# GOOD YEAR BOOKS

## *Sample Pages*

Sample pages from this product are provided for evaluation purposes. The entire product is available for purchase at www.socialstudies.com or www.goodyearbooks.com

To browse eBook titles, visit
http://www.goodyearbooks.com/ebooks.html

To learn more about eBooks, visit our help page at
http://www.goodyearbooks.com/ebookshelp.html

For questions, please e-mail access@goodyearbooks.com

## *Free E-mail Newsletter—Sign up Today!*

To learn about new eBook and print titles, professional development resources, and catalogs in the mail, sign up for our monthly e-mail newsletter at
http://www.goodyearbooks.com/newsletter/

### *For more information:*

10200 Jefferson Blvd., Box 802, Culver City, CA 90232
Call: 800-421-4246 • Fax: 800-944-5432 (U.S. and Canada)
Call: 310-839-2436 • Fax: 310-839-2249 (International)

# Science Fair Handbook

## *The Complete Guide for Teachers and Parents*


Anthony D. Fredericks
*and* Isaac Asimov

Illustrations by
Phyllis Disher Fredericks

A GOOD YEAR BOOK™

GOOD YEAR BOOKS
Culver City, California

To Walt Dudley – for his warm friendship, and his work with the Pacific Tsunami Museum in preserving the stories of the past while educating a new generation.

—A.D.F.

**Good Year Books**
are available for most basic curriculum subjects plus many enrichment areas.
For more Good Year Books, contact your local bookseller or educational dealer.
For a complete catalog with information about all Good Year Books, please contact:

**Good Year Books**
10200 Jefferson Boulevard
Culver City, CA 90232-0802
www.goodyearbooks.com

Book Design: Elaine Lopez
Cover Design: Dan Miedaner
Design Manager: M. Jane Heelan
Editor: Leslie Hann
Executive Editor: Judith Adams



ISBN 978-1-59647-029-3
ISBN-eBook 978-1-59647-210-5



GOOD YEAR BOOKS

A GOOD YEAR BOOK™

2 3 4 5 6 7 8 9 ML 09 08 07 06 05 04

# Contents

# Acknowledgments

Authors, like scientists, are dependent on others to guide their investigations, support their creativity, and sustain their endeavors. Several people were involved in the shape and direction of this book.

To Chris Jennison, who brought the two authors together for the first edition of this book, an eternal note of gratitude is extended. Chris is an "author's editor," one who nurtures and supports writers in countless ways from initial concept to published book.

Three educators who unselfishly contributed their ideas and materials deserve special thanks and appreciation: Mike Misko of the Catasauqua (PA.) Area School District, Jim McKinney of the Southern York County (PA.) School District, and Nat Harmon of the Dallastown (PA.) Area School District.

A special note of gratitude is extended to the scores of teachers from Hawaii to Maine who contributed their ideas in telephone conversations and E-mail messages. A resounding cheer is offered to the dozens of teachers around the United States who opened their classroom doors to share the joy, magic, and excitement of science fairs.

Most important, great thanks and appreciation are extended to the many students who were interviewed and observed throughout the creation of this book.

Finally, it is hoped that a new generation of young scientists will be the ultimate benefactors of the energy and dedication of the teachers, students, and colleagues who contributed to this book. That will be the finest acknowledgment of all!

# About the Revised Edition

When *The Complete Science Fair Handbook* was first published in 1990, we were not prepared for the overwhelming and enthusiastic response it received from thousands of teachers across the country. Teachers from urban, suburban, and rural schools used the book to share the excitement of science fairs with their students. Conversations with educators in school districts all over the United States indicated to us that a rich vein had been tapped—one that could invigorate both the teaching and learning of science.

Thousands of teachers confirmed our belief that fun, exciting, and easy-to-do science fairs could enhance an inquiry-based approach to science education.

Since the book was first published, science education has changed dramatically. The new National Science Education Standards, mind-boggling new Web sites, and a reconfiguration of science curricula across the country are contributing to a transformation that is taking place in thousands of schools and classrooms. This revised edition builds on these exciting changes, offering ideas, strategies, and meaningful opportunities to bring science alive for students through a classroom or school science fair. It includes a new chapter on the science standards and lists relevant Web sites. Throughout the book, an icon directs readers to especially helpful Web sites listed with other resources in Chapter 15. Although the Web sites were current as of the writing of this book, with the ever-evolving nature of the Internet, some sites may change, others may be eliminated, and new ones will be added.

The untimely death of Isaac Asimov in 1992 created an enormous void in the scientific community. I have missed his counsel, support, and encouragement, but can assure readers that his unwavering philosophy and commitment to science education still permeate these pages.

The emphasis of this book is on the processes of learning. Here teachers and parents will discover an endless variety of creative learning possibilities. Students will find a cornucopia of mind-expanding, concept-building, and real-world experiences that will reshape their perceptions of what science is as well as what it can be.

