FOREWORD

In a world increasingly dependent on technology—where new ideas and tools pervade our personal and civic lives and where important choices hinge on our knowledge of how things and people work—the imperative that all students should learn to understand and use technology well should be obvious. Yet in the American curriculum, still overstuffed with tradition and trivia, there is little room in the day for learning and teaching about important ideas from technology and very few resources for educators who want to engage their students in learning for the 21st century.

Stuff That Works! is a groundbreaking curriculum. It provides a set of carefully chosen and designed activities that will engage elementary students with the core ideas and processes of technology (or engineering, if you prefer). Elementary school is the ideal place to begin learning about technology. It is a time in students' development when they are ready and eager to take on concrete rather than abstract ideas. The concepts and skills presented in ***Stuff That Works!*** will support more advanced learning in mathematics, science, and technology as students move up through the grades.

But there is much more to ***Stuff That Works!*** than a set of activities. As a matter of fact, the activities make up less than a third of the pages. ***Stuff That Works!*** also includes helpful resources for the teacher such as clear discussions of the important ideas and skills from technology that their students should be learning; stories of how the materials have been used in real classrooms; suggestions for outside reading; guidance for assessing how well their students are doing; and tips on implementation. I hope teachers will take time to make full use of these valuable resources as they use ***Stuff That Works!*** If they do, they can help their students take the first, critical steps towards technological literacy and success in and beyond school.

George D. Nelson, Director
American Association for the Advancement of Science (AAAS) Project 2061

INTRODUCTION

What Is Technology?

Stuff That Works! *Packaging and Other Structures* will introduce you to a novel and very engaging approach to the study of technology at the elementary school level. In education today, the word *technology* is most often associated with learning how to use computers, and that is certainly important. But learning how to use a particular kind of technology is not the same thing as learning how and why the technology works. Children learn about computers as *users* rather than as students of how computers work or of how to design them. In fact, computer analysis and design require technical knowledge that is beyond most adults, let alone elementary-aged children. Fortunately, there are many other examples of technology that are much more accessible than computers and that present many of the same issues as computers and other "high-tech" devices.

The purpose of technology is to solve practical problems by means of devices, systems, procedures, and environments that improve people's lives in one way or another. Understood this way, a computer is no more an example of technology than...

- the cardboard box it was shipped in,
- the arrangement of the computer and its peripherals on the table,
- the symbol next to the printer's ON/OFF switch,
- or the ballpoint pen the printer replaces as a writing device.

A box, a plan for the use of table space, an ON/OFF symbol, and a pen are examples of technologies you and your students will explore in this and the other ***Stuff That Works!*** guides.

