

Wired: An Introduction to the 4-H Electric Series

Jeffrey L. Schiano and Claudia C. Mincemoyer
Department of Electrical Engineering/Agricultural and Extension Education
The Pennsylvania State University, University Park, PA 16802

Abstract

The Penn State Cooperative Extension Service (4-H) and the Department of Electrical Engineering are developing an electrical science and technology program that will be available to Pennsylvania 4-H youths, ranging in age from 8 to 19 years old, through local 4-H clubs and 4-H programs in local public schools. The specific aims of the program are to: 1) develop a series of hands-on activities that introduce youths to basic concepts of electrical science and technology, 2) foster a natural curiosity regarding electrical science and technology in youths, motivating their study of science and math, and 3) develop important life skills. A key component of the program is the generation of an Internet resource that provides a repository of low cost projects with detailed assembly instructions and background material, information on careers in electrical science and technology, and links to other relevant Internet resources. We present an overview of the program by describing some of the projects and discussing the logistics of recruiting and assisting adult leaders.

Challenges

Despite the significant impact of electrical science and technology during the last century, very few people have an understanding of basic electrical concepts. This observation even holds for many students entering the electrical engineering program at Penn State University. We are addressing two challenges that lie in the way of introducing youths to electrical science and technology. The first challenge is to find an effective vehicle for delivering the program to as many youths as possible. The second challenge is to develop a program that will capture and hold a youth's attention long enough to spark an interest in the material.

The Delivery Vehicle

The 4-H system implements science-based programs using the non-formal educational delivery system, Cooperative Extension, which is an effective and widely replicable alternative to teacher-led science-based educational experiences^{1,2}. Cooperative Extension (CE) Educators, also known as

county agents, are trained educators employed by the Cooperative Extension Service as part of the land-grant university located in each state within the United States. There are 67 counties in Pennsylvania with over 250 CE Educators. CE Educators recruit and train over 12,000 adult volunteer leaders who serve approximately 119,000 Pennsylvania 4-H youths who range in age from 8 to 19 years old.

Projects are the most common venue for information dissemination that occurs through several types of 4-H programs and clubs. Youth in schools participate in 4-H via 4-H school enrichment programs managed by CE Educators. Youth in communities participate in 4-H through community and project clubs. 4-H community clubs are comprised of youth and adults from a community who participate in one or more 4-H projects. Their interests are varied and they may participate in several 4-H projects throughout the year. Volunteers and youth who are interested in specific areas of study can form 4-H project clubs. For example, a group of young people may be interested in rocketry and aerospace topics. An adult volunteer with an interest in this area agrees to serve as their leader and guide them through the 4-H project. Each project consists of a sequential, developmentally appropriate set of learning activities, usually in the form of manuals or project books. A helper's guide accompanies each project to assist leaders in working with and understanding youth, to familiarize them with the project topic, and to provide detailed instructions for project implementation.

The Current 4-H Electricity Program

Although the national 4-H program currently offers curricula for electricity, last year only .625% of the Pennsylvania 4-H youths were involved in projects relating to electrical science and technology. In comparison, during the same period, about 5% of the Pennsylvania 4-H youths were involved with other programs in engineering sciences, such as rocketry. Feedback from adult leaders and CE Educators regarding the existing electricity curricula suggests several steps for increasing youth involvement. First, provide access to a repository of electricity projects suitable for different age and knowledge levels. Second, supply adult leaders with systematic instructions and background information, particularly for those with a non-technical background. Third, give adult leaders access to an expert who could clarify concepts or provide additional information. Fourth, generate project lists for county fairs.

One cannot overstate the importance of the fourth step: developing project lists for county fairs. The task of completing a project for competitive awards is a strong motivating factor, and youths are more likely to devote time to projects that capture their interest. As an example, Figure 1 shows two sets of 4-H projects on display at a fair in Pennsylvania in 2000. The number of rocket entries far outweighs the three projects related to electricity indicating that youths find the construction and launching of a model rocket far more appealing than wiring three light bulbs in parallel or building a switch using two nails and a paper clip. This leads us to the second challenge: designing a program that captures the imagination and enthusiasm of the youths.

