curriculum*) and collateral video products. The curricula and collaterals are being branded as HOPE (Hydrogen Outreach Programming for Education) products.

M.R.S. intends to complement the core HOPE products with items such as Sentech's Mission $H_2$ CD ROM and Eco Soul's reversible fuel cell kit.

The effort has also produced live science shows that present Hydrogen Program content and programming to local secondary school audiences.

Development of the core curriculum and collateral products nears completion. Planning of marketing strategy for promotion and distribution has begun. Both Internet and traditional channels are contemplated for marketing.

There is every expectation that the products will be available in the marketplace over the coming year.

## Long-Term Goals

The overarching long-term goal of this hydrogen outreach effort is to educate students and teachers about the properties and benefits of hydrogen, its technology applications and cross-cutting uses, as well as its potential as a fuel and energy carrier.

Consistent with the intent of the *Matsunaga Act* and the *Hydrogen Futures Act*, the specific goals of Hydrogen Instructional Programming (HIP) are*:*

- to increase awareness and preference for hydrogen energy uses and technologies
- to increase awareness and preference of renewable energy and energy efficiency technologies and practices

through development and dissemination of instructional materials (curricula, films, CD ROMs) and production of live science shows.

The instructional materials serve to accelerate adoption of hydrogen energy uses and technologies, building on increased awareness and preference for hydrogen energy uses and technologies, as well as renewable energy and energy efficiency technologies and practices. The dissemination strategy is intended to effectively distribute HIP products, resulting in deep penetration of our target markets, secondary school teachers and students. The production of live science shows is intended to complement development and dissemination of instructional materials and thereby reinforce the outreach effort.

## Current Year's Objectives and Rationale

The demand for hydrogen education outreach is growing. This demand is spurred by Congress, industry and progress in hydrogen technology research and development. These activities press toward commercialization of hydrogen and hydrogen related products, notably fuel cell technology. The NHA has identified outreach as one of its top priorities and one of industry's greatest needs. Moreover, popular culture has discovered hydrogen. An increasing number of publications from T*he Washington Post* to *Red Herring* are featuring hydrogen articles. The recent mini energy crisis offers another window of opportunity to introduce students and the greater public to hydrogen. Thus, this education outreach effort and its HIP products are very timely.

Important themes of this year's work are:

- progress toward completion and assembly of curriculum and collateral film and video products;
- enhancement of other outreach activities, notably live science shows;
- a coordinated approach to promotion of these products and activities that includes preliminary formulation of a distribution strategy using mixed print and web-based solutions.

A final cross-cutting theme, greatly encouraged by the Hydrogen Program, involves cooperation and collaboration with other organizations.

Although no funding was available to allow M.R.S. to formally coordinate programmatic outreach efforts as stated in the Annual Operating Plan, great effort was made to cooperate informally with key players. They include: the NHA, Sentech, Inc., Drs. Jay Keller and George Thomas from Sandia Livermore National Laboratory, the Florida Solar Energy Center, Eco-Soul, the California Fuel Cell Partnership and the National Fuel Cell Research Center at the University of California Irvine.

Specific objectives of HIP, this year's work are:

- to reach teachers and education decision-makers through the field-testing and evaluation processes
- to reach students directly through modular curricula that educate students about hydrogen and hydrogen technologies while reflecting current science and technology pedagogy and practice, including national science standards
- to reach students directly through audio-visual support materials, video and video-clips, that educate students about hydrogen and hydrogen technologies while also providing informal education opportunities
- to position the DOE Hydrogen Program to successfully market and distribute the breakthrough curricula by ensuring the best possible curricula products

## Current Year Tasks

Five discrete HIP tasks were funded by the Hydrogen Program. Two additional tasks, supported in part by the Hydrogen Program, proved sufficiently important to the long-term goals and current year objectives that other funding or M.R.S. cost-share resources were applied to their execution. These tasks are discussed below as Tasks 6 and other. A final task, listed in the Annual Operating Plan as (funding permitting) Task 5: Hydrogen Education Outreach Coordination, was not addressed because no resources were available from any source to create a comprehensive written plan for coordination of education outreach.