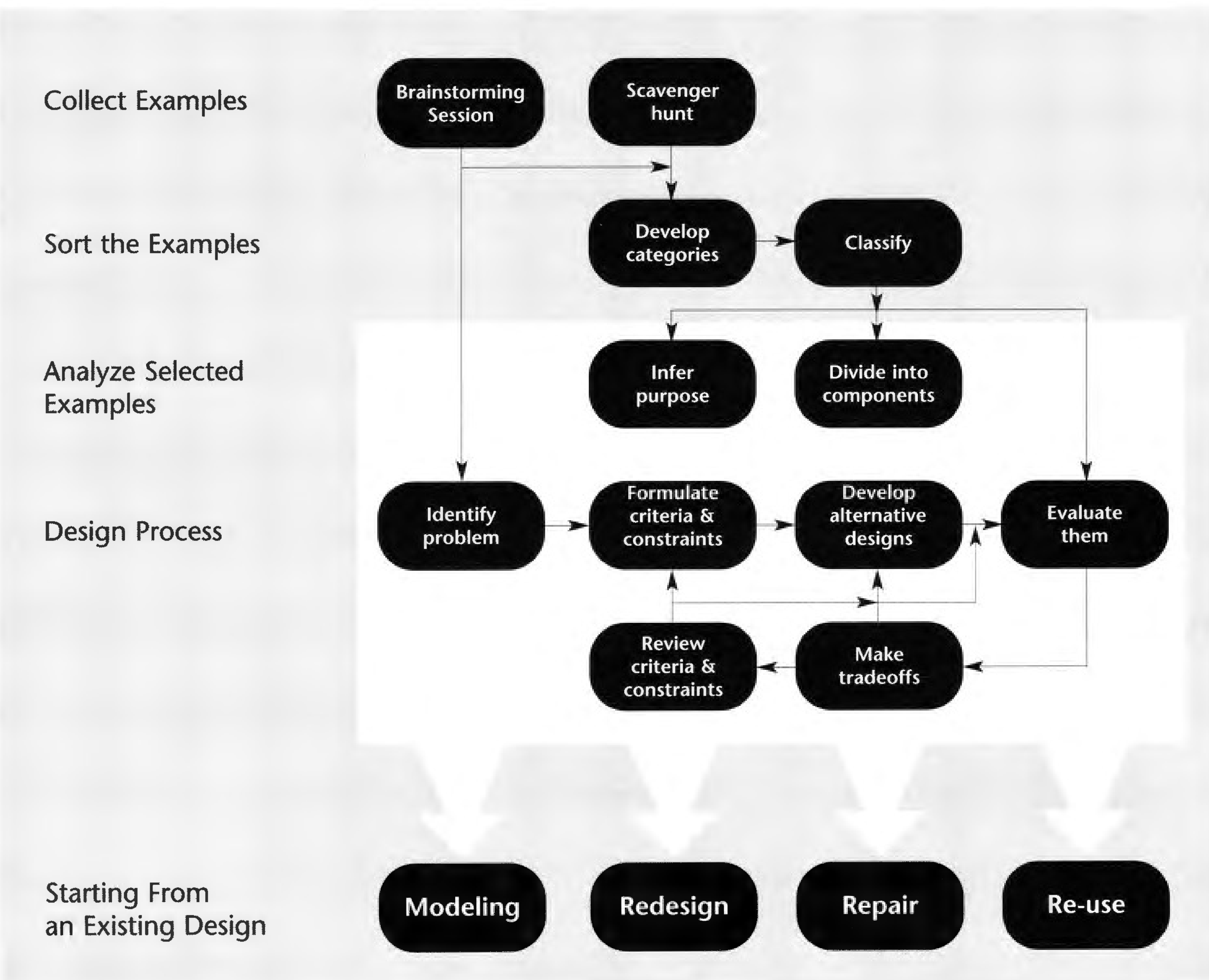
The ***Stuff That Works!*** approach is based on artifacts and systems that are all around us and available for free or at very low cost. You need not be a technical guru or rich in resources to engage yourself and your students in technology. The materials needed for *Packaging and Other Structures* are nearly all discarded items such as empty bottles, boxes, and bags; cushioning materials such as Styrofoam and bubble wrap, plus a few common school supplies such as blocks, tape, and glue.

Why Study Technology in Elementary School?

Below is a graphic summary of the process of "doing" technology as we present it in this book. The study of technology challenges students to identify and solve problems, build understanding, develop and apply competence and knowledge in a variety of processes and content areas, including science, mathematics, language arts, and social interaction.

The teachers who field-tested these materials underscored that these activities helped their students to:

- observe and describe phenomena in detail;
- explore real objects and situations by creating models and other representations;
- identify salient aspects of problems;
- solve authentic problems;
- use evidence-based reasoning;
- apply the scientific method;
- ask thoughtful questions (beyond the yes or no variety);
- communicate in oral, written, and graphic form;
- collaborate effectively with others.



Educational Goals for *Packaging and Other Structures*

Packaging and Other Structures explores how bags, boxes, cartons, and bottles work to contain, protect, dispense, and display products. All kinds of packaging materials are examples of structures, which are technologies designed to support mechanical loads. The content and activities in this book will help you to meet the following educational goals:

- Develop fundamental themes of systems, material properties, spatial relationships, and trade-offs;
- Motivate and illustrate concepts of force, structure, load and failure; compression, tension, and shear; repair, redesign, and re-use;
- Demystify common artifacts, and by extension, technology in general;
- Develop process skills in observation, classification, generalization, prediction, control of variables, design, and evaluation;
- Provide rich opportunities for group work;
- Develop environmental awareness.

How This Guide Is Organized

Each ***Stuff That Works!*** guide is organized into the following chapters.

Chapter 1. *Appetizers* suggests some things you can do for yourself, to become familiar with the topic. You can do these activities at home, using only found materials. They will help you to recognize some of the technology that is all around you, and offer ways of making sense of it.

Chapter 2. *Concepts* develops the main ideas that can be taught for and through the topic. These include ideas from science, math, social studies, and art, as well as technology. It also reviews what is known from relevant cognitive research.

Chapter 3. *Activities* contains a variety of classroom projects and units related to the topic, including those referred to in Chapter 4. Each activity includes prerequisites, goals, skills and concepts; materials, references to standards and teacher tips; and sample worksheets.

Chapter 4. *Stories* presents teachers' narratives about what happened in their own classrooms. Their accounts include photos, samples of children's work and children's dialog. Commentary by project staff connects the teachers' accounts with the concepts developed in Chapter 2.

Chapter 5. *Resources* provides a framework supporting the implementation of the activities. It includes an annotated bibliography of children's literature and a discussion of assessment principles and opportunities.

Chapter 6. *About Standards* shows how the activities and ideas in this book address national standards in technology, science, math, and English language arts (ELA).