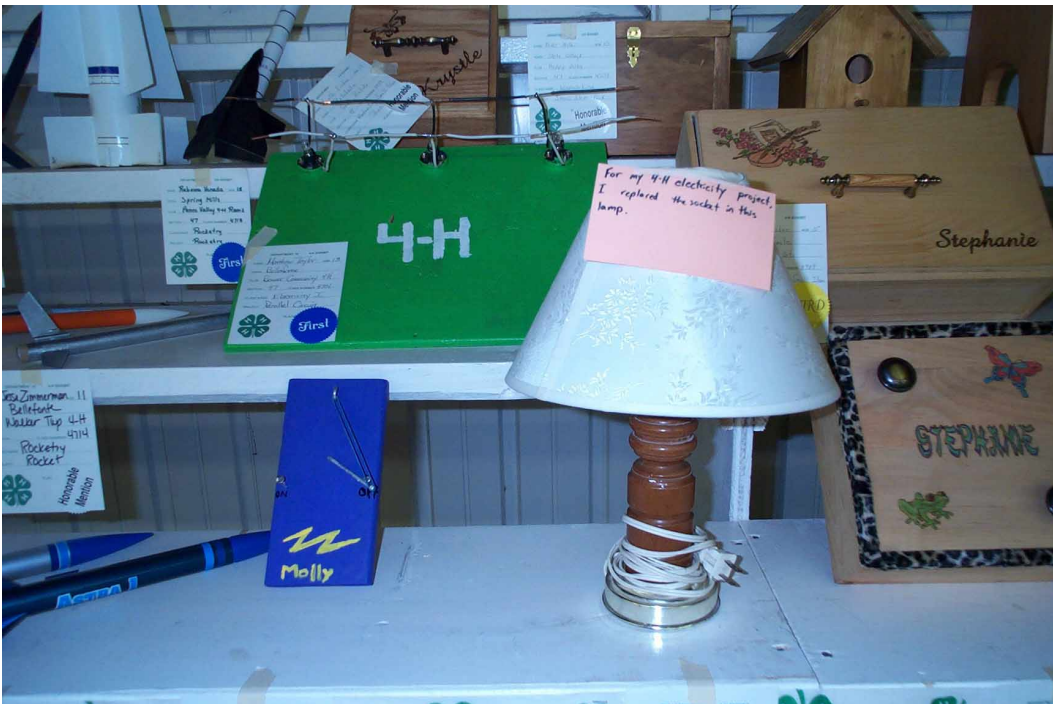


Figure 1: 4-H exhibits at a Pennsylvania fair.

The New 4-H Electricity Program

We are developing a new program during 2001 whose goal is to substantially increase the number of Pennsylvania 4-H youths who participate in the electrical science and technology program. The specific aims of the program are to: 1) develop a series of hands-on activities that introduce youths to basic concepts of electrical science and technology, 2) foster a natural curiosity regarding electrical science and technology in youths, motivating their study of science and math, and 3) develop important life skills. This effort will utilize existing 4-H curricula, generate new Internet-based resources, provide training for youth leaders, and maintain an inventory of reusable resources including electrical instrumentation, books, and videos that can be shared by 4-H clubs.

The strategy for achieving the specified aims is fourfold:

- 1. Directly Involve an Electrical Engineering Faculty Member**

The first author is directly involved and responsible for implementing each aspect of the proposed implementation strategy. These responsibilities include developing a repository of projects for the web page, providing yearly training sessions for CE Educators, answering questions posed by CE Educators and adult leaders via electronic mail, and creating project lists for county and state fairs.

- 2. Generate and Maintain an Internet Resource**

The Internet provides a direct conduit between the first author and the adult leaders and youths. The web page includes: 1) a repository of low cost projects with detailed instructions and background information; 2) information on careers in electrical science and technology; and 3) links to other relevant Internet resources.