A brief description of each task appears below:

**Task 1** Support for curriculum dissemination via field-testing and evaluation of the beta-version high school curriculum

**Task 2** A workshop devoted to revision of the beta version of the high school curriculum per field testing and evaluation results followed by field-testing and evaluation of the 1.0 version high school curriculum preparatory to its formal launch in education markets.

**Task 3** Modification of the high school curriculum to create a separate product that is appropriate for middle school populations, coupled with design of a framework for its field-test and evaluation.

**Task 4** Creation of short videos (working title *Red Thunder* now called *The Pollution Solution*; working title the *Dr. Bob Show* and working title *Beakman's World: Beakman on Hydrogen*) as collateral products that complement the curricula, comprising part of the deluxe CCC teachers' kit. These products also contribute to the EERE and Hydrogen Program portfolio of information tools available for informal education and public outreach.

**Task 5** Creation of a challenge project that will allow secondary schools to design and develop their own hydrogen technology demonstration.

**Task 6** **(Not DOE funded)** Production of live science shows, including the *DOE/NHA Secondary School Invitational* at the NHA annual Conference and the local middle school on-site production

**Other Outreach and Promotion**

**(Not DOE funded)** Conferences and Speaking engagements; general promotion; initial development of marketing strategy

## Current Year Progress

### *Task 1* Support for curriculum dissemination via field-testing and evaluation of the beta version curriculum.

Initial field-testing of the beta version high school curriculum occurred during the spring of 1999 under previously funded work. Participating teachers were recruited from M.R.S. presentations and other curriculum promotion efforts. No monies were available to compensate teachers. Teachers "self-selected" to participate in the field test on the basis of interest in the subject and ability to integrate the curriculum into existing courses.

With HIP funding, a field test survey instrument was developed and administered to participating field test teachers. A Field Test Survey Report was developed from the survey. The Field Test Survey provided significant feedback about important curriculum issues. This feedback has guided the formal field test process for academic year 2000. Survey results were analyzed and findings were summarized as Lessons Learned. Key Lessons Learned include: the importance of requiring use of lessons from all modules; the need to provide a financial incentive for participation; the importance of field-test timing; and the need to provide teachers with a paper copy of the curriculum, even in cases where an electronic copy is also desired.

No monies were available to pursue active development of a reversible fuel cell. However, M.R.S. began to use the (loaned) Eco-Soul reversible fuel cell kit as well as the Eco-Soul Hydrogen Fueling Station (designed to complement the curriculum's final project by the same name) for demonstration purposes. Both M.R.S. and Eco-Soul undertook this joint activity on a cost-share basis without HIP funding. The M.R.S. interest in this collaboration is enhancement of the hydrogen education outreach effort through availability of a kit that shows the reversibility of fuel cell and electrolysis processes in a safe, portable device.

### *Task 2 After the initial field-testing, a workshop devoted to revision of the beta version curriculum, followed by field testing and evaluation produced high school version 1.0 preparatory to its formal launch in education markets.*

A workshop was held in late summer to revise the *Clean Corridor Curriculum* in accordance with the results of field test and evaluation. The original *Clean Corridor Curriculum* team worked on the revision to modify existing lessons and added some new lessons. Dr. Robert Reeves and Dr. Jay Keller reviewed the revised material.

To assure classroom safety, an independent safety review was also conducted. M.R.S. developed a three-category template to assess the safety of individual labs and demonstrations in the classroom. The three categories classify labs as follows:

Category I) Low-no student safety risk;
Category II) Student safety risk associated with this lab (student participation may be considered);
Category III) Student safety risk (s) associated with this lab (student participation inappropriate).