How to Use This Guide

Different teachers will obviously come to this book with different needs and objectives. However, regardless of your background, instructional approach, and curricular goals, *we strongly recommend that you begin with Chapter 1, "Appetizers."* There is simply no better way to become acquainted with a topic and to understand what your students will be facing than to try out some of the ideas and activities for yourself. Chapter 1 guides you through that process.

The content and approach presented in *Packaging and Other Structures* are based on the premise that processes of design are central to the practice of technology, just as inquiry is the central activity of science. While no two design problems are the same, there are some features that characterize any design task:

- It should solve a problem of some sort.
- It must have more than one possible solution.
- There must be an effort to test the design.

A problem is like a trigger that initiates a design process. Often the problem is not well-formulated, a vague kind of "wouldn't it be nice if ..." In making the problem more specific, it is often helpful to list some criteria the design must address. In trying to satisfy these criteria, the designer is never completely free to do whatever he or she wants. There are always constraints, which could involve cost, safety, ease of use, and a host of other considerations.

Packaging and Other Structures presents a number of activities that include elements of design, but are not full-scale design projects. These elements of design are modeling, redesign, repair, and re-use.

• **Modeling** requires both a very close look at the original design and its modification to incorporate the use of different materials. A lot can be learned by observing how the substitution of materials affects the operation of the model. Modeling is only one kind of design activity that starts with an existing solution.

• **Redesign** starts with an existing but inadequate design. It involves analyzing the weaknesses of the original design and then figuring out how to correct them.

• **Repair** is a variant of redesign. It takes place after the existing design has already failed. Redesign and repair projects often use new materials or techniques to accomplish the original purpose.

• **Re-use** is a complementary kind of design activity where the original materials are used for a new purpose.

The concepts of redesign, repair, and re-use are of particular importance in a society that has been widely criticized for its wasteful practices. These three concepts are considerably more accessible than the more widely advanced notion of recycling, whose full implementation requires expensive equipment and specialized technical knowledge.

There is no one way to do design. It is a non-linear, messy process that typically begins with very incomplete information. Additional criteria become apparent as the design is implemented and tested. New constraints appear that were not originally evident. It is often necessary to backtrack and revise the original specifications. Such a messy process may seem contrary to the work you usually expect to see happening in your classroom. However, we encourage you to embrace the messiness! It will justify itself by improving students' competence in reasoning, problem-solving, and ability to communicate not only what they are doing but also why they are doing it and what results they expect.

A Brief History of *Stuff That Works!*

The guides in the ***Stuff That Works!*** series were developed through collaboration among three different kinds of educators:

- Two college professors, one from the School of Education of City College of the City University of New York, and the other from the City College School of Engineering;
- Two educational researchers from the Center for Children and Technology of the Education Development Center (CCT/ EDC);
- Thirty New York City elementary educators who work in the South Bronx, Harlem, and Washington Heights.

This last group included science specialists, early childhood educators, special education teachers, a math specialist, a language arts specialist, and regular classroom teachers from grades two through seven. In teaching experience, they ranged from first-year teachers to veterans with more than 20 years in the classroom.

During the 1997-98 and 1998-99 academic years, the teachers participated in workshops that engaged them in sample activities and also provided opportunities for sharing and discussion of classroom experiences. The workshop activities then became the basis for classroom implementation.

The teachers were encouraged to modify the workshop activities and extend them in accordance with their own teaching situations, their ideas, and their children's interests.

The teachers, project staff, and the research team collaborated to develop a format for documenting classroom outcomes in the form of portfolios. These portfolios included the following items:

- lesson worksheets describing the activities and units implemented in the classroom, including materials used, teacher tips and strategies, and assessment methods;
- narrative descriptions of what actually happened in the classroom;
- samples of students' work, including writing, maps and drawings, and dialogue; and
- the teachers' own reflections on the activities.

The lesson worksheets became the basis for the **Activities** (Chapter 3) of each guide. The narratives, samples of student work, and teacher reflections formed the core of the **Stories** (Chapter 4). At the end of the two years of curriculum development and pilot testing, the project produced five guides in draft form.

During the 1999-2000 academic year, the five draft guides were field-tested at five sites, including two in New York City, one suburban New York site, and one each in Michigan and Nevada. To prepare for the field tests, two staff developers from each site attended a one-week summer institute, to familiarize themselves with the guides and engage in sample workshop activities. During the subsequent academic year, the staff developers carried out workshops at their home sites to introduce the guides to teachers in their regions. These workshops lasted from two to three hours per topic. From among the workshop participants, the staff developers recruited teachers to field-test the ***Stuff That Works!*** activities in their own classrooms and to evaluate the guides. Data from these field tests then became the basis for major revisions that are reflected in the current versions of all five guides.