Anthony D. Fredericks

# The Point of Science Fairs

"The United States is, of all nations on Earth, the most technologically advanced."

But what do we mean when we say that? The phrase "the United States" is in many ways an abstraction. The United States is a region on the map, and it is also a region on the Earth's surface. It is a stretch of land with mountains and plains, rivers and deserts. It is a body of history and tradition, of laws and social custom. Yet all these things are empty of meaning if that is all that exists. So far, I have described only the background, the scenery of the play, the binding of the book. What we need, in addition, is the foreground, the actors of the play, the words in the book.

What the United States really is, more than anything else, is its population, the people that make it up, the people whose muscle and mind have formed, developed, and improved the nation over the generations and made out of what was once a wilderness, a mighty land that is the most technologically advanced on Earth.

But this means that it is the *American people* who are the most technologically advanced on Earth. Without our scientists, our engineers, our technologists, our construction workers, our skilled handlers of machinery, we could not maintain the technological superiority we possess. And that would mean we could not maintain our prosperity, our high standards of living, nor the strength we require to preserve our liberties and free way of life in a world that, for the most part, lacks all these things.

What must we do to preserve this technological advancement of our people? It would be foolish to concentrate on adult Americans, since they, for better or worse, have found their niches. They have received their education and chosen their work and social functions, and we must accept them as they are.

It is, rather, the children, who have not yet been educated, who have not yet chosen their work and social functions, on whom we must concentrate, for it is on them that we must rely to continue the technological advancement we need so much.

This is all the more so because the adult population is with us only temporarily. The decades pass, and our adults move into retirement. They

are succeeded by the children, now grown up. Even before retirement, adults gradually find themselves out of touch with a technology that is rapidly improving and changing, while the children, growing up in that changed world, are at home in it.

It comes to this, then. If we are to keep the United States what it has been, and what it is now, we must concentrate on our children, for they are our greatest resource—our *only* resource in a way, for they will make all other resources possible.

And since it is our great technological expertise that keeps us comfortable and powerful, that means that our children must be well educated, well directed, well trained, in the direction that counts most—in the understanding of science and technology.

Of course, not everyone has the talent or the inclination to become a scientist or engineer, but those who do should surely receive the best education in that direction that is possible.

Again, we need to have millions of people who are skilled in other directions—farmers, entertainers, artists, writers, service workers—and yet even they should have some basic understanding of science and technology. After all, the important life-and-death decisions we as a nation must make concerning the ozone layer, acid rain, nuclear wastes, the greenhouse effect, pollution, all involve an understanding of science. Since the United States is a democracy, we must choose our own leaders and produce an enlightened public opinion that drives the leaders in appropriate directions. To know proper directions in which to encourage them to move, requires, these days, an understanding of science and technology, or democracy will prove a failure.

So if our technological advancement is to remain the best, the technological training of our youngsters must be the best, too. Unfortunately, there is general agreement that it isn't. We don't have enough teachers, especially teachers who understand science; and we don't have properly equipped schools. We must therefore strive to improve our educational procedures.

This can be done in many ways. Schools and teachers can use more money, more training, more equipment. In addition, however, there must be improvements in the very philosophy of teaching science.

It is insufficient merely to teach science as a block of facts, or as a set of rules. That can be unbearably dull for those who possess talent but lack a devouring fascination, for those who could do well if properly inspired, but

*only* if properly inspired. We need something more than the words of a teacher presented to the student and then reproduced by the student on the test paper. That is so easily resented at the start and forgotten at the last.

It would be useful to involve as many students as possible in the actual *practice* of science. The important thing about science is not the advanced conclusions that can only be reached and understood by virtuosos. It is not the endless bodies of facts already observed and established. It is a *process*, a way of thinking and acting. What counts is the *scientific method* that makes all else possible.

This is what youngsters should learn—how to think scientifically, how to reason logically, how to make observations, how to gather and organize them, how to perform experiments and draw conclusions, how to make an intelligent guess in advance as to what those conclusions might be, and see them supported or rejected or left undetermined. And they must learn the joy and pleasure of doing all this for the sake of learning and not for awards—just as a game of football can be exciting even if you don't win.

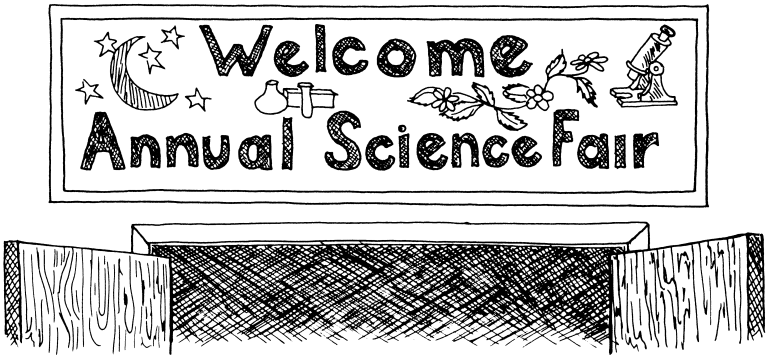
This is the point of science fairs—to engage the interest of youngsters—to introduce them to the scientific method—to encourage them to understand science and possibly to become a scientist or an engineer—to help maintain the scientific lead and the prosperity of our nation—and, perhaps, to transfer that prosperity to the whole world.