The primary safety reviewer was Mr. Paul Mercier, a secondary school science teacher/former college science instructor from Arizona. (See the attached report). Dr. Robert Zalosh of Worcester Polytechnic Institute in Massachusetts provided a secondary safety review. The safety review was not anticipated or funded by DOE. The NHA graciously furnished a stipend for the principal reviewer for this activity. The secondary reviewer graciously declined a stipend.

An improved field test survey instrument was devised for the high school version 1.0. A new group of field test teachers was recruited from M.R.S. growing network of teachers. Now in a formal, nationwide field-test, the curriculum contains five major modules and a final project, plus a sixth module that features exercises related to the exciting Sentech CD ROM, *Mission* $H_2$.

### *Task 3 Modification of the existing curriculum to create a separate product that is appropriate for middle school populations, coupled with design of a framework for its field-test and evaluation.*

During the curriculum writing workshop substantial progress occurred on development of the middle school curriculum. The high school curriculum was modified and expanded to create a separate product that is appropriate for middle school populations. The middle school curriculum was structured in three modules: 1) Basics; 2) an event based module entitled "The Pollution Solution"; and 3) a unit constructed around *Renewable Power: Earth's Clean Energy Destiny*. Additional work is needed before the draft will be ready for technical review.

A framework for an academic year 2000-2001 field test of the middle school beta version is substantially complete. It will be finalized on completion of the formal field-test for the high school curriculum. Recruiting for middle school field test participation has been brisk.

### *Task 4 Creation of short videos that complement the curriculum, compromising part of the deluxe teachers' kit and contributing to the EERE and Hydrogen Program portfolio of informal education and public outreach information tools.*

Post-production work on the *Dr. Bob Show* editing continues in the DOE editing suite consistent with the Edit Decision List and storyboard. Narration was recorded; work on laying the sound track has begun. Although progress is good, S-1 projects have delayed completion of the video.

Production work on The *Pollution Solution* (working title *Red Thunder*), including fuel cell animation, was completed. The video has gone to the editing suite for post-production creation of the "off-line."

It was determined that *Beakman: Beakman on Hydrogen* will be able to proceed in accordance with Columbia Tri-Star's requests. The next phase will entail execution of necessary legal documents with Columbia Tri-Star, followed by contracts with the cast, crew and supporting science writers and advisors.

### *Task 5 Creation of a challenge project that will allow secondary schools to design and develop their own hydrogen technology demonstration*

Challenge Project Grant applications will be distributed on completion of the formal field test. Field test participants will have priority for these awards. The awards are intended to allow secondary schools to design and develop their own hydrogen technology demonstrations. All grant recipients will be required to share their projects with the Hydrogen Education Outreach effort. This information will be available on the web site to be constructed as soon as funding is available. Amount of the awards is expected to range from $50-$250. Awards will be made in September 2000.

### *Task 6 Other Progress (Not DOE funded)*

- *Production of live science shows, including the March 1 DOE/NHA Secondary School Invitational at the NHA annual Conference and the upcoming local middle school science show*

The *Secondary School Invitational* (*SSI*) was held in conjunction with the annual National Hydrogen Association on March 1. Over 100 students from the Nysmith School from Virginia and the Heights School from Maryland attended the full-day event. A live science show, formerly the *Dr. Bob Show,* featuring Jon Hurwitch and his crew from Sentech, Inc. was the highlight of the morning session. During the morning, Dr. Keller demonstrated *Red Thunder*, the remote control fuel cell vehicle, and students built a fuel cell model from everyday materials. Dr. Peter Lehman demonstrated the Schatz fuel cell at lunch. The afternoon consisted of rotations between the *Dr. Bob Laboratory*, the *Learning Center* (hydrogen and fuel cell exhibits for students) and the NHA trade show. The show closed with a career panel, *Career Opportunities of a Lifetime.* A press release announcing development of the *Clean Corridor Curriculum* was prepared for distribution by the NHA before and during the annual conference.