- 3. Offer Semiannual Training Sessions for CE Educators**

The Pennsylvania 4-H system currently offers yearly training sessions at the Penn State University Park Campus for CE Educators. We will instruct a session on the proposed electrical science and technology program at least twice a year.

- 4. Assemble and Distribute Resource Kits to CE Educators**

The high cost of materials can potentially limit accessibility to the electrical science and technology program. For this reason, we are assembling low-cost resource kits containing electrical instrumentation, books, and videos that are available to 4-H volunteers through their local county office.

A key component of the strategy is the generation of a series of projects that will capture the attention of youths. We do not underestimate the difficulty of this task, and will rely on feedback from youths and adult leaders to determine the direction in which project lists will evolve. As a starting point we are developing two series of projects: one that leads to the construction of an AM radio, and another that leads a robotic vehicle driven by nitinol wire. As examples, Figure 2 (A) shows a sample AM radio receiver while Figure 2(B) shows a set of butterfly wings whose motion is driven by a single nitinol wire driven a by a simple electronic timer circuit.

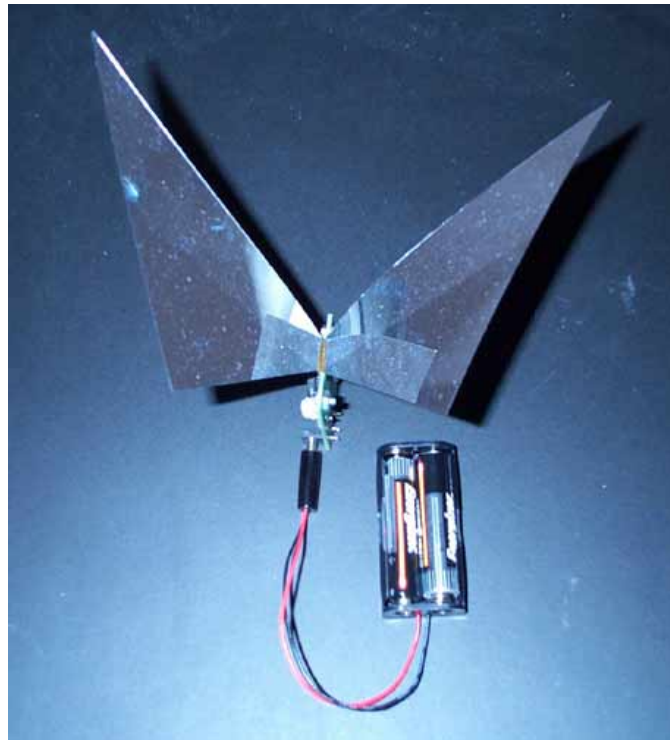
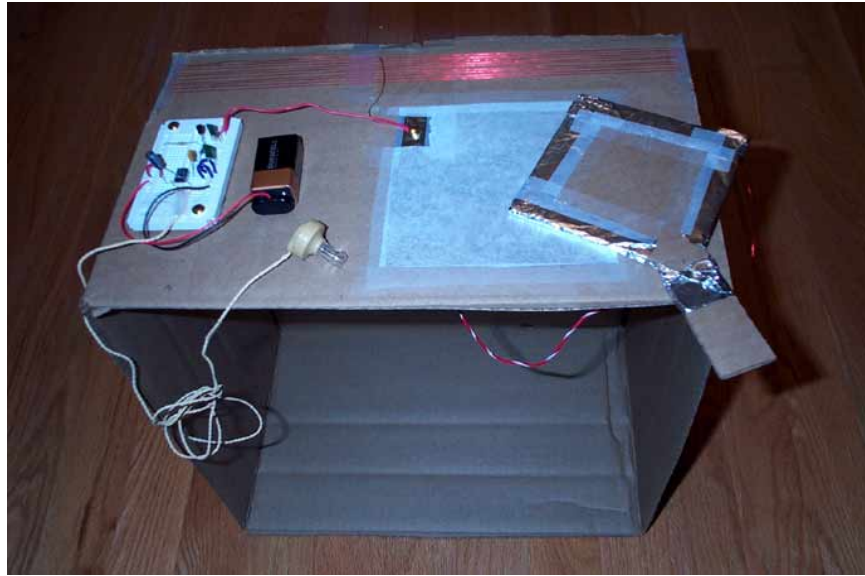


Figure 2: Prototype AM radio and robotic project for 4-H youths.