And for this reason, Anthony Fredericks and I have prepared this guide to science fairs.

Isaac Asimov
(1920–1992)

# A Note to Teachers

Science fairs have been part of the American education system since the early part of the twentieth century, offering students opportunities to display their scientific knowledge in engaging ways. Science fairs continue to offer students a showcase for scientific investigations and personal discoveries. They have been as much a part of the school curriculum as textbooks, standardized tests, and report cards.




The ultimate goal of a science fair is to encourage students to see how science works outside the classroom—how scientists investigate and learn about the world in which we live as well as worlds beyond ours. Today, more than ever, students need to understand and appreciate science: the scientific principles that influence their everyday lives as well as the scientific discoveries that add to their knowledge.

A science fair can be one of the most exciting parts of your classroom or school science curriculum. It can energize a science program and stimulate students' interest and participation. Unfortunately, a lack of resources for teachers and guidelines for students often result in lackluster participation and quickly designed projects.

If you tour a typical science fair you are likely to find:

- Too many volcanoes and solar system models; too little originality and planning
- A multitude of projects hastily constructed one or two nights before the science fair opened
- Projects that bear the unmistakable signature of Mom or Dad
- Poorly constructed projects that fall apart or collapse after a few days

- Projects that appeared last year, and the year before, and the year before that
- Frustrated parents and uninterested students
- A low level of participation by a single class or an entire school

This book is designed to be a convenient ready reference that helps teachers guide their students through the exciting and dynamic world of science. Its concept of effectiveness in a science fair is not based on the number of ribbons awarded and won. Rather, it places a premium on the processes of science—on helping to develop successful thinkers, not on trophies and awards. This book provides the ideas, strategies, and techniques you need to help students appreciate the world of science and their place in it—including a host of explorations and discoveries that will endure long after the last display has been taken down.

This book is a systematic guide to the design and development of a successful science fair. It is intended to stimulate higher levels of participation, well-designed and functional projects, an abundance of originality, and your students' deeper appreciation of how they can actively participate in the scientific world. In short, these ideas will stimulate:

- Greater student participation
- Greater creativity, originality, and overall quality
- Greater use of investigative skills and problem-solving activities
- A more positive attitude toward science

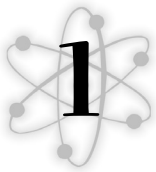
*Everything* you need to develop and promote a successful science fair is included. We suggest that you take time to read the different sections and to discuss them with your students. Let students know that taking part in the science fair is not only exciting in itself but will bring them a deeper appreciation of scientific processes and procedures.

As you discuss the different sections of this book with your students, invite their comments. Give them a chance to contribute their ideas to the science fair and you'll be guaranteeing their motivation throughout the entire event. Above all, make it clear to them that participation and involvement—not ribbons and trophies—are the crucial elements of the fair.

The ideas and strategies in this book are offered as suggestions, not as absolutes. We encourage you to make additions, subtractions, and changes according to the needs of *your* science fair. You may find it useful to duplicate these pages so that students and parents can use them as your

science fair progresses from plan to reality. You, your students, and your students' parents will find valuable ideas garnered from science fairs throughout the country—procedures to ensure the success of any science fair.

The projects, strategies, and formats presented here are designed to give your students a fresh, exciting perspective on the scientific world. Their participation in a carefully crafted science fair can be their starting point for self-initiated investigations into the world around them. More important, this book and your science fair offer your students an enjoyable and worthwhile look at the wonders of science—a look that can last well beyond their projects and their school days.



# 1 The National Science Education Standards and Science Fairs

In response to a growing concern about the state of science education in the United States, hundreds of teachers, scientists, science educators, and other experts worked together to outline the necessary ingredients for achieving scientific literacy.

This intensive examination resulted in the National Science Education Standards. The standards are based on the premise that science is an active process—that learning science is something that students do, not something that is done to them. Blending the ideas of "science as process" and "science as inquiry," the standards encourage a "hands-on, minds-on" approach. This approach helps students develop an understanding of science by combining scientific knowledge with reasoning and thinking skills.

Rather than a curriculum, the standards provide an outline for the development of science instruction. They are organized into six broad categories:

- Standards for science teaching
- Standards for professional development for teachers of science
- Standards for assessment in science
- Standards for science content
- Standards for science education programs
- Standards for science education systems

This section describes how science fairs support each of the standards in the *teaching* and *content* categories.