The other live science show is scheduled for May 23 at a local Washington area middle school.

- *Creation of curriculum safety review process for laboratories and demonstrations with support of NHA*

As an adjunct to the technical review, laboratories and demonstrations were reviewed separately for classroom safety. From this exercise a 3 category safety review process evolved. The purpose of the safety review process is to determine whether a laboratory or demonstration is "safe" for classroom use. If a particular laboratory or demonstration is deemed to present no safety hazards for classroom use, it is accepted as is. If it is deemed to have safety hazards, either modifications are proposed to ensure its safe use in the classroom by students or a recommendation are made to use the laboratory as a teacher demonstration only. If use as a teacher demonstration is still deemed inappropriate for safety purposes, a recommendation can then be made either to remove the laboratory/demonstration or use it only as a "virtual" demonstration, on film or CD ROM.

### *Other Outreach and Promotion*

- *National Science Teachers' Association Annual Conference – Exhibition and Speaking*

M.R.S. exhibited at the National Science Teachers' Association (NSTA) Annual Conference from April 6-9. This is the most important trade NSTA show, attracting upwards of 25,000 educators each year. The M.R.S. exhibition included: a curriculum workshop with a demonstration of *Red Thunder*, the remote control fuel cell car; use of the DOE funded Sentech exhibit *The Evolution of Energy;* the curricula*;* promotional material on the Sentech CD ROM *Mission* $H_2$*;* and demonstration of a reversible fuel cell by Eco-Soul. M.R.S developed special curriculum announcements for this important trade show.

Neither Sentech nor Eco-Soul had Hydrogen Program funding to support this event. However, in the spirit of collaboration intended to better position the Hydrogen Program's products, M.R.S. invited Sentech (and Eco-Soul) to exhibit.

- *Biannual ChemEd Conference, Annual Maryland Association of Science Teachers' (MAST) Conference, semi-annual MAST Road show, Harford County Teachers In-Service Training*

These speaking engagements afforded M.R.S. the opportunity to build awareness about our instructional materials in the education community. It also provided an opportunity to train teachers and recruit field test participation.

- *Published articles on hydrogen outreach education in NHA News*

The NHA published an article an M.R.S. Education Outreach article in the fall 1999 issue and another M.R.S. article on the *Secondary School Invitational* for its April publication. These

articles spread news of hydrogen education outreach activities throughout the hydrogen community.

- *2nd Annual Lake Tahoe Fuel Cell Conference and Canadian Fuel Cell Conference (not DOE funded)*

These opportunities permitted M.R.S. to expose the greater hydrogen energy community – a primary "affinity" marketing group -- to the existence of the curriculum and its collateral products. The Annual Lake Tahoe Fuel Cell Conference was held in the fall. The P.I. also spoke on the marketing of hydrogen education at the May Canadian Hydrogen Conference. No HIP funds were used in either effort. Rather, they were supported by M.R.S. cost-share.

- Participated in Marketing Panel at 10th Annual Canadian Hydrogen Association Meeting

  The M.R.S. presentation on the Marketing Panel was well received. The Canadians initiated discussions about possible use of the curricula and cooperation in that aspect of the Hydrogen Education Outreach effort.

- *Acquired domain rights to web addresses for use in promoting/distributing hydrogen outreach products (not DOE funded)*

M.R.S. purchased the rights to the following domain names: hydrogen education.org; hydrogen education.com; hyed.org and hyed.com. These were acquired in anticipation of construction of a web site for promotion and distribution of the curriculum and collateral products. The web site is a cornerstone of the promotion strategy for our products.

- *Initial development of marketing strategy*

Thinking about distribution channels (web and print) for the curricula and collateral products is an ongoing process. The NSTA conference offered opportunities to explore general marketing approaches and specific distribution channels. Importantly, preliminary contacts were made with several potential publishers.