Projects require youths to maintain a laboratory notebook and will challenge youths by requiring them to perform simple experiments in order to answer questions. The projects also introduce design concepts, for example, how to systematically vary a parameter to achieve a desired performance under specified constraints. Each project emphasizes a particular area of technology so that youths can make a connection between their project and a specific electrical technology area.

We have just recently started our project and are in the process of generating the project web page and preparing for a training session for CE educators in March 2001. The first author is working with a local 4-H club this spring to determine if the projects are of a suitable level and are of interest to the youths. Future objectives include distributing resource kits to CE Educators across the state of Pennsylvania for use with 4-H volunteers, generating a multi-media display and series of hands-on activities for advertising the electrical science and technology program at county and state fairs, developing additional project areas, and creating a list of projects that youths can complete and enter for competition at county and state fairs.

Program Evaluation

Several different forms of evaluation will determine the extent to which the program goals are met. Our initial efforts focus on evaluating the in-service training of CE educators. Using a post-, then a pre-evaluation method, the CE educators will indicate their level of knowledge of the project areas before and after training, their perceived capability to introduce these projects to volunteers and 4-H youths, and their ability to link the science, math, engineering and technology concepts to everyday life.

The next phase of evaluation addresses program outcomes. Formative measures will assess the level of interest in the project (number of youth participating), suggestions for improving project delivery by volunteers, ease of use for youths and volunteers, level of parental involvement, challenges and successes encountered during project implementation, and future needs of this target population.

A major outreach and training component of this project is the development of a web site with electricity related resources, projects, activities, and relevant links. As the web site is accessible by extension educators, 4-H volunteers, parents and youth, it provides a convenient means for assessing the program. In addition to documenting the access rate, an on-line evaluation provides feedback regarding the projects and web site information. Evaluative data will include demographics and informative evaluation measures such as suggestions for improvement, requests for additional information, difficulties encountered, and ease of navigating through the site.

Outreach and 4-H recruitment activities at state and community events such as the Pennsylvania State Agricultural Progress Days, the Pennsylvania State Farm Show, 4-H State Achievement Days, and local county fairs and expositions provide additional assessment data. Evaluative data will include

exhibit usage data, the number of youth receiving 4-H recruitment information, the number of youths entering electricity projects for competition, and the number of printed materials distributed at these events.

Bibliography

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JEFFREY L. SCHIANO

Jeffrey L. Schiano is an associate professor in the Department of Electrical Engineering at The Pennsylvania State University. He earned his B.S.E.E. degree at Carnegie Mellon University with university honors in 1983, and the M.S.E.E. and Ph.D. degrees from the University of Illinois at Urbana-Champaign in 1985 and 1991, respectively. He has previously developed an electrical science and technology program entitled *Shocks, Shorts and Shenanigans* for students 10 to 12 years of age in conjunction with a local children's museum. He also instructs high school students for a two-week period each summer in the High School Student Intern Program (HSSIP) in Engineering and Technology sponsored by the Office of Naval Research and The Penn State Applied Research Laboratory.

CLAUDIA C. MINCEMOYER

Dr. Claudia Mincemoyer is an assistant professor in Agricultural and Extension Education, and has experience developing curricula and programs at both the community and state levels. She instructs extension faculty and staff in the areas of program development, developing age-appropriate activities and curricula, and life skill development and evaluation. She serves on many curriculum design teams and consults with other outreach faculty regarding project development and evaluation. Dr. Mincemoyer is also a member of the national steering committee for the 4-H Cooperative Curriculum System.