Product branding was key to initial development of a marketing strategy. After market research the name HOPE (Hydrogen Outreach Programming for Education) emerged as the best possible brand name for our hydrogen education outreach products. The curricula themselves will be renamed to reflect their science content and facilitate promotion and distribution.

As previously discussed, conference and speaking engagements offered important opportunities to build awareness about our instructional materials in the hydrogen and renewable energy communities. The community is viewed as a set of affinity groups, some of which are expected to become partners in the marketing effort. For instance,
The Florida Solar Energy Center (FSEC) has made an offer to promote and distribute the instructional materials. Likewise, the National Fuel Cell Research at University of California Irvine has made a similar offer. The California Fuel Cell Partnership is expected to issue formal statements of support for the curriculum soon.

## Impact of Current Results

### *Instructional materials*

The high school version 1.0 of the *Clean Corridor Curriculum* is now available for field test and inspection. The field test of the beta version curriculum entailed 3,000 student contact hours with 300 students. Assuming a minimum of 50 teachers complete the 12 hour classroom requirement, the formal 2000 field test will entail a minimum of 9,000 contact hours with 1,500 students.

The technical review of the middle school curriculum should be complete by the beginning of FY 2001. The middle school field test framework anticipates 9,000 student contact hours in the 2000/2001 field test.

### *Films*

*The Pollution Solution* and *Beakman's World: Beakman on Hydrogen* will be complete soon. They will be assembled with the middle school curriculum for field-testing and with the high school curriculum for distribution. On completion, *Dr. Bob* will be broadcast on cable TV.

### *Teacher contacts*

This year's HIP activities included personal contact with 350+ teachers; the NSTA exhibit had an audience of 25,000 educators.

### *Live Science Show Student contact*

This year's estimate for live science show contact is 400 middle school students

### *Publisher contacts*

Preliminary meetings with over a dozen publishers

### *Mailing Lists*

The contacts made at various shows and conferences will be used to develop customized, targeted mailing lists for use in marketing and promotion.

## Objectives for next year:

Next year's objectives encompass three major themes: completion of product development, product dissemination and enhancement of live science shows. These objectives expand on current year objectives. Next year's specific objectives are, as follows:

- to complete product development of core curriculum products
- to perform field test and evaluation of the middle school curriculum in support of product development
- to participate in industry meetings and develop supporting communications that inform the education markets and greater hydrogen industry about our curricula and collateral products while encouraging their adoption and use

- to develop and implement a product distribution strategy, supported by a mixed-media promotion strategy that features internet use

## Plans for next year

Plans for next year consists of tasks related the three objective areas: completion of product development in preparation for dissemination; create and begin execution of a marketing strategy for the HOPE products; and produce live science shows.

### *Task 1 Completion of product development in preparation for dissemination*

- Revise high school curriculum using field test results, adding material on renewable energy
- Field-test middle school curriculum, subsequently revise as indicated
- Add value to the curricula while emphasizing safety through development of CD Rom of virtual experiments as well as acquisition and use of reversible fuel cell kit for classroom demonstration (funding permitting)
- Brand instructional materials as HOPE (Hydrogen Outreach Programming for Education) products

### *Task 2 Create and begin execution of a marketing strategy that addresses all relevant aspects of product, promotion, place and price*

- Develop and implement strategy to market and distribute curricula and collateral products, including selection of a print publication channel
- Design a supporting public relations strategy that ensures state of the art internet-based promotion
- Hold industry meetings to promote awareness, preference and adoption of HOPE products among decision-makers and teachers in education markets, and key players in hydrogen and related industries, funding permitting

### *Task 3 Produce Live Science Shows*

- Continue to produce the DOE/NHA *Secondary School Invitational* local middle school live science show in conjunction with Sentech and historical collaborators
- Create the *SuperSecondary* Science Show with professional talent, funding permitting

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## References


American Association for the Advancement of Science. 1993. *Benchmarks for Science Literacy: Project 2061,* New York, New York. Oxford University Press.

Cannon, James. *Harnessing Hydrogen. The Key to Sustainable Transportation*.

Carol D. Perkins Vocational Education Act of 1984. Pub. L. 88-210 (1984). STAT 98-2435 (1984).

Carol D. Perkins Vocational and Applied Technology Education Act Amendments of 1990. Pub. L. No. 202-392. Stat 104-753 (1990).

The Clean Air Amendments of 1990. Pub. L. No. 101-549. STAT 104-2399 (1990).

The Energy Policy Act of 1990. Pub. L. 102-486. Section 2026.

Thomas, Sharon and Zalbowitz, Marcia. 2000. *Fuel Cells Green Power*. Los Alamos, New Mexico: Los Alamos National Laboratory.

Hearkenen, Henry et al. *Chemistry in the Community.* Dubuque, Iowa. Kendall-Hunt Publishing Company.

The Hydrogen Future Act of 1996. Pub. L. 104-271.

International Technology Education Association. 1996. *Technology for All Americans: A Rationale and Structure for the Study of Technology*. Reston, Virginia. International Education Association.

Kotler, Philip. *Marketing Management*. 1997. Upper Saddle River, NJ. Prentice Hall.

Los Angeles Unified School District: Board of Education. 1997. *Draft Interim Guidelines for Instruction: Secondary School Curriculum: Science*. Los Angeles, California.

The Matsunaga Hydrogen Research, Development and Demonstration Act of 1990. Pub. L. No. 101-566. Section 102.

National Academy of Sciences. 1992. *Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base*. Washington, D.C. National Academy of Sciences.

National Council for Teachers of Mathematics. 1997. Mathematics: An Introduction to the NCTM Standards. Reston, Virginia. National Council for Teachers of Mathematics.

National Council for Teachers of Mathematics, 1997. Mathematics: Making a Living, Making a Life. Reston, VA. National Council for Teachers of Mathematics.

National Research Council. 1996. National Science Education Standards. Washington, D.C. National Academy Press.

National Science Foundation. 1997. *ChemQuest: Chemistry for the Information Age: A Technology-Rich High School Chemistry Curriculum on CD ROM*. Washington, D.C. National Science Foundation.

MacKenzie, James J. 1994. *The Keys to the Car. Electric and Hydrogen Vehicles for the 21st Century*. The World Resources Institute.

M.R.S. Enterprises. *Clean Corridor Curriculum*. 1999. U.S. DOE Contract No. DE-FG01-EE35109.

Office of Technology Assessment. 1996. *Changing by Degrees: Steps to Reduce Greenhouse Gases* (OTA-0-482). Washington, D.C. Office of Technology Assessment.

President's Committee of Advisors on Science & Technology 1997. Report to the President on the Use of Technology to Strengthen K-12 Education in the United States. Washington D.C. President's Committee of Advisors on Science and Technology.

Ronkainen, M.R. and I.A. Czinkota. *International Marketing* – Fifth Edition. 1997. Orlando, FL. Harcourt Brace College Publishers.

Rocky Mountain Institute. *Green Development*. 1998. New York: John Wiley & Sons.

Sentech, Inc. 1997 Mission $H_2$ CD ROM. Bethesda, MD 20814.

Gordon, Deborah for Union of Concerned Scientists. 1991. *Steering a New Course.* Cambridge, MA. Union of Concerned Scientists.

U.S. Department of Energy. Office of Conservation and Renewable Energy. 1992. Hydrogen Program Plan FY1993-FY1997. Golden, CO. National Renewable Energy Laboratory.

U.S. Department of Energy. Office of Policy, Planning and Analysis. 1990. *The Potential of Renewable Energy: An Interlaboratory White Paper*, Golden, CO. Solar Energy Research Institute.

U.S. Department of Labor. 1991. What Work Requires of Schools. Washington, D.C. U.S. Government Printing Office.